ECSS Virtual Congress 2021

BOOK OF ABSTRACTS

Editors:
Dela, F., Helge, J.W., Müller, E., Tsolakidis, E.

26th Annual Congress of the

EUROPEAN COLLEGE OF SPORT SCIENCE

8th - 10th September 2021

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Welcome

Welcome to the 26th Annual Congress of the ECSS

Dear Valued Member of the ECSS Sport Science Community,

Welcome to the 26th ECSS Annual Congress, 2021!

Over the last year, the global COVID-19 pandemic has disrupted our normal life and has caused major suffering and economic problems all over the world.

In Science, both research and teaching as well as scientific meetings, has taken a heavy toll and we are all slowly recovering. For the ECSS the Executive and Scientific Boards have attempted to maneuver within these difficult conditions. In late October 2020, we managed to successfully run our 25th ECSS Anniversary Congress as a full virtual congress. For this year 2021, we have after very careful consideration, and detailed discussions, again decided to organize a full virtual 26th annual congress.

This year the scientific program offers a broad interdisciplinary spectrum of current research in sport science, where the major highlights will be the live streams of our three plenary sessions, more than 25 invited symposia, and not least the Young Investigators Award (YIA) presentations. Furthermore, we will provide access to a huge amount of video-streamed oral, traditional poster and e-poster presentations.

As a benefit, the entire 26th ECSS Congress program and presentations will be made available for you, via your personal ECSS account, until the end of December 2021.

Based on our very positive experience of the 25th ECSS anniversary virtual congress, we are confident that the science presented and discussed at this year's 26th annual ECSS congress will be of very high quality and will stimulate discussion and interaction.

We sincerely hope that you will enjoy the 26th ECSS annual Congress and we look forward to seeing you in person in beautiful Seville in 2022, where we all hope that the pandemic has finally succumbed.

Jørn Wulff Helge, ECSS President
Flemming Dela, Chair ECSS Scientific Board
Elias Tsolakidis, ECSS Technical Director

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Live Sessions: Wednesday, September 8, 2021

08:30 - 10:00

IS-AP01 Individualized Recovery Management for Athletes - sponsored by adidas

INDIVIDUALIZED RECOVERY MANAGEMENT FOR ATHLETES – RESULTS FROM A NINE-YEAR MULTICENTER RESEARCH PROGRAM

WIEWELHOVE, T.

RUHR UNIVERSITY BOCHUM, FACULTY OF SPORT SCIENCE

Numerous studies have already investigated the accuracy of different markers (e.g., blood markers, practical performance tests, muscle contractile markers, heart rate-based markers, and/or subjective markers) for the assessment of fatigue and recovery as well as the effects of different recovery interventions (e.g., active recovery, cryotherapy, hydrotherapy, massage, compressive clothing) on fatigue markers following various training and competition loads.
Based on the results, several practical recommendations for the recovery management in sport have been derived. However, new scientific issues also arose, which in recent years were investigated in a multicenter recovery-related research program entitled “Optimization of Training and Competition: Management of Recovery in Elite Sports”. These include the aspects of individualization, timing, and dosage of recovery interventions, as well as their combined use and interference with training adaptation.

INDIVIDUALIZED MONITORING OF RECOVERY IN SPORT

SKORSKI, S.

UNIVERSITY OF SAARLAND

Training load and competition frequency are steadily increasing and performance differences between race winners and “also-ran” are becoming more marginal. Consequently, athletes and coaches face the difficult task of maximizing training load and adaptation whilst avoiding insufficient recovery. Assessing the current fatigue status of an individual athlete is a critical task to fine-tune training prescriptions and includes load monitoring and recovery interventions. The “gold-standard” of fatigue in competitive athletes is a decline in discipline-specific performance. However, requiring maximum effort, this parameter is not suitable for repeated routine assessment. Therefore, other indicators of fatigue and recovery have been investigated including a wide range of blood-borne parameters, psychological questionnaires, or the assessment of autonomous nervous system balance (heart rate and heart rate variability). Surprisingly, no parameters have been established with adequate sensitivity and reliability for the monitoring of fatigue and recovery during athletic training cycles. This is possible due to a large interindividual variability impeding the diagnostic accuracy of fatigue indicators known to date. Thus, individualizing load monitoring e.g., by using individual reference ranges and joint consideration of selected parameters in multivariate classifiers might be a solution to this dilemma.

TRAINING IN THE HEAT - WILL POST-EXERCISE COOLING ENHANCE RECOVERY OR INTERFERE WITH ADAPTATION?

IHSAN, M.

SINGAPORE SPORTS INSTITUTE

Undertaking dedicated training sessions in the heat (i.e., heat acclimation/acclimatisation; HA) is the most important countermeasure athletes can adopt to safeguard their health and performance when competing in such environments. However, it is important for practitioners to recognise that repeated daily exposures to heat stress is a physiologically demanding endeavour. Prolonged heat exposure is characterised by increased thermal and cardiovascular strain, augmented glycogen utilisation and fluid losses, increased hormonal responses (i.e., increased cortisol and catecholamine secretion), cytokinaemia and endotoxaemia, which may
result in sleep and gastrointestinal disturbances, augmented lethargy and delayed physical recovery. It is therefore imperative to manage recovery when training in the heat, as accumulated fatigue may impact on the overall success of the HA programme, as well as interfere with the quality of other training sessions. Post-exercise cooling is a common strategy utilised by athletes in an attempt to ameliorate hyperthermia-induced fatigue. Whilst seemingly appropriate for acute recovery, the longer-term influence of post-exercise cooling on heat adaptation warrants further exploration. This is on the premise that the fundamental requisite for an effective HA involves substantial and repeated increases in body temperatures, skin blood and sweating; all of which are likely to be expeditiously reduced following cooling.
The aim of this symposia session is to discuss whether heat training and post-exercise cooling can be utilized in synergy to maximize recovery and training quality when undertaking heat training.

OP-AP10 Football and Rugby

PEAK FAT OXIDATION RATE INCREASES FOLLOWING A PRE-SEASON TRAINING PERIOD IN SUB-ELITE FOOTBALL PLAYERS

RØMER, T., THUNESTVEDT HANSEN, M., LANGE, K., LUNDGREEN PETERSEN, M., IBH, A., DELA, F., WULFF HELGE, J.

UNIVERSITY OF COPENHAGEN

INTRODUCTION:
The relationship between substrate utilization and exercise performance has been studied extensively during the past century. The peak fat oxidation rate (PFO) has been associated with performance in ultra-endurance sports, whereas performance in intermittent team sports is more dependent on glycolytic and anaerobic energy sources. Interestingly, recent studies reported high PFO in football players compared

to values reported in endurance athletes. This implies that PFO may be a physiological variable with importance to football performance, especially during low-intensity running periods of a football match. Whether PFO varies during a football season and if PFO increases following football training remains to be investigated. This study aimed to investigate if pre-season training increases PFO in sub-elite football players and whether PFO is related to football specific running performance.
METHODS:
47 sub-elite football players (age: 24±1 years, mean±95%CI) reported to the laboratory following an overnight fast the week prior to winter pre-season initiation. Body composition was determined by a DXA scan (weight: 78.3±2.1 kg; fat percentage: 14.9±1.1%; fat free mass (FFM): 66.4±1.7 kg). Subsequently, a resting venous blood sample was obtained and a graded exercise test on a treadmill was performed for determination of peak oxygen consumption (V̇O2peak: 57.0±1.4 ml/min/kg), PFO (0.65±0.06 g/min or 9.8±0.8 mg/kg FFM/min) and the intensity eliciting PFO (Fatmax: 46±3% of V̇O2peak). 15 players were semi-professional and repeated all testing following an 8-week supervised pre-season training period (3-4 sessions/week). These players performed the Yo-Yo intermittent recovery level 2 test (YYIR-2) before and after the training period. The remaining players were amateurs and hence unable to train due to COVID-19 restrictions.
RESULTS:
PFO increased by 26±14% (Student's paired t-test: p=0.003) in both absolute measures and relative to FFM, whereas Fatmax did not change following training (p=0.168). A 7±2% and 32±10% increase was observed following training for V̇O2peak and YYIR-2 performance, respectively.
The relative changes in PFO and V̇O2peak following training were not correlated (r2=0.01; p=0.709), but the changes in V̇O2peak were significantly correlated with the changes in YYIR-2 performance (r2=0.45; p=0.012). Pre-season training did not affect weight (p=0.648), but fat percentage decreased by 4±3% (p=0.012) and FFM tended to increase from 68.1±2.9 kg to 69.0±2.9 kg (p=0.071). No differences were observed in resting plasma free fatty acids or hemoglobin concentrations between test days (p=0.603 and p=0.247, respectively).
CONCLUSION:
An 8-week pre-season training period significantly increased V̇O2peak and PFO but not Fatmax in sub-elite football players. The increases in PFO and V̇O2peak were not correlated and only changes in V̇O2peak were significantly associated with the increased football specific intermittent running performance observed following pre-season training.

DOMINANCE AND BALL CONDITION AFFECT INSTEP KICKING KINEMATICS IN EXPERIENCED SOCCER PLAYERS

BERTOZZI, F.1, RABELLO, R.1, GUIZZETTI, C.1, STILLAVATO, S.2, GALLI, M.2,3, ZAGO, M.2,3, SFORZA, C.1

1 UNIVERSITÀ DEGLI STUDI DI MILANO, MILAN, ITALY; 2 POLITECNICO DI MILANO, MILAN, ITALY; 3 E4SPORT LAB, POLITECNICO DI MILANO, ITALY

INTRODUCTION:
Kicking is a critical soccer skill that requires optimal intersegmental coordination (1). When performing instep kicks in an attempt to score, players seek to generate high foot and, consequently, ball velocities (1). During games, players kick moving balls with both feet, involving timing and prospective control (2). Studies have recently demonstrated that the support limb also plays a fundamental role in kicking efficacy (3). However, previous analyses have mainly focused on evaluating the dominant limb biomechanics of stationary ball kicks. Therefore, this study aimed to compare kicking and support limbs kinematics when kicking a stationary or a moving ball with both dominant and non-dominant feet.
METHODS:
18 male soccer players (age: 21±2 yrs, BMI: 22.4±1.9 kg/m2, exp: 14±2 yrs, practices/wk: 3±1) volunteered for the study. They performed maximal instep kicks (size-5 ball) with both limbs in five conditions: stationary (STAT) or approaching at about 2 m/s anteriorly (ANT), posteriorly (POST), from kicking foot's lateral (LAT) and medial side (MED). Players approached the kicking point from 2 meters away at 45° and aimed at a target (1.2 m2) in a net 3 meters away. The 3D position of 43 reflective markers was obtained with an optoelectronic motion analysis system (BTS, Italy). A biomechanical model was developed in Visual 3D (C-Motion, USA) to obtain hip, knee, and ankle sagittal plane kinematics for kicking (KH, KK, KA) and support limbs (SH, SK, SA). The kicking foot Center of Mass (CoM) velocity (FV) and the feet CoMs distance (FD) were processed. All variables were computed upon ball impact. Repeated measures two-way ANOVA was implemented to compare the main factors (ball condition, limb dominance) and interaction effects, with α=0.05 (SPSS Inc., USA).
RESULTS:
A significant limb dominance effect was found for FV ($P<0.001$), higher for dominant limb, and for KH ($P= 0.009$), KA ($P= 0.016$), and SK ($P=0.005$), that were more flexed in non-dominant limb.
A significant ball condition effect was found for all the analyzed variables. After Bonferroni correction for multiple comparisons, FD was higher in MED than in the other conditions ($P<0.001$); KH was more flexed in LAT than in MED ($P=0.008$); SH was more flexed in MED than in POST ($P=0.034$) and STILL ($P=0.009$); SK was more flexed in MED than in the other conditions ($P<0.001$). No interaction effects were found.
CONCLUSION:
The study reveals that kicking and support limb kinematics vary depending on the limb used and the ball approach, especially in the MED condition. Moreover, FV, a critical efficacy determinant in instep kicking (1), is also affected by ball condition and limb dominance. These novel findings suggest that players should practice the kicking technique in several conditions to improve their readiness in the games ever-changing circumstances.
REFERENCES
1) Sinclair et al., Eur J Sport Sci, 2014
2) Lees & Rahnama, Sports Biomech, 2013
3) Augustus et al., J Sports Sci, 2017

CORRELATIONS BETWEEN MATURATION, ANTHROPOMETRIC MEASURES AND HAMSTRING MUSCLE ARCHITECTURE IN ELITE ACADEMY SOCCER PLAYERS

BROWN, M., GUILHEM, G., LACOME, M., HADER, K., BUCHHEIT, M.

PARIS SAINT GERMAIN FOOTBALL CLUB, FRENCH INSTITUTE OF SPORT (INSEP), KITMAN LABS

INTRODUCTION:
Muscle architecture has been associated with motor performance (1) and exposure to muscle strain injuries (2). The influence anthropometric measures may have on hamstring eccentric strength and muscle architecture is rarely considered (3). The main aim of this study was

to evaluate the ability of using anthropometric data to estimate hamstring muscle architecture involved in motor performance. A secondary aim was to provide normative eccentric hamstring strength and muscle data from an elite French soccer academy and make between age-group and maturity offset comparisons.
METHODS:
Sixty male footballers (16.6±1.05yrs) from the U16 (15.3±0.4yrs), U17 (16.4±0.4yrs) and U19 (17.5±0.7yrs) teams of a French Ligue-1 soccer club were included in this study. Muscle architecture (fascicle length, pennation angle, muscle thickness) of the bicep femoris long head (BFlh) and semimembranosus (SM) muscles were measured in both legs using ultrasound. Knee flexor eccentric strength was assessed using the Nordic hamstring exercise within 1 week of the ultrasound scans using a Nordbord. Anthropometric measures [body mass (BM), height, sitting height, leg length and femoral length] were taken within 1 week of the scans. Variance of muscle architecture with team and peak height velocity (PHV) was analysed using one-way ANOVAs. Stepwise regressions were used to analyse relationships between anthropometric measures and muscle architecture. Significance was set at $p<0.05$. Effect sizes (ES) were used to determine the magnitude of differences using Hopkin's scale.
RESULTS:
There were no significant effects ($p>0.05$) of age group on muscle architecture measures. However, moderately greater BFlh muscle thickness was shown for the post-PHV group compared to the PHV group (ES±90%CL; 0.72±0.49). The effect of maturity offset on the other muscle architecture measures was unclear.
Hamstring strength shared a significant relationship with BM ($R2=0.316$).
BFlh and SM muscle thickness showed significant relationships with BM ($R2<0.376$). We found significant relationships for BFlh fascicle length compared with femoral length and leg length ($R2=0.119$). Moreover, SM pennation angle showed significant relationships with BM and femoral length ($R2<0.341$). R2 values for all measures were <0.376.
CONCLUSION:
These findings show musculoskeletal imaging (e.g. ultrasound) is required to accurately determine muscle architecture that is influenced by additional factors (e.g. training level). Although, our results confirmed previous findings that eccentric hamstring strength is directly influenced by BM. Therefore, allometric scaling is recommended to normalize these values (3). Finally, increases in maturity offset had moderate effects on BFlh muscle thickness suggesting BFlh post-PHV hypertrophy.
References:
1. Lieber et al. (2000)
2. Bourne et al. (2017)
3. Buchheit et al. (2016)

OVERALL AND SPECIFIC BURDEN OF INJURIES ACCORDING TO MATURITY STATUS AND TIMING: A TWO-DECADE STUDY WITH 110 GROWTH CURVES IN AN ELITE FOOTBALL ACADEMY

MONASTERIO, X.1,2, GIL, S.M.1, BIDAURRAZAGA LETONA, I.1, LEKUE, J.A.1,2, SANTISTEBAN, J.1,2, DIAZ BEITIA, G.1,2, LEE, D.3, ZUMETA, L.3, MARTIN GARETXANA, I.1,2, BIKANDI, E.2, LARRUSKAIN, J.2

1 UNIVERSITY OF THE BASQUE COUNTRY , LEIOA, SPAIN; 2 MEDICAL SERVICES, ATHLETIC CLUB, LEZAMA, SPAIN; 3 BASQUE CENTER FOR APPLIED MATHEMATICS, BILBAO, SPAIN.

INTRODUCTION:
Reducing injuries to youth players is vital to football academies, as injuries can negatively affect player development [1] and lead to long-term pathology in adulthood [2]. Maturation is a potential risk factor for football injuries, however, available data on this topic has provided limited evidence due to methodological limitations [3]. This study aimed to build on these limitations by using two decades of reliable longitudinal anthropometric measurements to model the growth curves of elite academy football players, which were used to estimate age at peak height velocity (PHV) and investigate how maturity status and timing are associated with overall and specific injury burden.
METHODS:
Injury and growth data were prospectively collected for twenty consecutive seasons (2000-2020) in a cohort of elite academy football players. Longitudinal height records for 110 individual players were fitted with the Super-Imposition by Translation and Rotation model to estimate age at PHV. Players were clustered according to maturity status (pre-, circa-, post-PHV, and adult) and timing (early, on-time, late). Overall and specific injury burden (days lost/player-season) and rate ratios for comparisons between groups were calculated.
RESULTS:
Pre-PHV players had 3.2-, 3.7-, and 5.5-times lower overall burden compared with circa-PHV, post-PHV, and adult players, respectively. Concerning specific injuries, growth-related injuries were more burdensome circa-PHV, while muscle and joint/ligament injuries had a higher impact post-PHV and in adults. Injuries in on-time maturers were twice more burdensome pre-PHV compared with late maturers, due to higher impact of growth-related injuries, anterior inferior iliac spine osteochondrosis and knee joint/ligament injuries. In adult players, however, injuries were less burdensome for early maturers than on-time and late maturers. Besides, joint/ligament injuries of adult late maturers were 4.5-times more burdensome than those of early maturers.
CONCLUSION:
Football academies should regularly assess the maturity status and timing of young football players, as the impact of injuries varies with maturation status and timing.
References:
1. Larruskain J et al. Injuries have a negative impact on player progression in an elite football academy. Science and Medicine in Football Under review: [02/03/2021].
2. Maffulli N et al. Long-term health outcomes of youth sports injuries. Br J Sports Med 2010;44:21–5.
3. Swain M et al. Relationship between growth, maturation and musculoskeletal conditions in adolescents: A systematic review. Br J Sports Med 2018;52:1246–52.

RELATIONSHIP BETWEEN TRAINING AND MATCH EXTERNAL LOAD IN RUGBY UNION: INSIGHTS INTO TACTICAL PERIODIZATION

HU, X.P.1,2, BOISBLUCHE, S.3, MAURELLI, O.4, PHILIPPE, K.5, XU, B.2, LI, S.C.2, PRIOUX, J.1,2

1 M2S LABORATORY; 2 SCHOOL OF PHYSICAL EDUCATION AND HEALTH; 3 RUGBY CLUB VANNES; 4 LABORATORY OF MUSCULAR DYNAMISM AND METABOLISM ; 5 LABORATORY OF MOVEMENT, BALANCE, PERFORMANCE AND HEALTH.

INTRODUCTION:
Strength and endurance are two main acquisition days in the concept of tactical periodization (TP)[1]. This approach originated in soccer but is also being used within the elite rugby union (RU)[2]. To date, no conclusive research has focused on investigating and describing RU training and match external load parameters with TP. Therefore, the aims of this study were (1) to quantify and compare the external load of a professional RU teams training days and matches with two types of TP weekly models and (2) to investigate the relationship between match external load and training sessions, for both strength and endurance days, using these two models.
METHODS:
Forty-two professional players (25.5±4.0 years old) participated in the study. Data collection was carried out during 12 × 1-wk microcycles (6-wk in model 1 and 6-wk in model 2). On-field load during the daily training sessions (training specificity categorization by model: strength day of model 1 = M1S, endurance day of model 1 = M1E, strength day of model 2 = M2S, endurance day of model 2 = M2E) and 12 matches of the 2020-2021 season were recorded using 10 Hz GPS and GLONASS technology (Vector X7, Catapult Sports®, Australia). The variables selected for analysis during the ball-in-play time were total distance (TD), high-speed running (HSR), sprint running (SR), very high-speed running distance (VHSR), average velocity (AV), maximal velocity (MV), and repeated high-intensity efforts (RHIE). Repeated measures analysis of variances and Student's t-test were used to analyse the differences between the two models. Spearman correlation coefficients assessed the relationships between training and match variables.
RESULTS:
Players performed significantly more TD (ES=0.34, p=0.026), HSR (ES=0.75, p<0.001), SR (ES=0.63, p<0.001), VHSR (ES=0.56, p<0.001), AV (ES=0.82, p<0.001), MV (ES=0.38, p=0.011), and RHIE (ES=0.41, p=0.007) in M1S than M2S. However, there was no significant difference, for external load, between endurance days and matches when using both models. Additionally, moderate to strong relationships between training and matches were found for all variables (p<0.001), except AV (r=0.19, p=0.79) in M1E. The match external load parameters were also significantly correlated (p<0.001) to M1S (r=0.62-0.84), M1E (r=0.60-0.82), M2S (r=0.59-0.69) and M2E (r=0.65-0.81).
CONCLUSION:
The results of this study suggest that differences exist between the two TP models when analysing strength days. This holds true for TD, HSR, SR, VHSR, AV, MV, and RHIE. In addition, most GPS training indexes, in both TP models, are related to external load in RU matches.

PRE-SEASON ENDURANCE-BASED SKILLS-SPECIFIC RUNNING LOADS AND THE EFFECTS ON CHANGES IN BODY COMPOSITION IN PROFESSIONAL AUSTRALIAN FOOTBALLERS: IMPLICATIONS FOR CONCURRENT TRAINING

RITCHIE, D., KEOGH, J., REABURN, P., BARTLETT, J.D.

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INTRODUCTION:
Concurrent training (CT) is the simultaneous completion of both endurance (ET) and resistance training (RT) modalities within a periodised training program and is utilised frequently by team sport practitioners around the globe. The varying daily training demands of team sport athletes, poses a major practical challenge to the planning of same day CT. Currently, there exists a paucity of research examining the effects of both high RT and ET volume over an extended training period (10 weeks) on key physical performance outcomes of body composition. Given the physical and intermittent requirements of professional team sport athletes, a primary focus when preparing athletes for competition is to develop a 'match ready' physique which is low in fat mass (FM) and high in lean muscle mass. As such, the aim of the present study was to examine the role of ET volume and intensity along with RT volume in modulating changes in fat free soft tissue mass (FFSTM) and FM in professional team sport athletes.
METHODS:
Forty-six professional AF athletes (mean ± SD: age, 22.8 ± 3.4 yr; height, 189 ± 7.2 cm; body mass, 86.9 ± 8.6 kg; professional training age, 5.9 ± 3.5 yr) participated in this 10.1 ± 1.3 wk pre-season study. The CT program consisted of 3 skill-specific endurance-based training sessions a week performed in the morning followed by a RT session in the afternoon. Weekly and cumulative training volumes of both endurance (Total Distance (TD) (m), Total High Speed Running (>15 km.h-1) (HSR) (m), distance above >75% and >85% (m) maximal velocity and mean running speed (m.min-1)) and resistance training (tonnage) were computed and body composition was assessed via dual-energy x-ray absorptiometry (DXA) at the beginning and end of their respective training periods. Quadratic regressions with interactions between concurrent training loads were used to assess changes in FFSTM and fat mass FM, as well as being adjusted for years of training experience and initial body composition (i.e., starting FFSTM and FM).
RESULTS:
Higher volumes of RT tonnage was associated with greater increases in total and lower body FFSTM. However, higher RT tonnage concomitant with higher TD and HSR was associated with less changes in total and lower body FFSTM. Distance covered above >75% and >85% maximal velocity had no effect on changes in FFSTM even when RT tonnage was high. Years of training experience had a significant effect on changes in FFSTM, whereby athletes with <4 years' experience had greater changes in FFSTM compared to athletes with >4 years' experience.
CONCLUSION:
Cumulative skills/endurance running loads negatively effect changes in FFSTM across a pre-season period which is further compounded by high volumes of RT. Together, these data indicate that both high ET and RT volumes concurrently may not lead to desired training adaptations. Collectively, these data can assist practitioners in the organisation and structure of a same day CT regime.

OP-PN09 Nutrition and supplements

INGESTING RAW EGGS TO SUPPORT MUSCLE RECONDITIONING: DID ROCKY GET IT RIGHT OR WRONG?

FUCHS, C.J., HERMANS, W.J.H., SMEETS, J.S.J., SENDEN, J.M., VAN KRANENBURG, J., GORISSEN, S.H.M., BURD, N.A., VERDIJK, L.B., VAN LOON, L.J.C.

MAASTRICHT UNIVERSITY MEDICAL CENTRE+

INTRODUCTION:
Protein is ingested during recovery from exercise to stimulate post-exercise muscle protein synthesis and, as such, to support muscle conditioning during exercise training. In the movie Rocky, Rocky Balboa ingested several raw eggs prior to his workout. However, previous research has suggested that raw eggs are not as effectively digested and absorbed when compared with boiled eggs, which would make them less appropriate to stimulate muscle protein synthesis. In this study we compared postprandial muscle protein synthesis rates after the ingestion of raw versus boiled eggs during recovery from exercise.
METHODS:
In a parallel study design, forty-five healthy, resistance trained young men (age: 24±3 y) were randomly assigned to ingest 5 raw eggs (~30 g protein), 5 boiled eggs (~30 g protein), or a control breakfast (~5 g protein) during recovery from a single session of whole-body resistance type exercise (at t= 0 h). Primed continuous L-[ring-13C6]-phenylalanine infusions were applied, with frequent collection of blood samples. Muscle biopsies were collected immediately after cessation of exercise (before food intake) and after 2 and 5 h of post-exercise recovery. A two-factor (time*treatment) repeated-measures ANOVA was performed for analyses of plasma amino acid concentrations and muscle protein synthesis rates. Cohen's effect size (d) was calculated for the differences in muscle protein synthesis rates between raw eggs vs control breakfast and boiled eggs vs control breakfast. Data are expressed as means±SD.
RESULTS:
Ingestion of eggs strongly increased plasma essential amino acid concentrations, with greater increases following ingestion of boiled compared with raw eggs (P<0.001). Muscle protein synthesis rates were significantly increased during the post-exercise period when compared with basal, post-absorptive values in all groups (P<0.001). Over the entire postprandial period, muscle protein synthesis rates were ~20% higher after ingesting raw eggs (0.067±0.021%·h-1; effect size (d): 0.63), and ~18% higher after ingesting boiled eggs (0.065±0.014%·h-1; effect size (d): 0.69) when compared to the control breakfast (0.056±0.014%·h-1), with no significant differences between groups (time X treatment interaction: P=0.077).
CONCLUSION:
The ingestion of 5 boiled eggs increases plasma essential amino acid concentrations to a greater extent than the ingestion of 5 raw eggs. However, post-exercise muscle protein synthesis rates do not differ after the ingestion of 5 raw or boiled eggs. Clearly, Rocky did not compromise the muscle conditioning response by not boiling his eggs.

VITAMIN D SUPPLEMENTATION AND ENHANCED DAIRY PROTEIN INTAKE DO NOT AFFECT GAIN IN LEAN MASS, MUSCLE STRENGTH, OR PHYSICAL PERFORMANCE IN HEALTHY 6-8-YEAR-OLD CHILDREN – THE D-PRO RANDOMIZED TRIAL

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INTRODUCTION:
There is a high prevalence of inadequate vitamin D status among children at Northern latitudes, especially during winter, and dairy consumption by children has in many countries waned in recent decades. In elderly, vitamin D deficiency has been suggested to negatively affect muscle protein turnover, contribute to proximal muscle weakness, and impair physical function. However, there is limited evidence for the impact of vitamin D on healthy children's muscle mass, strength, and function. Dairy protein intake has been associated with higher gain in lean mass (LM) in children, but the impact of high dairy protein intake on muscle strength is not elucidated. This study aimed to assess the separate and combined effects of vitamin D supplementation and high dairy protein intake on LM, muscle strength, and physical performance in 6-8-year-old children. We hypothesized that a combined positive effect would be observed on these outcomes.
METHODS:
In a 2×2-factorial, randomized trial, 200 healthy 6-8-year-old white, Danish children (55°N) were instructed to substitute 260 g/day dairy in their diet with high protein (HP, 10 g protein/100 g) or normal protein (NP, 3.5 g protein/100 g) yogurt and received blinded tablets with either 20 µg/day vitamin D3 (Minisun®) or placebo for 24 weeks during winter. We measured LM by dual-energy X-ray absorptiometry, maximal muscle strength by isometric leg press and handgrip, and physical performance by squat jump, long jump, and 30s sit-to-stand. In addition, physical activity was assessed by 7-day accelerometry.
RESULTS:
In total, 184 children (92%) completed the study. Baseline (mean±SD) serum 25-hydroxyvitamin D was 80.8±17.2 nmol/L, which increased to 88.7±17.6 nmol/L and decreased to 48.4±19.2 nmol/L in children randomized to vitamin D and placebo, respectively. Baseline protein intake was 15.5±2.4 E%, which increased to 18.4±3.4 E% with HP and persisted with NP (P<0.001 between groups). We observed no separate or combined effects of vitamin D supplementation and high dairy protein intake on LM, muscle strength, or physical performance measured in jump tests. While a significant interaction was observed on sit-to-stand (P=0.02), it attenuated (P=0.18) after adjusting for change in physical activity. As expected, the intervention elicited increases (P<0.001) in total LM, muscle strength as well as physical performance, irrespective of group. All groups became less physically active to a similar extent during the intervention (from baseline to endpoint, P<0.01), as anticipated when transitioning from summer to winter.
CONCLUSION:
Overall, vitamin D supplementation in a dose that prevents winter deficiency and high dairy protein intake did not affect changes in LM, muscle strength, or physical performance in healthy children. The trial was registered at clinicaltrials.gov as NCT03956732 as part of the D-pro trial and funded by Arla Food for Health.

CHEESE INGESTION INCREASES MUSCLE PROTEIN SYNTHESIS RATES BOTH AT REST AND DURING RECOVERY FROM EXERCISE IN HEALTHY, YOUNG MALES

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INTRODUCTION:
It has been well-established that ingestion of milk protein increases muscle protein synthesis rates both at rest and during recovery from exercise. As the food matrix in which protein is provided can strongly modulate post-prandial protein handling, it is important to study the muscle protein synthesis response to the ingestion of milk-derived whole-foods like cheese. Therefore, this study compared the impact of ingesting 30 g protein provided as milk protein or cheese on post-prandial plasma amino acid concentrations and muscle protein synthesis rates at rest and during recovery from exercise in vivo in young males.
METHODS:
In this randomized, parallel-group intervention trial, twenty healthy males ingested 30 g protein provided as milk protein (n=10) or cheese (n=10) following a unilateral bout of resistance-type exercise. Primed, continuous intravenous L-[ring-13C6]-phenylalanine infusions were combined with the collection of blood and muscle tissue samples to assess post-prandial plasma amino acid concentrations as well as post-absorptive and post-prandial muscle protein synthesis rates at rest and during recovery from exercise. Data were analyzed using repeated measures ANOVA with Time (basal vs post-prandial) and Leg (exercise vs rest; for muscle parameters) as within-, and Group (milk vs cheese) as between-subjects factors. Data represent means±SDs.
RESULTS:
Plasma total amino acid concentrations increased after protein ingestion (Time: P<0.001), with greater increases following milk protein when compared to cheese ingestion (Time*Group: P<0.001). In agreement, plasma amino acid availability (AUC) was 12.4% higher following milk when compared to cheese ingestion (P=0.003). Skeletal muscle protein synthesis rates increased following both milk protein and cheese ingestion from 0.034±0.008 to 0.056±0.010 %/h and 0.037±0.014 to 0.055±0.018 %/h at rest and from 0.030±0.008 to 0.063±0.009 %/h and 0.031±0.010 to 0.067±0.013 %/h following exercise, respectively (both Time: P<0.001), with no differences between groups (Time*Group: P=0.642 and P=0.662, respectively). Greater increases in muscle protein synthesis rates were observed in the exercised when compared to the rested leg (Time*Leg: P=0.002).
CONCLUSION:
Cheese ingestion increases muscle protein synthesis rates both at rest and during recovery from exercise. The post-prandial muscle protein synthetic response to the ingestion of milk protein or cheese does not differ when 30 g protein are ingested at rest or during recovery from exercise in healthy, young males.

THE ERGOGENICITY OF ACUTE CARNOSINE AND ANSERINE SUPPLEMENTATION: THE SEARCH FOR AN UNDERLYING MECHANISM

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INTRODUCTION:
Acutely ingesting carnosine and anserine was found to be ergogenic in maximal performances (1). Underlying mechanisms of the improvements are yet to be elucidated. Based on effects on peak power, along with the absence of improvements in antioxidant status or blood acidosis, two other properties of carnosine were tested. Neuromuscular potentiation, hypothesized based on the Severin phenomenon, and an effect on muscle blood flow were explored. This enhanced blood flow response could be anticipated if carnosine elicits a histaminergic signal. This will be assessed in a test where antihistamines are known to reduce muscle perfusion.
METHODS:
Two double-blinded, randomized crossover studies were conducted in healthy, active men.
In study A, 15 men performed 3x 5s maximal voluntary contractions (MVC) with electrical stimulation of the knee extensor muscles, followed by 5x 6s cycling sprints every 30s, on two occasions on which they ingested a placebo or 30mg/kg of carnosine and anserine. On the MVC plateau, a superimposed twitch was administered, followed by three relaxed twitches. The MVC and sprints were done before and 60min after supplementation. Plasma carnosine and anserine was measured with LCMS.
In study B, 8 men performed a high-intensity training, followed by 2hrs of femoral artery blood flow monitoring using Doppler-Ultrasound, on three occasions on which they ingested a placebo, 30mg/kg carnosine and anserine or a histamine H1 and H2 receptor blockade. The training consisted of 4x 4min cycling at respiratory compensation threshold and 3min at 90% gas exchange threshold.
RESULTS:
In study A, plasma carnosine and anserine increased by 37.8µM (p<0.001). The concentration positively correlated with peak power improvement during the cycling sprints (r=0.65; p=0.01), but not during MVCs (r=-0.22; p=0.44). However, no effects of supplementation on performance or electrostimulation parameters were found.
In study B, blood flow remained 20min above baseline in the placebo and 15min in the antihistamines condition. After ingesting carnosine and anserine, blood flow remained elevated for 25min. The incremental area under the curve decreased by 27% (p=0.05) with antihistamines but was not increased with carnosine and anserine (-5%; p=0.88) compared to placebo.
CONCLUSION:
We found that acutely ingesting 30mg/kg of carnosine and anserine increased plasma concentration without affecting voluntary or electrically-stimulated contraction parameters, pleading against neuromuscular potentiation as ergogenic mechanism. Second, while antihistamines reduced post-exercise hyperaemia, no opposite effect of carnosine and anserine was found, which does not support the hypothesis of histamine-induced muscle perfusion potentiation. The ergogenic mechanism of acute histidine-dipeptide supplementation therefore remains elusive.
(1)Blancquaert et al. (2021). Acute pre-exercise supplementation of combined carnosine and anserine enhances initial maximal power of Wingate tests in humans. J Appl Physiol.

CARBOHYDRATE REQUIREMENTS FOR STRENGTH TRAINING PERFORMANCE: A SYSTEMATIC REVIEW

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INTRODUCTION:
Diets with high carbohydrate intake can enhance endurance sports performance and is often recommended in various sports, including strength sports. However, the research examining the effects on strength training performance are unclear. It is therefore pertinent to systematically analyze the research on carbohydrate intakes for strength performance.
METHODS:
A systematic literature search was conducted in the PubMed, Google Scholar and Scielo databases. We included published trials where carbohydrate intake (including supplements) was manipulated between conditions, either acutely prior to dynamic strength training, or over the course of a strength training period (≥2 days). The outcomes were strength performance reported as dynamic maximal strength, maximal power or repetitions to failure.
RESULTS:
A total of 44 studies were included, 22 acute and 22 long-term studies. The sample included mostly young participants (25 ± 5 years old) with a mixed training status: sedentary or untrained (n = 4 studies), active (n = 5), strength-trained (n = 30) or athletes (n = 5). Carbohydrate supplements in the acute studies consisted of 0.16-1.5g/kg bodyweight (often 1g/kg bw), and all studies compared it to a non-caloric or lower energy content placebo group. For the longer-term experiments, study durations lasted from 48 hours to 3 months (average 5 weeks), and daily carbohydrate intakes ranged between 165-643 grams and 15-347 grams in the higher and lower carbohydrate group comparisons, respectively.
Performance was not affected by acute carbohydrate supplementation in 12 studies, enhanced in 8 studies and had a negative effect in 2 studies. Five of the 8 studies with acute performance enhancing effects were in a fasted state before carbohydrates ingestion, and 3 in a fed state. Interestingly, one study found that the performance-enhancing effects after a placebo-breakfast was similar to a carbohydrate breakfast. For the longer-term experiments, 2 studies that compared the carbohydrate condition to a lower energy- or to a non-specified energy intake group observed a performance enhancing effect of higher carbohydrate intakes, 1 study found a detrimental effect and 19 studies found no effect of carbohydrate intake.
CONCLUSION:
In sum, only 10 out of 44 studies observed a benefit of higher carbohydrate intakes. None of those were matched for energy intake between groups, and most acute studies used a fasted control group. Thus, one could speculate if the observed performance enhancing effects may be attributed to higher energy intakes, rather than carbohydrate intake per se. Additionally, there is evidence suggesting that the benefits of higher carbohydrate intakes may be placebo. In conclusion, individuals engaging in no exercise other than strength training may opt to determine their carbohydrate intake primarily based on other factors than performance, including personal preference.

OP-MH09 Ageing and frailty

LONGITUDINAL DECLINE IN RELATIVE SIT-TO-STAND POWER AND ITS ASSOCIATION WITH PHYSICAL PERFORMANCE DECLINE IN OLDER ADULTS.

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INTRODUCTION:
Relative muscle power has been demonstrated to be an essential concept in geriatrics due to its strong association with physical function, frailty and mortality and its more precipitous decline with age compared to strength. Relative muscle power can be easily assessed using the 5-rep sit-to-stand (STS) power test; however, no longitudinal investigation has examined the magnitude and major determinants of age-related relative STS power (RPOW) decline as well as its association with physical performance in older adults.
METHODS:
A total of 648 older adults (70.4±4.5 years; 74.8% women) from the EXERNET multicentre study completed the follow-up assessment (7.7±0.6 years) and were included in this investigation. Body mass index (BMI), legs skeletal muscle index (SMI) assessed by bioelectrical impedance analysis, and relative (normalized to body mass), allometric (normalized to height2) and specific (normalized to legs SMI) STS power produced during the 5-rep STS power test were recorded. Age-related declines in these variables were established according to previously reported cut-off points. Maximal gait speed (MGS), agility (AG) and cardiorespiratory fitness (CRF) were assessed by the 30-m walking test, timed-up-and-go test and 6-min walking test, respectively. Independent Student's t-test was used to assess differences between RPOW loss between sexes. Sex- and age-adjusted regression analyses were used to assess the relationship between RPOW loss and loss of physical performance.
RESULTS:
RPOW decreased in 81 (49.7%) men and 236 (48.7%) women. In these participants, RPOW declined -0.13 W·kg-1·year-1 in men and -0.11 W·kg-1·year-1 in women (both -3.5 %·year-1), with no significant differences between sexes ($p>0.05$). In 71 (87.7%) men and 186 (78.8%) women, RPOW losses were caused by losses in allometric STS power alone, in 3 (3.7%) men and 15 (6.4%) women they were caused by an increase in BMI alone, while both a decline in allometric STS power and an increase in BMI explained RPOW losses in 7 (8.6%) men and 35 (14.8%) women. Moreover, allometric STS power decreased due to a loss in specific STS power alone in 61 (75.3%) men and 182 (77.1%) women, due to a loss in legs SMI alone in 2 (2.5%) men and 3 (1.3%) women, and due to a combination of both in 18 (22.2%) men and 51 (21.6%) women. Finally, RPOW losses were associated with MGS and AG losses in men ($\beta=-0.33$; $\beta=-0.36$; all $p<0.05$) and MGS, AG and CRF losses in women ($\beta=-0.18$; $\beta=-0.23$; $\beta=-0.13$; all $p<0.05$), respectively.
CONCLUSION:
RPOW decreased similarly in men compared to women (3.5%·year-1) due to a decrease in allometric STS power, which in turn was mostly caused by a decrease in specific STS power, while increases in BMI and decreases in legs SMI contributed, respectively, to a lesser extent. In addition, the age-related loss of RPOW was associated with a reduction in physical performance, which strengthens the relevance of maintaining adequate levels of RPOW throughout old age.

SCREENING TOOLS TO EXPEDITE ASSESSMENT OF FRAILTY IN PEOPLE RECEIVING HAEMODIALYSIS: A DIAGNOSTIC ACCURACY STUDY

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INTRODUCTION:
Frailty is associated with multiple adverse outcomes in stage-5 chronic kidney disease (CKD-5) and upwards of one third of people receiving haemodialysis (HD) are frail. While many frailty screening methods are available in both uremic and non-uremic populations, their implementation in clinical settings is often challenged by time and resource constraints. In this study, we explored the diagnostic accuracy of time-efficient screening tools in people receiving HD.
METHODS:
A convenience sample of 76 people receiving HD [mean age=61.1 years (SD=14), 53.9% male] from three Renal Units were recruited for this cross-sectional study. Frailty was diagnosed by means of the Fried phenotype. Physical performance-based screening tools encompassed handgrip strength, 15-feet gait speed, timed up and go (TUG), and five-repetition sit to stand (STS-5) tests. In addition, participants completed the SF-36 Health Survey, the short-form international physical activity questionnaire and the Tinetti falls efficacy scale (FES) as further frailty-related measures. Outcome measures included the area under the curve (AUC), sensitivity, specificity, positive (PPV) and negative predictive values (NPV). The diagnostic performance of screening tools in assessing fall-risk was also investigated.
RESULTS:
Overall, 36.8% of participants were classified as frail. All the examined instruments could significantly discriminate frailty status in the study population. Gait speed [AUC=0.89 (95%CI: 0.81-0.98), sensitivity=75%, specificity=93%] and TUG [AUC=0.90 (95%CI: 0.80-0.99), sensitivity=89%, specificity=85%] exhibited the highest diagnostic accuracy. There was a significant difference in gait speed AUC (20%, p=0.013) between participants aged 65 years or older (n=36) and those under 65 years of age (n=40), with better discriminating performance in the younger sub-group. The Tinetti FES was the only instrument showing good diagnostic accuracy (AUCs≥0.80) for both frailty (sensitivity=82%, specificity=79%) and fall-risk (sensitivity=82%, specificity=71%) screening.
CONCLUSION:
This cross-sectional study revealed that time- and cost-efficient walking performance measures can accurately be used for frailty-screening purposes in people receiving HD. While self-selected gait speed had an excellent performance in people under 65 years of age, TUG may be a more suitable screening method for elderly patients (≥65 years). The Tinetti FES may be a clinically useful test when physical testing is not achievable.

THRESHOLDS AND CUT-OFF POINTS FOR LOW RELATIVE SIT-TO-STAND POWER ASSOCIATED WITH CHAIR RISE DISABILITY AND MOBILITY LIMITATIONS IN OLDER PEOPLE

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Co-authors: Delecluse, C.4, Sardinha, L.B.3, Ara, I.1

INTRODUCTION:
A validated, standardized and feasible test to assess muscle power in older adults has recently been reported: the sit-to-stand (STS) muscle power test. This investigation aimed to provide normative data, cut-off points associated with mobility limitations and thresholds of low relative muscle power related to chair rise disability in a large European cohort of older women and men.
METHODS:
A total of 11,583 older adults (7,443 women and 4,140 men) aged 60-103 years participated in this cross-sectional study. The 5-rep and 30-s versions of the STS test were used to assess chair rise ability. Chair rise disability was defined as being unable to complete ≥5 STS repetitions. Relative (normalized to body mass) muscle power was assessed by the STS power test. Body composition was evaluated by dual energy X-ray absorptiometry or bioelectrical impedance analysis, and legs skeletal muscle index (SMI; normalized to height squared) was calculated. Habitual and maximal gait speed, timed up-and-go test and 6-min walking distance were collected as physical performance measures, and participants were classified into two groups: well-functioning and mobility-limited older adults. Disability in basic and instrumental activities of daily living was also recorded using the Katz and Lawton questionnaires.
RESULTS:
A total of 1,129 older women (18%) and 510 older men (16%) presented mobility limitations (out of 6,161 and 3,159 participants, respectively). Mobility-limited older adults were older and exhibited lower relative STS power, higher BMI and legs SMI (both only in women) and lower legs SMI (only in men) than their well-functioning counterparts (all $p<0.05$). ROC curve analyses determined a low relative STS power below 2.1 W·kg-1 in women (area under the curve (AUC) [95% CI] = 0.85 [0.84–0.87) and below 2.6 W·kg-1 in men (AUC [95% CI] = 0.89 [0.87–0.91]). The age-adjusted odd ratios [95% CI] for mobility limitations in older women and men with low relative STS power were 10.6 [9.0–12.6] and 14.1 [10.9–18.2], respectively. Finally, 456 older women (6%) and 191 older men (5%) presented chair rise disability. The thresholds of relative power required to perform ≥5 STS repetitions increased linearly with participants' height ($p<0.001$) and did not differ by sex or test (i.e. 5-rep vs. 30-s version) (both $p>0.05$). Thus, for the average older woman and man (height: 1.54 and 1.66 m, respectively), the required thresholds of relative power were 1.0 and 1.1 W·kg-1, respectively. Notably, 100% of the participants below these thresholds presented mobility limitations and up to 50% of them exhibited some type of disability in activities of daily living ($p<0.001$).
CONCLUSION:
Relative STS power was negatively and strongly associated with mobility limitations and chair rise disability. Our study provides normative data, functionally relevant cut-off points and minimum thresholds of relative muscle power for their use in daily clinical practice.

INFLUENCE OF TRAINING INTENSITY IN THE CROSS-EDUCATION PHENOMENON PROVOKED BY POWER TRAINING IN OLDER ADULTS.

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INTRODUCTION:
In older adults, 2-week immobilization of the lower extremities requires twice the retraining time to restore their basal muscle function. Unilateral training during immobilization may prevent this decline through the cross-education phenomenon. This study aimed to explore the potential cross-education phenomenon after 12 weeks of light vs. heavy load unilateral power training (LL-PT vs. HL-PT, respectively) in older adults.
METHODS:
After an 8-week follow-up control (CON) period (>65y, n=45), participants were randomized to complete a 12-week LL-PT (40% 1-RM, n=9) or HL-PT (80% 1-RM, n=10) with one of their legs whereas the contralateral leg did not exercise (LL-NE vs. HL-NE, respectively). Training sessions were conducted on a horizontal leg press, executing the concentric phase as fast as possible. The 1-RM, estimated force at zero velocity (F0), maximal unloaded velocity (V0), and maximum muscle power (Pmax) were determined through a force-velocity relationship test conducted on the leg press, while maximal isometric force (MIF) and rate of force development (RFD) were assessed for the knee extensors. Quadriceps muscle cross-sectional area (CSA) was assessed by ultrasonography. Changes noted over each leg were compared using linear mixed models and Cohen's d effect sizes.
RESULTS:
No significant changes in any parameter were observed after the CON period (all d=−0.02 to 0.00; p≥0.668). In contrast, both LL-PT and HL-PT (exercised legs) provoked small to moderate increases in 1-RM (d=0.38–0.65; p<0.001), including a transfer effect to the contralateral non-exercised legs (i.e., LL-NE and HL-NE; d=0.35–0.42; p<0.001). Only HL-PT triggered a moderate increase of F0 (d=0.45, p<0.001), whereas no meaningful changes were noted after the other treatments (d=0.02–0.23; p≥0.078). A moderate increase in V0 (d=0.45–0.47, p≤0.012) was noted after LL-PT and HL-PT, which was also observed in the contralateral non-exercised legs (d=0.44–0.68, p≤0.020). Similarly, LL-PT and HL-PT developed Pmax moderately (d=0.54–0.66, p<0.001), even in their contralateral non-exercised legs (d=0.49–0.54, p<0.001). No changes were found between treatments regarding MIF nor RFD (both p>0.05). Finally, larger muscle CSA values were noted after both power training interventions (d=0.26–0.39, p<0.001), while small albeit significant changes were observed in their contralateral non-exercised legs (d=0.14–0.24, p≤0.013). No significant differences were noted between changes observed in LL-NE vs. HL-NE legs across the recorded measures (all p>0.05).
CONCLUSION:
Unilateral power training for the lower limbs provoked moderate improvements in maximal dynamic strength and maximal muscle power on the non-exercised contralateral legs of older adults, irrespectively of the load used. However, this cross-education phenomenon was specific to the training movement pattern. Besides, this phenomenon was accompanied by limited or negligible adaptations on muscle size, suggesting the major implication of neural adaptations.

WHAT KEEPS GRANNY MOVING? PERSPECTIVES OF OLDER ADULTS AND THEIR INSTRUCTORS ON FACTORS OF ENGAGEMENT IN GROUP-BASED EXERCISE PROGRAMS

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Introduction
Community-based group exercise programmes for older adults (OA) improve emotional wellbeing and maintain adherence in the short term [1]. However, little is known about the facilitators for exercise engagement or whether OA and their instructors have similar views. Using a socio-ecological model of health behaviour [2], this study aimed to understand what factors influence uptake and long-term adherence to group-based exercise in OA.
Methods
Participants were 52 older adults from group-based exercise programmes and six of their instructors. The OA took part in focus groups and the instructors took part in interviews. The questions focused on: barriers, facilitators and benefits of engagement in exercise, and (for instructors) the teaching methods used to facilitate adherence. Template analysis was used following a deductive approach to coding.
Results
Both the instructors and the participants agreed that an exercise setting that promotes social interaction and a welcoming atmosphere is important from the first session. This can be achieved for example by a built-in social gathering before and after the session. Participants appreciated instructors' individualised approach because it improved their skills and felt safe, but also because it gave them a sense of competence. Perhaps the most important factor for long-term adherence is the enjoyment felt by participants who attend. This enjoyment can derive from participants' perceived skill improvement, especially if they had a history of exercise and were driven to exercise. Enjoyment can also derive from socialising and building friendships among the group especially for those who were not driven to exercise. Instructors used a non-judgemental, person-centred and supportive teaching approach to foster individual motivations.
Discussion
The study revealed that instructors have an accurate view of what motivates OA to engage with exercise. The results highlight the importance of the exercise programme meeting participants basic psychological needs of competence, autonomy and relatedness [3]. A compassionate teaching style and well-designed exercise program which attend to both socialising and skill development have the potential to sustain the long-term engagement of OA in exercise.
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10:30 - 12:00

OP-BM09 Fatigue and neuromuscular systems

SEX DIFFERENCES IN FATIGABILITY DURING AN OLYMPIC TRIATHLON

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INTRODUCTION:
Sex differences in triathlon performance range around 10-20% of the overall time likely due to physiological, morphological, and hormonal factors (1). To date, studies investigating sex differences showed that women (W) present a higher percentage of type I fibers, a better substrate efficiency, lower VO2max values, and a lower O2-carrying capacity than men (M) (2). Despite M are usually stronger and more powerful than W (3, 4), after multiple cycling sprints (5), and prolonged running (6) W showed lower levels of fatigability. The aim of this study was to evaluate sex differences in the magnitude of neuromuscular fatigue during an Olympic triathlon.
METHODS:
Twenty-four recreational triathletes, 12 W (age: 35±7 years, VO2peak: 51.6±4.0 ml/min/kg) and 12 M (age: 34±8 years, VO2peak: 57.7±3.5 ml/min/kg) participated in the study. Rate of perceived exertion (RPE-10), knee extensors maximal voluntary strength (MVS) during isometric contractions, and countermovement jump (CMJ) height and power were assessed: before the race (PRE); during the transition phases after swimming (T1) and cycling (T2); after the running section, at the end of the race (POST). Speed and pace were obtained from a GPS system positioned on the athlete's wrist. During the race HR was also monitored by a chest band.
RESULTS:
Total performance time was longer for W (170±15 min) than M (155±10min, P=0.01). During the race both groups maintained similar exercise intensities (~80-85% HRpeak, P=0.6). RPE-10 increased progressively during the race for all participants (7±2, 8±1, and 9±1 at T1, T2, and POST, respectively, all P≤0.005) with no sex difference (P ≥ 0.09). Before and during the race, CMJ height and power were significantly lower in W compared to M (both P<0.001). MVS was lower in W (519±91N) than M (815±114N, P<0.001) at PRE; while the percent decline along the race was lower in W (-2±4%, -11±7%, and -15±7%) than in M (-13±7%, -23±7% and -24±8%, all P<0.001) at all time points.
CONCLUSION:
W showed lower levels of fatigability than M during an Olympic triathlon race, despite similar cardiovascular response to exercise and rate of perceived exertion. These results extend our current knowledge about sex differences in fatigability during endurance exercises; also suggesting a different approach to the training schedules for W vs. M triathletes. Further studies are needed to investigate the etiology and the effects of different race distances on the magnitude of neuromuscular fatigue in Olympic triathlon.
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SUBJECTIVE, BEHAVIOURAL AND PHYSIOLOGICAL RESPONSES TO MENTAL FATIGUE IN (SUB-)ELITE TABLE TENNIS PLAYERS.

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VRIJE UNIVERSITEIT BRUSSEL

INTRODUCTION:
Mental fatigue has been proposed as an important aspect of the fatigue spectrum, and thus performance, in sports. This specific type of fatigue has been defined as a psychobiological state caused by prolonged periods of demanding cognitive activity and can manifest itself subjectively, behaviourally and/or physiologically. It has been shown that it affects depending sport-specific performance factors such as accuracy, reaction time and decision-making. To further unravel the psychobiological mechanism(s) behind the mental fatigue-induced sport-specific impairments this study used subjective, behavioural and physiologically measurements during a visuomotor task. We predicted that mental fatigue results in 1) an increase in subjective ratings of the level of mental fatigue and 2) would negatively affect performance on the visuomotor task.
METHODS:
Nine (sub-)elite table tennis players (age: 25 ± 5 y, 3 females, 6 males) came to our lab for two experimental trials in this randomized, blinded, cross-over study. The participants completed a visuomotor task and Flanker task before and after the mentally fatiguing task (an individualized 60 minutes Stroop task) or control task (documentary). Multiple physiological (heart rate, EEG, RPE) and psychological measures (MF, cognitive load, motivation) were assessed during the protocol.
RESULTS:
The subjective level of mental fatigue was significantly higher in the Stroop task compared to the documentary (p<0.05). Behaviourally, no decrease in performance on the Stroop (reaction time) and Flanker task (reaction time and accuracy) was detected. Also for the visuomotor task, performance (reaction time) was not affected by the intervention. On the physiological level no differences were detected for heart rate.
CONCLUSION:
The results imply that mental fatigue was successfully induced in (sub-) elite table tennis players. The subjective feeling of mental fatigue did however not affect their performance level on a table tennis-specific visuomotor task. Although mixed results are found in the literature, the current study adds strength to research indicating that task representativeness or movement automatization might ensure that athletes are more resistant to the negative effects of mental fatigue. However, given the mixed results in the literature, more research is required to draw definite conclusions on the impact of subject expertise or level. Brain measurements will be a useful addition to explain the mechanisms by which mental fatigue might affect performance capacity.

ACUTE EFFECTS ON CREATINE KINASE, PERCEIVED FATIGUE AND PHYSICAL PERFORMANCE OF DIFFERENT POST-EXERCISE RECOVERY METHODS IN ELITE BASKETBALL PLAYERS: A CROSSOVER RANDOMIZED CONTROLLED TRIAL

MARIN GALINDO, A., VELÁZQUEZ DÍAZ, D., ESCUDIER VÁZQUEZ, J.M., PEREZ BEY, A., CORRAL PÉREZ, J., NARANJO, C., VAZ PARDAL, C., CALLEJA GONZÁLEZ, J., CASALS, C., PONCE GONZÁLEZ, J.G.

UNIVERSITY OF CÁDIZ, PUERTO REAL, SPAIN

INTRODUCTION:
The basketball characteristics and the congested calendar present recovery as a key role in the performance of professional players (1).
The aim of this study was to compare the effects of intermittent cold-water immersion (CWI), a supplement of protein and carbohydrates (SUPPL), and active recovery (ACT) on creatine kinase (CK), perceptual and performance markers of recovery in elite basketball players after a specific fatigue protocol.
METHODS:
Fifteen elite basketball players (age 23±4 years; height 190.5±8.9 cm; body mass 90.3±9.6 kg; body fat 13.8±4.4 %; VO2max 45.8±4.7 ml/kg/min) participated in this crossover-controlled trial. All participants were randomly measured in 4 recovery method conditions 1-week apart after a fatigue exercise protocol (~45´of high intensity intermittent effort with basketball-specific movements). Recovery methods consisted in CWI at 10ºC in periods of 2 minutes submerged and 2 minutes out of the water, SUPPL with a 0.3gr/kg of maltodextrin and 0.2gr/kg of neutral whey protein in 0.5 litres of water, ACT pedaling for 25 minutes at 50% of maximal heart rate, or a placebo drink (PLA). The Visual Analogical Scale of Fatigue (VAS), Rate of Perceived Exertion (RPE), CK, and physical performance (jumps, velocity, isometric and dynamic squat strength tests) were measured prior to (PRE), after (POST), and 24 hours after (POST24h) the fatigue protocol. The VAS and RPE were also measured immediately post-recovery method application (POST25'). A 2-way repeated-measures ANOVA and Bonferroni post-hoc comparisons were applied, with significance set at $P<0.05$.
RESULTS:
The VAS was lower at POST25' in the ACT ($P=0.015$), SUPPL ($P<0.001$), and CWI ($P=0.044$) groups, but not in PLA ($P=0.159$), compared with POST measurements. The RPE was reduced ($P<0.05$) from POST to POST25' in all conditions but remained higher compared to PRE ($P<0.05$), except for the CWI group ($P=0.082$). The CK level was increased from POST to POST24h for all groups ($P<0.05$), except for CWI ($P=0.062$). For jump tests, there was only a significant difference in the change of POST to POST24h in the countermovement jump test, where CWI improved the performance significantly more than SUPPL ($P=0.009$). The time in the 4x10m agility test improved significantly ($P=0.027$) at POST24h only in CWI. There were no effects of the recovery method for sprint test and isometric or dynamic strength tests in squat exercise ($P>0.05$).
CONCLUSION:
The results suggested that CWI, SUPPL, and ACT could be effective to improve perceptual measures of recovery compared with a PLA condition. The CWI method seemed to be the best option to quickly reduce the rate of perceived exertion and exercise-induced muscle damage markers and to achieve a higher physical performance recovery in elite basketball players.
Key Words: cryotherapy, recovery strategies, nutrition, team sports, supplement, muscle damage
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EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULATION ON THE MAXIMAL CAPACITIES OF THE NEUROMUSCULAR SYSTEM TO PRODUCE FORCE, VELOCITY AND POWER

ALIX FAGES, C., ROMERO ARENAS, S., CALDERÓN NADAL, G., JEREZ MARTÍNEZ, A., COLOMER POVEDA, D., GARCIA RAMOS, A., MÁRQUEZ, G.

UNIVERSIDADE DA CORUÑA

INTRODUCTION:
The effects of transcranial direct current stimulation (tDCS) on the maximal capacities of the neuromuscular system to produce force, velocity and power are still inconclusive. This work aimed to explore the acute effect of tDCS on the sprint, countermovement jump (CMJ) and bench press force-velocity relationship.
METHODS:
A research compendium of different studies performed by our laboratory measuring the effects of tDCS on force-velocity relationship parameters, have been presented in this work. Three different studies have been included. A total of sixty-three subjects were randomly stimulated over the dorsolateral prefrontal cortex with either ANODAL, CATHODAL or SHAM tDCS for 15 minutes at 2 mA. All experimental sessions were separated by 7 days. The maximal capacities of the neuromuscular system to produce force, velocity and power were measured on a jump, bench press and 30-m sprint task. In the first study, the one-repetition maximum (1RM) estimated from the individual L–V relationship and the force–velocity relationship parameters were evaluated during the bench press exercise before and after receiving the tDCS. For the experimental sessions of the second study, subjects completed 3 CMJ trials separated by 1 minute before and after each of the 3 experimental conditions. In the third study, each session consisted of two maximal sprints of 30 meters that were performed after receiving the tDCS.
RESULTS:
No significant changes were observed in the 1RM or in the bench press force-velocity relationship parameters between tDCS conditions ($p \geq 0.377$). Besides, neither 30-m time nor the horizontal F-v profile variables reached statistical differences between tDCS conditions ($p \geq 0.061$) and the magnitude of the differences was negligible for most of the comparisons (effect size [ES] ≤ 0.20). CMJ performance were not affected by any of the tDCS conditions ($p \geq 0.920$) and effect size was trivial for all conditions (0.01–0.14).
CONCLUSION:
The present work revealed that 15 minutes of ANODAL or CATHODAL tDCS applied over the DLPFC at 2mA does not affect the maximal capacities of the neuromuscular system to produce force, velocity and power on jumping, sprinting and bench press lifting.

IS-MH06 Achilles tendon rupture – Risk Factors, mechanisms and how to manage?

CHRONIC HYPERGLYCEMIA, HYPERCHOLESTEROLEMIA AND METABOLIC SYNDROME ARE ASSOCIATED WITH RISK OF TENDON INJURY

COUPPÉ, C., SIERSMA, V., KLAUSEN, S.B., VISNES, H., HAUKENESS, I., BANG, C.W., BAGER, P.M., SILBERNAGEL, K.G., GAIDA, J., MAGNUSSON, S.P., KJÆR, M., SKOVGAARD, D.

UNIVERSITY OF COPENHAGEN

INTRODUCTION:
Tendon injury is a considerable problem affecting both physically active and sedentary people. The aim of this study was to examine the relationship between markers for metabolic disorders (hyperglycemia, hypercholesterolemia and metabolic syndrome) and the risk of developing tendon injuries requiring referral to a hospital.
METHODS:
The Copenhagen City Heart Study is a prospective study of diabetic and nondiabetic individuals from the Danish general population with different physical activity levels. The cohort was followed for 3 years via national registers with respect to tendon injuries. Data from 5856 individuals (median age 62 years) were included.
RESULTS:
The overall incidence of tendon injury in both upper and lower extremity that required an out-patient or in-house visit to a hospital was ~5.7/1000 person years.
Individuals with elevated HbA1c (glycated hemoglobin) even in the prediabetic range (HbA1c>5.7%) had a ~3 times higher risk of tendon injury in the lower extremities only, as compared to individuals with normal HbA1C levels. Hypercholesterolemia (total cholesterol>5 mmol/l) increased risk of tendon injury in the upper extremities by ~1.5 times, and individuals with metabolic syndrome had ~2.5 times higher risk of tendon injury in both upper and lower extremities.
CONCLUSION:
In conclusion, these data demonstrate for the first time in a large cohort with different physical activity levels that the indicators for metabolic syndrome is a powerful systemic determinant of tendon injury, and two of its components, hyperglycemia and hypercholesterolemia, each independently make tendons susceptible for damage and injury.

MECHANISMS BEHIND TENDON HEALING THAT CAN BE RELATED TO CLINICAL OUTCOMES

ELIASSON, P.

LINKÖPING UNIVERSITY

Tendon ruptures are common, problematic to treat and often result in remaining deficits. The ruptured tendon heals through scar formation and not regeneration. This healing resembles wound healing and is classically divided into three overlapping phases. My talk will relate what we know experimentally and clinically from each of these three phases. I will also talk about how different types of interventions can be beneficial in one phase but not in another. Inflammation is important to initiate the healing response, but prolonged inflammation is poor for matrix quality. In the same way, unloading during tendon healing will result in poor mechanical strength as loading provides important ques for the tendon cells, but too much loading is equally bad as it might lead to tendon elongation or even tendon rupture. The purpose of this session is to put biological mechanisms of tendon healing into a clinical context.

TENDON LOADING IN THE CLINICAL SETTING –OPTIMISATION AND INDIVIDUALISATION

WEISSKIRCHNER, K.

XXX

Tendon loading has been shown to be important for tendon healing in the lab and looking at flexor tendons in the upper limb. However, clinical studies investigating patient reported and clinical outcomes have not shown effect of loading the Achilles. The presentation will discuss:
•If loading matters for the patient in treatment of acute Achilles tendon ruptures.
•Different loading modalities
•Individualisation of treatment. Can we differentiate patients?
•Should sutured and non-sutured tendons be loaded alike

IS-EX02 ECSS-JSPFSM: Arterial Stiffness and Exercise Training: An Update

EFFECTS OF ENDURANCE EXERCISE WITH ELECTRICAL MUSCLE STIMULATION ON THE ARTERIAL FUNCTION

MIURA, H.

TOKUSHIMA UNIVERSITY

Several previous studies have noted an improved arterial function via endurance cycling or running exercises. Although those exercises are recommended, patients suffering from paralysis, arthritis or osteoarthritis of hip/knee cannot perform these kinds of lower-limb exercises. Such patients instead typically perform upper-limb exercises to increase their physical fitness. However, our group reported increased arterial stiffness after acute arm-cranking exercise and suggested the efficacy of upper-limb exercise with passive exercise stimulation, such as electrical muscle stimulation (EMS), on the lower limbs. EMS can be applied as a complementary intervention to voluntary exercise. In clinical practice, EMS of non-active muscles improves the skeletal muscle volume, function, or exercise capacity. Accumulated evidence has demonstrated the potential for EMS to have a major impact on lifestyle-related diseases and its role in metabolic enhancement and orthopedic rehabilitation. EMS of the lower limbs during arm-cranking exercises may promote peripheral circulation due to increased cardiac output and decreased peripheral vessel impedance, which is related to an improved arterial function. In this symposium, we will present recent results for two different protocols: Protocol 1 was designed to assess the effect of acute submaximal arm-cranking exercise with

EMS on the arterial function. Protocol 2 was designed to determine whether or not arm-cranking exercise training with EMS has a greater effect of improving the arterial function than the same exercise training without EMS.

THE PROXIMAL AORTIC FUNCTION AND INTRACRANIAL FLUID DYNAMICS IN ENDURANCE ATHLETES: THE FINDINGS FROM MRI STUDIES

TARUMI, T.

NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY

The proximal aorta is highly compliant and has a cushioning function for dampening stroke volume and making continuous blood flow in the end-organ microcirculation. The brain is a high flow, low resistance organ and may be vulnerable to elevated arterial pulsatility transmitted from the cardiovascular system. On the other hand, high-intensity aerobic exercise training is associated with eccentric cardiac hypertrophy and greater stroke volume which may increase mechanical stress on the proximal aorta and the cerebral circulation. The recent advent of CINE phase-contrast magnetic resonance imaging (PC-MRI) has made us capable of measuring the proximal aortic morphology and function as well as intracranial fluid dynamics, including the arterial and venous blood and cerebrospinal fluid flows. This talk will present the results from our recent cross-sectional studies that investigated the impact of high-intensity aerobic exercise training on the proximal aorta and intracranial fluid dynamics measured by CINE PC-MRI.

THE EFFECT OF PHYSICAL ACTIVITY ON INVASIVELY DETERMINED MICROVASCULAR FUNCTION AND ARTERIAL COMPLIANCE IN MEN AND WOMEN

HELLSTEN, Y.

UNIVERSITY OF COPENHAGEN

Reduced vascular compliance and microvascular dysfuntion are two key risk factors for the development of cardiovascular disease. Both factors are highly influenced by age and lifestyle related factors with physical inactivity and activity playing an important role. Vascular compliance is commonly assessed by pulse wave velocity but direct measurements can also be made by use of invasive procedures involving intraarterial pressure measurements and doppler ultrasound. Concomittantly, invasive measurements with arterial catheterizations allow for the evaluation of microvascular function where the change in vascular conductance is assessed in response to intraarterial infusion of vasodilators such as acetylcholine and sodium nitropusside. This talk will focus on such invasive measurements of arterial compliance and skeletal muscle microvascular function. Changes in the two variables will be discussed with interventions including immobilization, physical activity and pharmacologic treatment. In addition, the influence of sex hormones and age will be covered.

IS-BM01 The state-of-the-art of swimming biomechanics

WHOLE-BODY THREE-DIMENSIONAL MOTION ANALYSIS IN SWIMMING: A DIRECT BRIDGE BETWEEN AQUATIC KINEMATICS AND KINETICS

GONJO, T.

NORWEGIAN SCHOOL OF SPORT SCIENCES

Swimming velocity is determined by the balance between propulsive and resistive forces, and these forces are produced mainly due to the motion of the limbs. In on-land sports, the inverse-dynamics approach is often used to comprehensively analyse kinematics and kinetics and primarily to obtain joint torque information. However, the same approach cannot be used in swimming because the entire pressure distribution around the body segments cannot be quantified, and consequently, the free-body diagram of each segment cannot be established. Instead, this approach can be applied when the interest is in whole-body kinematics and kinetics. The whole-body centre of mass acceleration reflects the net-force and the whole-body angular acceleration is directly linked to the net-torque. Furthermore, obtaining three-dimensional linear and angular velocity as well as the whole-body moment of inertia enables researchers to assess the kinetic energy associated with a swimming motion. In this first presentation, basic background knowledge of the approach, application examples and outcomes are introduced and discussed.

NOVEL TECHNOLOGY FOR OBTAINING KINEMATIC INFORMATION IN SWIMMING RACES

OLSTAD, B.

NORWEGIAN SCHOOL OF SPORT SCIENCE

Obtaining race information in swimming competitions is a challenging task. Swimmers are not allowed to put any sensors during competitions, researchers can put cameras only at limited locations of the pool, and in most cases, obtaining underwater information is very difficult. Therefore, an alternative approach to quantifying swimmer's race performance is required. The latest hardware and software technologies enable researchers and coaches to quantify kinematic information during a simulated race (i.e. a race outside official competitions). This methodological evolution produced opportunities for acquiring kinematic variables throughout a race without any physical devices attached on the swimmer. In this presentation, studies conducted with this latest technology is introduced with specific focuses on variables that classical race analysis methods could not quantify, such as underwater kinematics and stroke-to-stroke variability of swimmers.

PROPULSIVE FORCES IN FRONT CRAWL SWIMMING AND THEIR RELATIONSHIPS WITH UPPER BODY KINEMATICS

KUDO, S.

REPUBLIC POLYTECHNIC

In the past, swimming propulsion was considered to be related to the action-reaction interaction between the hands and the water. However, developments in swimming fluid dynamics have implied more complex and dynamic phenomena, such as vortices and turbulent, causing swimming propulsion. In other words, swimming propulsion cannot be explained by a simple steady physics theory, but there are

many other unsteady factors to be considered. Pressure sensors have attracted researchers especially in the last decade, as the sensors have a potential to quantify hydrodynamic forces with unsteady fluid factors taken into consideration. In this presentation, the application of pressure sensors in swimming research is introduced with key factors, advantages and limitations of the method. Furthermore, the latest knowledge in the relationship between upper body motion and hydrodynamic forces produced by the hand is discussed.

12:30 - 14:00

PS-PL01 Sprint performance: beating the limits

THE PHYSIOLOGICAL DETERMINANTS OF SPRINT PERFORMANCE: AN INTEGRATIVE

CALBET, J.A.L.

UNIVERSITY OF LAS PALMAS DE GRAN CANARIA

Sprint performance is critical for success in many sports. A high-level sprint performance requires the optimal application of force to produce the highest power output possible. In many athletic events, the time available to generate force is very short (<75 ms), and therefore the capacity to produce high power since the very beginning of contractions is crucial for performance. Neural, muscular and mechanical factors influence the ability to generate outstanding levels of power. Several approaches trying to isolate the role played by each factor have been undertaken.

However, there is lack of experimental evidence on how the three components interact to limit performance and how they respond to changes in stimulation (training/detraining) under varying circumstances (duration of contractions, temperature, fatigue, etc.). The force exerted at any given time depends on the number of cross-bridges generating tension. On the other hand, the shortening velocity depends mostly on the speed at which myosin detaches and re-attaches to actin, whose primary determinant is the myosin ATPase activity. The neural component should produce synchronised activation of all motor units at the highest frequency possible during explosive muscle contractions, with timely activation of the agonist and antagonist/synergist muscles. A higher proportion of myosin heavy chain (MCH) IIX is associated with greater force and shortening velocity, a distinctive quality of the faster mammals in nature. The quicker and larger Ca2+ transients of type II fibers are also contributing factors, which may become more critical as fatigue develops.

Calcium transients are sensed by the calcium decoding proteins, namely Ca 2+ /calmodulin-dependent protein kinase II (CaMKII) and calcineurin. Increased CaMKII phosphorylation may induce muscle hypertrophy and reduce muscle breakdown by downregulation of the ubiquitin E3 ligases. Paradoxically, MCH IIX increase with immobilization and decrease with exercise training. Although the most effective strategy to improve muscle power is by loaded contractions performed at the highest speed possible (explosive-type strength training), the level of fatigue reached during each set has a major impact on muscle adaptations. Reducing the level of fatigue allowed during the training session helps to preserve MCH IIX and is associated with greater improvement in jumping and sprinting performance. In vitro experiments indicate that muscle contractions to failure are associated with increased reactive oxygen species production, which reduces Ca2+ release and Ca2+ sensitivity, thus hampering peak power output. During prolonged sprints, as well during repeated short sprints, the mechanisms limiting performance become more complex and will be analysed with some detail.

Department of Physical Education and IUIBS (Research Institute of Biomedical and Health Sciences), Canary Islands, Spain; Department of Physical Performance, Norwegian School of Sport Science

NUTRITIONAL STRATEGIES TO ENHANCE SPRINT PERFORMANCE

BURKE, L.

AUSTRALIAN CATHOLIC UNIVERSITY

Despite the unique characteristics of each sport, all competitors share a desire to pace their performance to achieve the highest sustainable power outputs while maintaining technical proficiency, with the likelihood of “fatigue” (notionally, a reduction in some performance metrics) occurring intermittently, towards the end of the event, or both. Nutritional strategies can directly enhance performance when they reduce or delay the onset of the various factors which underpin such fatigue, with targets including the defense of homeostasis in various body systems, the availability of appropriate muscle substrates and optimization of central nervous system function. The development of specialized nutrition strategies for competition performance is better characterized in endurance sports, perhaps due to the combination of a longer history of investigation of the factors limiting performance as well as opportunities to provide nutritional support during the event to address some of these factors. Although our knowledge of nutritional strategies to address performance of a single brief (e.g. 10 s) sprint is under-developed, as the sprint becomes longer (e.g. 60 s) or is repeated without full recovery between bouts, a greater range of fatigue-evoking factors accrues and provides targets for nutritional support. Such opportunities can also be found during the training phase where they may be able to support higher quality training or promote adaptation to the training stimulus. Strategies that could be considered by sprint-based athletes include creatine supplements to enhance the phosphocreatine energy system, and supplement strategies to enhance the buffering capacity of extracellular (e.g. bicarbonate supplementation to increase blood buffering capacity) and intracellular (β-alanine supplementation to increase muscle carnosine stores) origin. Caffeine supplementation has the potential to enhance sprint performance by masking the perception of fatigue or soreness during longer/repeated sprints and/or by direct affects on muscle contractility. Newer areas of investigation include the effects of acute or chronic supplementation with various antioxidant nutrients/phytochemicals on the production of reactive oxygen species. There is also interest in the potential effects of mouth-sensing of bitter tastants (e.g. quinine) on corticomotor excitability.

14:30 - 16:00

IS-EX01 ECSS-ACSM: Exercise & Health : molecular aspects

MUSCLE AS AN ENDOCRINE ORGAN

PEDERSEN, B.

RIGSHOSPITALET

When skeletal muscle contracts it produces, expresses and releases myokines with either autocrine, paracrine or endocrine effects. Hundreds of secreted peptides have been identified as part of the muscle secretome and provide a conceptual basis for understanding how muscles communicate with other organs, such as adipose tissue, liver, pancreas, bone and brain.
Some myokines are thought to induce anti-inflammatory responses with each bout of exercise and other mediate long-term exercise-induced improvements in cardiovascular risk factors, having an indirect anti-inflammatory effect. Myokines also mediate anticancer effects and contribute to regulate metabolism and cognitive function.
Centre of Inflammation and Metabolism and Centre for Physical Activity Research, Rigshospitalet, University of Copenhagen.

EXERCISE-INDUCED ADAPTATION-A TALE OF TWO MYOCYTES

POWERS, S.

UNIVERSITY OF FLORIDA

It is established that endurance exercise training produces many health-related benefits in both cardiac and skeletal muscles. Indeed, repeated bouts of endurance exercise results in protection of cardiac myocytes against ischemia-reperfusion induced cardiac injury.
Further, endurance exercise training also results in important adaptations within skeletal muscle fibers; this exercise preconditioning is associated with a fiber phenotype that is protected against inactivity-induced muscle wasting.
This lecture will discuss the mechanisms responsible for exercise-induced preconditioning of both cardiac and skeletal muscle myocytes.

OP-MH10 Diabetes; Physical activity and COVID 19

IMPROVEMENT OF BETA-CELL FUNCTION IN PATIENTS WITH TYPE 2 DIABETES BY PHYSICAL TRAINING.

INGERSEN, A., ALEXANDERSEN, C., SCHMÜCKER, M., GRAUNGAARD, B., THORNGREEN, T., HELGE, J.W., DELA, F.

UNIVERSITY OF COPENHAGEN

INTRODUCTION:
Failing beta-cell function and insulin resistance are pivotal in the pathophysiology of type 2 diabetes (T2D). Glucagon-like peptide-1 receptor analogs (GLP-1 RA) exert their glucose lowering action in part by restoring beta cell function and physical training increases insulin sensitivity and may affect insulin secretion. Studies on the combined effect of training and GLP-1 RA treatment on these parameters are non-existing. We hypothesized that GLP-1RA (semaglutide) and aerobic training (both alone and in combination) would improve insulin secretory capacity in T2D.
METHODS:
Patients with T2D (time since diagnosis, 5.6±1.0 yrs; age, 57±1 yrs; body mass index (BMI), 34±1 kg/m2; HbA1c, 52±3 mmol/mol, V̇O2max, 25±1 ml/min/kg) were randomized to 12 wk aerobic training (AT, n=8) (3x45 min ergometer cycling/wk @75% of heart rate reserve), 12 wk semaglutide (S, n=6) (0.5 or 1.0 mg s.c. once weekly), or 12 wk combined (S+AT, n=9) intervention. AT were in treatment with metformin (n=8)/SGLT2 inhibitor (n=1), and S+AT in addition to semaglutide with metformin (n=2). Glucose stimulated insulin response (GSIR) (sequential hyperglycemic clamp, 2h at 20 mM and at 30 mM; data are reported as averaged plasma insulin concentrations [for every 15 min] across each clamp step), V̇O2max (Oxycon PRO) and body composition (DXA) were measured before and after the intervention. Data are analyzed by mixed model for repeated measures, and reported as mean± SE.
RESULTS:
VO2max increased similarly in the training groups (AT: 25±2 to 28±2; S+AT: 25±1 to 28±2 ml/min/kg (both P<0.01) and remained unchanged in S (from 26±1 to 25±1 ml/min/kg). BMI (kg/m2) decreased in S (from 33±1 to 32±1) and in S+AT (from 32±1 to 31±1) (both P<0.01), but not in AT (from 34±2 to 34±2). HbA1c (mmol/mol) decreased in S (to 47±2) and S+AT (to 43±1) (both P<0.01), but not in AT (to 48±2). GSIR at 20 and 30 mM increased in S by 360±153 and 885±411 % (from 368±59 and 554±292 to 1627±499 and 5493±1888 pM, respectively (both P<0.001)), in AT by 13±10 and 47± 20 % (from 372±40 and 621±65 to 430±62 and 907±125 pM, respectively (both P<0.04), and in S+AT by 17±11 and 30±19 % (from 1882±461 and 5696±1539 to 1992±389 and 6390±1321 pM, respectively (P=0.19)).
CONCLUSION:
As expected, semaglutide alone improved GSIR dramatically in T2D. Aerobic training also markedly increased GSIR in T2D patients (which is directly opposite to what has previously been shown in healthy people), but there is no additive effect of the two. Most likely because the insulin secretion is already at its max with semaglutide (the measured insulin concentrations are the highest ever reported for patients with T2D). The training effect is independent of weight loss, but the mechanism remains to be found. It may include a decreased lipo-/glucotoxic load on the beta-cells and/or a training induced relief of beta-cell stress via improved insulin sensitivity.

NEUROMUSCULAR ELECTRICAL STIMULATION (NMES) PREVENTS MUSCLE WASTING IN PATIENTS WITH SARS-COV-2 (COVID-19)

MORTEN, R., ANDERSEN, B.1, HANSEN, S.K.1, FRYDENLUND, A.1, POGGI, A.1, MERHI, Y.2, AGARWALA, S.2, MIKKELSEN, P.H.2, NYGAARD, J.V.2, SUETTA, C.1

BISPEBJERG AND HERLEV HOSPITAL, UNIVERSITY OF COPENHAGEN

INTRODUCTION:

The ongoing crises of the SARS-CoV-2 (Covid-19) pandemic has put health care systems under pressure worldwide and led to a large number of hospitalized patients. Muscle wasting and impairments in physical function are well-recognized sequelae to critical illness and apart from recovery from COVID-19, these patients will need to recover from the loss of muscle mass. The aim of the present study was to counteract muscle wasting in acutely admitted COVID-19 patients using a customized Neuromuscular Electrical Stimulation (NMES) solution.
METHODS:
Patients with positive SARS-CoV-2 infection but no need for mechanical ventilation were enrolled in the study within the first 48 hours of admittance. Leg lean mass was assessed by bedside bioimpedance (InBody S10, InBody, Korea) and muscle thickness (m. vastus lateralis, VL) was measured with Ultrasound (UL, Sonoscape E1, SonoScape, China). Patients received unilateral daily NMES sessions at full consciousness through bio-compatible electrodes integrated into existing healthcare textiles (TED-stockings) normally used to prevent deep venous thrombosis. NMES was applied to a randomized leg (ES), with the opposite leg serving as control (CO). The stimulation protocol was 60Hz/400µs, 30 min 2/day, 7days/week for a minimum of 5 days at a subjective tolerance. For pairwise comparison between the time of inclusion (pre) and discharge (post) on VL thickness and regional muscle mass, we used a parametric paired t-test. In addition, data from ultrasound scans were further analyzed for group differences of the relative change in VL thickness between ES and CON using a nonparametric Mann-Whitney test. Data are presented as mean ± SD.
RESULTS:
Sixteen SARS-CoV-2 (Covid-19) positive patients (12m/4w, mean age 56.3 ± 19.3 years) completed the NMES protocol for a period of 6.6 ± 0.7 days with an average intensity of 42.4 ± 8.1 mA. In ES, muscle thickness was unchanged from pre to post (21.0 ± 1.4 mm vs. 21.3 ± 1.4 mm) whereas VL-thickness decreased -9.1 ± 2.8% (21.0 ± 1.4 mm vs. 19.1 ± 1.3 mm, $p<0.01$) in CON leading to a significant group difference between ES and CON ($p<0.01$). Data from bioimpedance analysis on segmental leg lean mass also revealed a significant decrease in CON (8.4 ± 0.6 kg vs. 8.1 ± 0.6 kg, $p<0.05$), but not in ES (8.5 ± 0.6 kg vs. 8.2 ± 0.6 kg, $p=0.07$).
CONCLUSION:
Just six days of hospitalization led to a marked (-9.1%) decline in leg muscle thickness and a significant loss of leg lean mass (~300 g) in hospitalized Covid-19 patients. Notably, NMES twice daily with a customized NMES system could mitigate the loss of leg lean mass and the decline in muscle thickness and may be a promising solution to counteract muscle wasting in a wide range of critically ill patients (trauma, stroke, postoperative patients etc.) prone to immobilization and/or hospitalization.

EFFECT OF A WORKPLACE PROGRAM TO PROMOTE PHYSICAL ACTIVITY DURING THE COVID-19 PANDEMIC

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INTRODUCTION:
The health crisis caused by COVID-19 has highlighted the importance of physical activity to improve the prognosis of this disease (1). However, an overall reduction in physical activity levels and an increase in population weight have been observed during this period (2). Currently, most of the population spends at least half of their waking hours in the workplace, this being an ideal place to implement programs to improve the health of employees (3). The results of the previous investigations seem to be promising in relation to the improvement of the physical activity level (4), the physical condition (5) or the BMI (6). However, there are conflicting conclusions about the impact of these programs on blood pressure or blood glucose (6). Furthermore, there are no studies that have analyzed the impact of these programs on the identity fusion, the interplay of personal (worker) and social (the company) identities. Therefore, the main objective of this study was to analyze the impact of a workplace program to promote physical activity during the COVID-19 pandemic on different biometric variables related to cardiovascular risk and on the identity fusion between workers and the company.
METHODS:
54 office workers (17 women; 47±9.1 years; 26.14±3.95 kg/m2 BMI) participated in a 18-week theory-informed -Behaviour Change Wheel (7)- online program based on education, counselling and individualized prescription of physical exercise. Both before and after the intervention, blood samples were taken, blood pressure was measured and the handgrip strength was evaluated. Participants also completed the IPAQ questionnaire and the Verbal Identity Fusion Scale. Paired samples T-test and Cohen's d were used to evaluate the effect of the intervention program.
RESULTS:
After the intervention, significant improvements were observed for physical activity level ($p<.001$, $d=0.54$), hand grip strength ($p=.002$, $d=0.15$), BMI ($p=.010$, $d=0.13$), blood pressure ($p=.007$, $d=0.31$), HbA1c ($p<.001$, $d=0.47$) and identity fusion ($p=.010$, $d=0.36$).
CONCLUSION:
This theory informed 18-week online workplace program was effective to improve the physical activity level, hand grip strength, BMI, blood pressure, HbA1c and identity fusion in office workers even during the COVID-19 pandemic. In this way, the potential of this type of interventions to alleviate some of the negative effects caused by this disease was confirmed.
REFERENCES:
(1) Dwyer et al., 2020; (2) Deschasaux-Tanguy et al., 2020; (3) Jirathananuwat & Pongpirul, 2017; (4) Malik, Blake & Suggs, 2014; (5) Burn et al., 2019; (6) Proper & van Oostrom, 2019; (7) Michie et al., 2014.

PHYSICAL ACTIVITY INTERVENTION COMBINING DIFFERENT REMOTE MODALITIES TO PREVENT PHYSICAL DECLINE RELATED TO COVID-19 LOCKDOWN IN COMMUNITY-DWELLING OLDER ADULTS.

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INTRODUCTION:
More than 50% of seniors are physically inactive. This lifestyle habit is one of the major causes of physical declines. However, this lifestyle and these age-related declines are accentuated by COVID-19 lockdown. Telerehabilitation has been shown to be a potential solutions to promote physical activity (PA) and to counteract physical performance declines in older adults. In addition, up to 50% of older adults reported using computer devices and internet. Thus, the goal of this study was to explore if physical activity intervention combining different remote modalities to prevent physical decline related to COVID-19 lockdown in community-dwelling older adults.
METHODS:

During the 2nde wave of the COVID-19 pandemic, 46 older adults aged 60yrs and over, inactives (< 2hours/week) and living in the community were recruited to follow a 12-week PA intervention (3 sessions/week; 1h/session) and randomized in 2 groups: 1) Interactive-Recorded-Interactive group (IRI; n=22) vs. 2) Recorded-Interactive-Recorded group (RIR; n=24). Interactive sessions were realized in synchronous mode via Zoom© and in group with a kinesiologist. Recorded sessions were realized unsupervised and in asycnhronous mode through a dedicated website.
Acceptability, feasibility as well as functional (gait parameters: normal & fast 3-m TUG, SPPB; unipodal balance) and physical capacities (10rep sit-to-stand / 30-sec chair test) were assessed pre- and post-intervention. Per-protocol analysis using ANOVA repeated measures were performed ($p < 0.05$: significant).
RESULTS:
The drop-out rate was 14% in IRI group (n=3/22) and 29% in RIR group (n=7/24). The adherence was acceptable (>70%) and similar across groups among participants who completed the intervention. Both groups reported the same level of satisfaction (satisfied /very satisfied: IRI:71% vs. RIR:68%) and enjoyment (enjoy/very enjoy: IRI: 93% vs. RIR:92%) even if they found the intervention slightly difficult (Borg-Scale:5-6/10; IRI:58% vs RIR:63%). Both groups significantly improved functional capacities (normal & fast 3-m TUG; normal walking speed; 5rep sit-to-stand), muscle power (Takaï equation), muscular endurance (30-sec sit-to-stand). Improvements in muscle power (W; IRI: T0:35.4±14.8 vs. T12:48.0±18.9; RIR: T0:37.1±13.8 vs. T12:39.7±14.0; time*group effect: p=0.006) and muscular endurance (n; IRI: T0:14.8±4.2 vs. T12:19.4±1.3; RIR: T0:14.4±3.0 vs. T12:18.8±5.6; time*group effect: p<0.001) are significantly more important in IRI group than in RIR group.
CONCLUSION:
Physical activity interventions using different remote modalities and ratio seems feasible and acceptable. These PA modalities appear to be effective at improving functional and physical capacities during COVID-19 lockdown. However, having more interactive sessions than pre-recorded sessions in the intervention modality ratio seems more effective to promote physical health. This finding needs to be confirmed before to implemented in clinical setting.

OP-AP11 Pacing and performance

ADOPTING A HOLISTIC FOCUS OF ATTENTION PROMOTES ADHERENCE AND IMPROVES PERFORMANCE IN COLLEGIATE TRACK AND FIELD ATHLETES

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INTRODUCTION:
Research suggests that adopting an external focus improves performance and facilitates learning in comparison to internal focus (1). It can be problematic to adopt focus cues consistent with an external focus for many tasks such as dancing, figure skating, or gymnastics. Becker et al. (2) suggested that a holistic focus cue can be adopted when an external focus is not practical. A holistic focus directs attention to the general feeling of the movement, potentially aiding in automatic control of a movement but not directing attention internally. Research has shown holistic focus to improve performance and learning (3). The purpose of our study was to investigate the effects of various attentional foci within expert track and field athletes performing an underhand shot-put throw.
METHODS:
18 female track and field athletes (NCAA Division I) performed an underhand shot-put throw (4kg) under three focus conditions, in a regulation shot-put field with an orange cone placed 18m from the toe board. Internal (IF), external (EF), and holistic (HF) foci were provided in the counterbalanced order and the throwing distance was recorded for each throw. All participants signed informed consent and then performed warm up exercises. Following the warm-up, participants made a throw with no attentional instruction to ensure the task was understood. Three throws under each condition were then completed with one-minute rests between throws and two-minute rests between conditions. For IF, participants were told to focus on “extending your knees and arms as rapidly as possible”. EF focused on “throwing as close to the orange cone as possible”, and HF on” being as explosive as possible”. Following each condition participants reported their adherence to the focus cue and recorded their focus preference at the conclusion on the experiment.
RESULTS:
Repeated measures ANOVAs with Sidak post-hoc were used to analyze throw distance and adherence. For throw distance there was a significant main effect for condition ($F=23.451$, $p<.001$). HF threw significantly further than IF ($p<.001$) with no difference between any other condition ($p>.05$). For adherence there was also a significant main effect for condition ($F=9.67$, $p<.01$). HF significantly adhered to the focus cue more frequently than IF ($p<.05$).
CONCLUSION:
Previous research has suggested that an external focus is beneficial for novice performers but studies involving experts have not been clear. Our results support previous work in novice performers showing a benefit to a holistic over and internal focus. Holistic focus also led to more adherence to the cue provided. This is significant for elite performers and coaches as holistic cues are easy to adopt and greatly impact elite performance.
References:
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2) Becker et al., J Motor Learn Dev, 2019
3) Abedanzadeh et al., Psych Research, 2021

PERFORMANCE AND MICRO-PACING STRATEGIES IN A FREESTYLE CROSS-COUNTRY SKIING DISTANCE RACE

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INTRODUCTION:
Pacing strategies in cross-country skiing (XCS) are largely influenced by the course topography [1]. Recent research has identified that skiing velocity during some key track sections (i.e. the micro-pacing strategy) was related to faster race times [2]. Specifically, skiing velocity during transitions between uphill, flat and downhill sections were strongly related to faster classic XCS sprint race times among female skiers [2]. Previous research has also shown that pacing strategies might vary between techniques (i.e. classic vs. skate) [1] and sexes [3].

Therefore, this study aimed to examine the relationship between micro-pacing strategies and performance during a freestyle XCS distance race in women and men.
METHODS:
Nine female and 10 male XCS athletes wore a GNSS device (Catapult OptimEye S5; 10 Hz) during a senior FIS-sanctioned freestyle distance race. The race lap was 4892 m in distance with 165 m of vertical climbing. The women completed two laps (9964 m), while the men completed three laps (14678 m). The course was divided into uphill (S1, S3, S5, S7), downhill (S2, S4, S6, S8) and flat sections (S9) for analyses. In order to compare skiers' velocities at the same track locations, GNSS positioning data were resampled at every 1-m interval along the course. Statistical parametric mapping (SPM; linear regression) was used to determine the track positions where instantaneous skiing velocity was significantly associated with race time.
RESULTS:
Race time was associated with velocity during parts of S1 (the second longest climb) on lap 2 for both sexes ($t \geq 4.206$, $p < 0.001$) and on lap 3 for men ($t = 4.308$, $p = 0.047$). By contrast, race time was unrelated to velocity during S3 (the shortest climb) for both sexes. Race time was related to velocity during parts of S5 (the longest climb) on lap 1 for women ($t = 4.663$, $p < 0.001$) and on laps 2 and 3 for men ($t \geq 4.031$, $p \leq 0.009$). While race time was not related to velocity during S7 (the second shortest climb) for men, it was for women on lap 1 ($t = 3.871$, $p = 0.002$). Race time was largely unrelated to velocity during all downhill sections for both sexes. Finally, race time was related to velocity through S9 (the flat section) for women ($t = 3.716$, $p = 0.001$), but not for men.
CONCLUSION:
SPM analyses revealed specific uphill and flat track sections where athletes with faster race times skied with higher velocities, compared to athletes with slower race times. Specifically, more successful women adopted more aggressive micro-pacing strategies on some parts of the three longer uphill sections (S1, S5, S7), as well as on the flat section of the course (S9). The more successful men also adopted more aggressive micro-pacing strategies on some parts of the two longest uphill sections (S1, S5). Coaches and athletes can use this information to optimise micro-pacing strategies and improve performance.
1. Stöggl et al. (2018); 2. Ihalainen et al. (2020); 3. Andersson et al. (2019)

THE PHYSIOLOGY OF PACING: INSIGHTS FROM CLUSTERING PACING STRATEGIES DURING 5000-M TIME TRIALS IN TRAINED RUNNERS

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INTRODUCTION:
Pacing can be defined as the competitive strategy in which athletes manipulate their speed to achieve the highest performance. Previous literature demonstrated that pacing strategies vary among distances [1], events [2] and performance levels [3]. However, limitations arise from a high variability within the groups and the comparison of absolute (rather than normalised) velocities. Since physiological changes are considered the main afferent driver for regulating pace as described by the anticipatory feedback model [4], it seems reasonable that the individual pacing strategy is largely influenced by the underlying metabolic profile of the athlete. This study aims to categorise homogeneous pacing clusters and analyse differences in terms of performance and their underlying physiological profiles in trained runners and triathletes.
METHODS:
44 competitive female and male endurance runners and triathletes performed several laboratory tests to determine maximal oxygen uptake (VO2max), lactate threshold, running economy and maximal lactate accumulation rate (VLamax) [5]. Furthermore, the participants performed a 5000-m time trial on an outdoor track and were instructed to achieve the best overall performance and adjust their freely chosen pacing strategy accordingly. All 25 split times (every 200 m) were normalised to the individual mean velocity and implemented into hierarchical cluster analysis by using Ward's linkage method. Clusters were compared by using one-way ANOVA and Bonferroni-adjusted post-hoc tests or non-parametric equivalents.
RESULTS:
Three homogeneous clusters were determined. Cluster A demonstrated a moderate start, negative splits and a fast finish over the last 200 metres. Cluster B and C demonstrated rather similar pacing as shown by their fast start and rather positive splits. However, unlike Cluster C, only Cluster B demonstrated a fast finish similarly to Cluster A. There were no differences in 5000-m performance, anthropometrics and physiological parameters between clusters except for VLamax ($p = 0.006$) and the ratio between VO2max and VLamax ($p = 0.004$). Post-hoc tests revealed that the Cluster A athletes had a significantly higher VLamax ($d = 1.26$, $p = 0.005$) and lower VO2max/VLamax ($d = -0.89$, $p = 0.004$) compared to Cluster C.
CONCLUSION:
Since research in middle distance running demonstrated similar pacing strategies in females and males [3], the distribution of sexes between clusters might not influence these findings. It seems that the ability to produce lactate and concomitantly reduce intracellular pH provides an immediate afferent feedback that influences individual pacing. Thus, athletes with a high VLamax might benefit from a negative pacing strategy since a courageous start might lead to premature pace reduction or failure in these individuals.
1) Casado et al. (2020) J Sport Health Sci
2) Hanley & Hettinga (2018) J Sports Sci
3) Hettinga et al. (2019) Front Sports Act Living
4) Tucker (2009) Br J Sports Med
5) Quittmann et al. (2020) J Sci Med S

THE DEVELOPMENT OF PACING BEHAVIOUR DURING ADOLESCENCE DIFFERS BETWEEN MEN AND WOMEN: A LONGITUDINAL STUDY IN LONG-TRACK SPEED SKATING.

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INTRODUCTION:
The development of pacing behaviour (i.e. the outcome of the decision-making process regarding the distribution of effort over an exercise task) during adolescence has been established in literature [1]. However, the majority of the literature features only men and has a cross-sectional design, which is deficient in detecting developmental change. Given the established differences in maturation and cognitive

development between sexes, it is hypothesised that there are differences in pacing behaviour development between men and women [2]. The current study tested this hypothesis by longitudinally tracking the development of pacing behaviour of talented long-track speed skaters of both sexes throughout adolescence.
METHODS:
89 talented Dutch long-track speed skaters (48 women, 41 men) who were between 13 and 20 years old and performed 1500m races during two or more seasons between 2009 and 2013, were included in the study (294 performances: 158 by women, 136 by men). The split times of each skaters' season best 1500m time were converted into relative section times (RST) (i.e. the percentage of total time spent in each section of the race) in order to control for differences in performance. Using MLwiN (P<0.05), longitudinal multilevel prediction models in which repeated measures (level 1) were nested within individual athletes (level 2), were used to analyse the effect of sex (men = 0, women = 1) and age (13 years old indicated age = 0) on RST.
RESULTS:
RST 0-300m at 13 years old was lower for women than men (-1.44%) and was impacted by age for women (0.48%*age - 0.05%*age^2), there was no age effect for men. RST 300-700m at 13 years old was lower for women (-0.55%) and was impacted by age for women (0.20%*age - 0.03%*age^2) and men (-0.07*age). RST 700-1100m at 13 years old was higher for women (0.70%) and impacted by age for women (-0.36%*age + 0.03%*age^2) and men (-0.08%*age). RST 1100-1500m at 13 years old was higher for women (1.43%) and impacted by age for women (-0.51%*age + 0.04%*age^2) and men (0.18%*age).
CONCLUSION:
The multilevel models indicate that the effect of age on RST in women is characterized by a quadratic relationship, indicating a decrease in the development of pacing behaviour during late adolescence (17-19 years old). On the other hand, the effect of age on RST in men is characterised by a linear relationship, indicating a continuation of pacing behaviour development through late adolescence and into early adulthood. These findings suit previous literature, which describes women' musculoskeletal maturation to drop off after ~17 years of age, whereas men' muscles growth continues into their twenties [2]. Moreover, women exhibit an earlier onset and completion of puberty related cognitive development, compared to men [2]. Coaches should take into consideration not only that the pacing behaviour of athletes develops during adolescence, but also that this development differs between sexes.
1. Menting et al. (2019)
2. Elferink-Gemser & Hettinga (2017)

THE METRONOME AS A COACH'S TOOL TO INVESTIGATE SWIMMING PERFORMANCE

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INTRODUCTION:
The metronome is increasingly used in cyclical sports as in swimming [1,2]. This is because it allows coaches and athletes to find the right balance between stroke frequency and length during training sessions to learn and customize the best race strategy. The aim of this study was to investigate whether the use of metronome could be useful in the evaluation of the athletes performance during the training period.
METHODS:
Fourteen competitive swimmers performed three 50m freestyle time trials during pre-season and after 2 months, during the in-season period. The outcome parameters used to evaluate the performance were: the total time on 50m (TT), the mean intra-stroke-interval (ISI) and the stroke length (SL). During the first trial participants were asked to swim at their maximum intensity without metronome (NO-metronome condition) and ISI was computed as the time between strokes. The mean value of ISI of each subject was used as individual reference value. In the second trial, swimmers were asked to swim in synchronous with the audio feedback provided by a waterproof metronome positioned under the swimming cap and set at own ISI value measured in the first trial (MET100). During the third trial, the metronome was set at 95% of the ISI measured without metronome, i.e., the 5% shorter than MET100 condition (MET95 condition). The swimmers repeated these three trials during the in-season period. The parameters evaluated in NO-metronome condition in pre- and in-season were compared by means of a paired t-test. The parameters measured during MET100 and MET95 conditions were analysed by means of ANOVA with time (pre-season vs. in-season period) and ISI (MET100 vs. MET95) as within-subject factors. Newman–Keuls post hoc tests were applied in the presence of a significant effect ($p \leq 0.05$).
RESULTS:
In NO-metronome condition, TT was lower in the in-season period with respect to the pre-season period (p=0.05), whilst no significant change was observed for ISI (p=0.18) and SL (p=0.352). On the other hand, SL evaluated with metronome showed a significant effect of time (p=0.045) with SL significantly larger in the in-season period with respect to pre-season period. With reference to metronome, a reduction in SL was observed in MET95 with respect to MET100, indicating a significant effect of stroke rate on SL.
CONCLUSION:
In this study, we showed that the use of the metronome is able to disentangle between the different parameters influencing performance improvement. Indeed, in NO-metronome condition although the TT was shorter in the in-season period it was not possible to identify the parameters responsible of this result. Conversely, with metronome, there was a significant change of SL with time suggesting that athletes improved stroke efficiency with training sessions. In conclusion, we think that our metronome approach could be useful for coaches.
REFERENCES:
[1] van Houwelingen, J. PloS one, 2017.
[2] Yamakawa, K. Human movement science, 2017.

16:30 - 18:00

OP-MD02 Muscle - Tendon / Gender

DEVELOPMENT OF MUSCLE-TENDON ADAPTATION IN PREADOLESCENT ATHLETES AND NON-ATHLETES: A 12-MONTH LONGITUDINAL STUDY

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INTRODUCTION:
Longitudinal investigations concerning the development of muscle and tendon adaptation and the effects of specific athletic training during preadolescence are scarce (1,2). The purpose of the current study was to investigate the effects of long-term athletic training on the development of the triceps surae muscle-tendon unit properties in preadolescence.
METHODS:
We recruited 21 preadolescent artistic gymnastic athletes and a group of eleven untrained children of similar age (9 ± 1.7 years) and maturity (Tanner Stage I and II). The measurements were conducted every three months for one year, and the training volume and duration of the athletes were documented for one week every month. By integrating kinematics, ultrasonography and dynamometry we measured the muscle strength of the plantar flexors, Achilles tendon stiffness, maximum tendon strain and gastrocnemius medialis (GM) morphometrics. A linear mixed-effects model was used to analyse the investigated parameters. Statistical tests were performed comparing intercepts between groups, checking if slopes were different from zero (difference over time) and if slopes differed between groups. A comparison of the residual variance between groups was investigated by assessing the fluctuations around the model.
RESULTS:
We found greater muscle strength ($p<0.001$) in athletes compared to non-athletes but no differences in Achilles tendon stiffness ($p=0.252$), indicating a training-induced imbalanced adaptation of muscle strength and tendon stiffness in preadolescent athletes. Although GM pennation angle ($p=0.490$), thickness ($p=0.917$) and fascicle length ($p=0.667$) did not differ between athletes and non-athletes, we found higher fluctuations in muscle strength and angle of pennation over the one-year period in athletes. The imbalanced adaptation of muscle strength and tendon stiffness together with the greater fluctuations of muscle strength resulted in a higher frequency of athletes (67%) with high-level tendon strain (≥9%) compared with non-athletes (46%) and greater tendon strain fluctuations over the one-year period ($p=0.017$).
CONCLUSION:
The study shows negligible effects of athletic training on tendon stiffness and GM muscle morphometrics in preadolescence. We provide first-time evidence that a specific long-term athletic training in preadolescence with a high loading demand for the triceps surae muscle-tendon unit, mainly by jumping and landings exercises, is associated with higher fluctuations of Achilles tendon strain and a temporarily increased mechanical demand for the tendon indicating the implementation of individual tendon training concepts (3) in preadolescent athletes.
REFERENCES
1) Pentidis et al, Front Physiol, 2019
2) Waugh et al, J Appl Physiol, 2014
3) Arampatzis et al, Front Physiol, 2020

FEMALE LEADERSHIP IN SPORT SCIENCES: REPRESENTATION OF WOMEN IN PUBLICATIONS AND EDITORIAL BOARD POSITIONS

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ECSS Virtual Congress 2021, September 8-10 2021
Female leadership in sport sciences: representation of women in publications and editorial board positions
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Background
Gender inequality in leading scientific positions and academia deserves attention (1). Women are underrepresented in a variety of scientific fields (2). However, the gender gap in Sport Sciences research leadership remains unknown. The aim of this study is to provide an overall picture of the representation of women in sport sciences research leadership by assessing the proportion of women in (i) leading authorship positions of randomized controlled trials (RCTs) published from January 2000 to September 2020 in sport sciences journals and (ii) editorial boards of these journals as of September 2020.
Methods
PubMed was searched for articles filtered as RCTs published from January 1, 2000, to September 1, 2020, in 14 sport sciences journals from the 2019 Journal of Citations Reports (JCR) ranking. The sex of first and senior authors, as well as editorial board members, was identified through photographs, sex pronouns, Google Scholar, ResearchGate, and other institutional or social media profiles.
Results
A total of 4,841 articles were analyzed. The average proportions of female first and senior authorship were 24.8% and 16.8%, respectively. The percentage of female first authorship increased by ~0.5% annually ($\beta=0.702$; $B=0.46$, 95% CI=0.24 to 0.68, $p<0.001$) from 2000 to 2020, while the percentage of female senior authorship did not change over time ($\beta=0.274$; $B=0.15$, 95% CI=-0.102 to 0.398, $p=0.230$). Among the editorial boards' positions, 18.3% were occupied by women. None of the editors-in-chief of the selected journals were women.
Discussion

The findings revealed that women are markedly underrepresented in leading authorship and editorial board positions in sport sciences, despite a ~0.5% annual increase in female first authorship in the past two decades. The mechanisms underlying these findings (e.g., demographic inertia, pipeline theory, Matilda effect, among other) and the actions needed to reduce potential gender inequalities in this field warrant further research.

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RELATIONSHIP BETWEEN REPEATED REBOUND JUMP PERFORMANCE AND STEP CHARACTERISTICS DURING 5000-M RACE IN ENDURANCE RUNNERS

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INTRODUCTION:
Stretch-shortening cycle (SSC), which is a combination of a rapid eccentric action followed immediately with a concentric action, enhanced the force output in the short amount of time (Komi, 2000). Moreover, while better SSC function would contribute to improve running economy by prompting the utilization of musculotendinous elastic energy (Fletcher & MacIntosh, 2017), it can be speculated that SSC function may affect step characteristics during running, which are key factors of endurance race performance (Hasegawa et al., 2007), due to increase the leg muscle power. However, the relationship between SSC function and step characteristics during the competitive endurance race remains unclear. Therefore, the present study aimed to determine the relationship between SSC function and step characteristics in competitive 5000-m races.
METHODS:
Twenty-two male competitive endurance runners participated in this study. Participants performed counter movement jump (CMJ) and repeated rebound jump (RJ) for estimating SSC function of limbs (Markovic & Mikulic, 2010). Flight time and contact time during each jump were measured using a contact mat system. For the CMJ and RJ, jump height was calculated. For the RJ, RJ-index were calculated as jump height/contact time. The analysis of step characteristics was conducted in 5000-m races. Step length, step frequency, contact time, flight time of 4 consecutive ground contacts were measured every 400-m by using high-speed video image. Moreover, step length index was calculated as step length/contact time to evaluate SSC function during running. In addition to step characteristics on each lap, average values of all laps were used for analysis of this study.
RESULTS:
RJ-index correlated significantly with average and maximum, minimum contact time during 5000-m race ($r = -0.499$ and -0.540, -0.626, $P < 0.05$ for all). Additionally, RJ-index correlated significantly with average and maximum, minimum step length index during 5000-m race ($r = 0.463$ and 0.506, 0.551, $P < 0.05$ for all). Moreover, to minimize the differences in running speed among participants, step characteristics were normalized to running speed, and RJ-index correlated significantly with relative values of average and maximum, minimum contact time ($r = -0.504$ and -0.508, -0.621 $P < 0.05$ for all). Furthermore, RJ-index correlated significantly with the relative value of minimum step length index ($r = 0.530$, $P < 0.05$).
CONCLUSION:
The present study showed that better RJ-index was associated with shorter contact time and higher step length index during the 5000-m race. These findings suggest that better SSC function is advantageous in decreasing contact time and increasing step length index during the race in endurance runners.
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OP-PN08 Temperature; Cardiovascular Physiology

NO DIFFERENCES IN ACUTE LUNG FUNCTION RESPONSES BETWEEN TWO COLD AIR EXERCISE TRIALS OF DIFFERENT DURATIONS.

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INTRODUCTION:
During or shortly after strenuous exercise, some individuals may exhibit exercise-induced bronchoconstriction (EIB) (1). Training in sub-zero temperatures, where the inspired air is cold and dry, can exacerbate the physiological stimuli that give rise to EIB and accentuate lung injury (2). To date, little is known about the training factors, such as duration and modality of exercise that result in airway damage in cold environments. Here, we aimed to examine the influence of exercise duration in cold on lung function and EIB incidence among healthy individuals.
METHODS:
Eighteen healthy, non-asthmatic, physically active volunteers (males/females: 14/4, age: 29.4 ± 5.9 years old, maximal oxygen consumption [$\dot{V}O_2max$]: 61.3 ± 8.7 ml/kg/min) who had never competed at the elite level, completed two moderate-intensity (60% $\dot{V}O_2max$) climate chamber running trials at -15 ºC lasting for 30 and 90 min in a randomized cross-over design. Impulse oscillometry (IOS) was conducted before, 12, and 50 min post-trials to assess resistance at 5 and 20 Hz as well as reactance at 5Hz. Forced expiratory volume in 1s (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio were measured via dynamic spirometry before, 15, and 55 min after the trials. Two-way repeated measures ANOVAs were performed to determine the impact of trial and time on the percentage change of IOS and spirometry variables.
RESULTS:
There were no significant effects of trial (30 min vs 90 min trial), time (pre-trial vs post-trial time points), or interaction effects for any spirometry or IOS variable. None of the participants exhibited EIB, defined as a ≥10% reduction in FEV1, at any time point (15 min after

exercise: +0.37 ±1.95% for the 30 min trial and -0.25 ± 3.47% for the 90 min trial; 55 min after exercise: +0.85 ± 2.32% for the 30 min trial and +0.15 ± 3.97% for the 90 min trial).
CONCLUSION:
The acute lung function responses to exercise did not differ between the 30- and 90-min trials. Additionally, moderate-intensity exercise at -15 ºC did not lead to lung function decrements or onset of EIB in healthy individuals who train regularly outdoors.
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EXERCISE PERFORMANCE AND THERMOREGULATORY RESPONSES OF ELITE ATHLETES EXERCISING IN THE HEAT: OUTCOMES OF THE THERMO TOKYO STUDY

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INTRODUCTION:
The environmental conditions during the Tokyo Olympic Games are expected to be challenging. Hence, participating athletes are at risk to develop profound core temperature elevations and experience reductions in exercise performance. We examined the impact of simulated Tokyo 2020 environmental conditions on exercise performance, thermoregulatory responses and thermal perception among Dutch elite athletes.
METHODS:
105 elite athletes from different sport disciplines (N=27 endurance trained athletes, N=31 mixed trained athletes, n=12 power trained athletes and n=35 Skill trained athletes) performed two individualized exercise tests in simulated control (15.9±1.2°C, relative humidity (RH) 55±6%) and Tokyo (31.6±1.0°C, RH 74±5%) environmental conditions. The exercise tests consisted of a 20 min warm-up (70% HRmax), followed by an incremental phase until volitional exhaustion (5% workload increase every 3 min). Exercise performance (time to exhaustion and peak power output), gastrointestinal temperature (Tgi), heart rate, and thermal perception were measured and compared across conditions.
RESULTS:
Time to exhaustion was 16±8 min shorter in the Tokyo versus the control condition (44±10 min versus 60±14 min, $p<0.001$), corresponding to a reduction of 26±11%. Peak power output decreased by 0.5±0.3 W/kg in the Tokyo condition (2.6±0.8 W/kg versus 3.1±1.0 W/kg, $p<0.001$) corresponding to a reduction of 16±7%. For both performance outcomes, large variations in heat stress induced decrements in exercise performance were observed across athletes (-48% to +15%). Greater exercise-induced increases in Tgi (1.8±0.6°C versus 1.5±0.5°C, $p<0.001$) and higher peak Tgi (38.9±0.6°C versus 38.7±0.4°C, $p<0.001$) were found in the Tokyo versus control condition. Again, large inter-individual variations in exercise-induced increase in Tgi (range: 0.7–3.5°C) and peak Tgi (range: 37.6–40.4°C) were found in the Tokyo condition, with greater responses in endurance versus mixed- and skill trained athletes. There were no associations between peak Tgi or exercise-induced increase in Tgi and performance outcomes. Peak thermal sensation and thermal comfort scores deteriorated in the Tokyo condition, with aggravated responses for power versus endurance- and mixed trained athletes.
CONCLUSION:
The Tokyo climate has a major impact on the exercise capacity of non-acclimated elite athletes, independent of sports discipline. A large interindividual variability was found for exercise capacity and thermoregulatory responses, whereas no significant association was found between peak core temperature and performance outcomes. Findings from this study emphasize that it is impossible to offer a 'one-size-fits-all' heat mitigation strategy to elite athletes and underline the importance to determine the individual's needs for heat acclimation and cooling interventions to allow safe and maximal exercise performance during the Tokyo Olympics.

HIIT AND HEAT FOR VASCULAR HEALTH

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INTRODUCTION:
Exercise is essential for preventing the development of cardiovascular disease, however much of the worlds global population fail to perform the recommended amount of physical activity, resulting in an unprecedented rise in global obesity and cardiovascular diseases (CVD). Furthermore, the rise in CVD has been associated with an increase in cerebral vascular diseases including vascular dementia and stroke. Additionally, other therapies such as passive heating have been compared with exercise and through the same shear rate mediated mechanism, appear effective at inducing cardiovascular benefits. However, understanding how shear rate increases with passive heating relative to different exercise intensities is important to determine specific guidelines for CVD and cerebrovascular disease prevention. While shear rate increases during exercise and passive heating, cardiovascular alterations are known to occur for prolong periods after the interventions, which contribute to vascular adaptations.
METHODS:
Therefore, we aimed to compare the increase in shear rate in the cerebral (internal carotid (ICA) and vertebral (VA)) and peripheral (common femoral) vasculature using Doppler ultrasound immediately after, and at 20-minute intervals up to 80 minutes following passive heating and treadmill running. In a randomised crossover design study, 15 moderately trained (VO2, 55.8 ± 10.4 ml·kg·min-1) participants (age, 27 ± 4 years) underwent 30 minutes of whole-body passive hot water immersion (PH) (42°C), 30 minutes threshold running, performed at participants respiratory compensation point and 5x4 min high intensity intervals (HIIE) (85-95% maximum heart rate).
RESULTS:
All interventions produced comparable increases in ICA (PH Δ15 ± 41, threshold Δ30 ± 48, HIIE Δ32 ± 38 s-1) (P=0.4643) and VA shear rate (PH (Δ19 ± 25 s-1, threshold Δ38 ± 27 s-1, HIIE Δ 31 ± 26 s-1) (P=0.1940). Furthermore, all interventions produced comparable increases in femoral shear rate (PH Δ118 ± 34 s-1, threshold 97 ± 31 s-1, HIIE 104 ± 30 s-1) (P=0.0671), however HIIE kept peripheral shear rate elevated for a longer (60 mins, P=<0.0464), post intervention compared with both other conditions.
CONCLUSION:
Threshold running and HIIE provide comparable increases in cerebral and peripheral artery shear rate to passive heating when measured post intervention. However, shear rate remains elevated to a greater extent in the peripheral vasculature following high intensity exercise

compared with passive heating and threshold running. Such findings provide further support for the application of passive hot water immersion and high intensity exercise for maintaining cerebral and peripheral vasculature health in young healthy individuals.

ECCENTRIC VERSUS CONCENTRIC CYCLING EFFECTS ON CEREBRAL BLOOD FLOW IN HEALTHY ADULTS

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INTRODUCTION:

INTRODUCTION: Eccentric cycling (ECC) allows for a greater muscular workload at a reduced cardiovascular burden, prolongs the onset of the ventilatory threshold, and is associated with greater neuronal activation compared to concentric cycling (CON). The present study investigated if cerebrovascular responses would be different between ECC and CON.

METHODS:

METHODS: Healthy adults (8♂, 8♀) were randomized to a within-subject cross-over study, using ramped CON and ECC cycling protocols with workload being matched at 50-65% heart rate (HR) reserve. Middle (MCAv) and posterior (PCAv) cerebral artery velocities, and femoral artery blood flow during and after cycling were measured via B-mode ultrasound. Blood pressure (MAP), HR, rate pressure product (RPP), cardiorespiratory measures and rate of perceived exertion (RPE) were also compared between exercise modalities.

RESULTS:

RESULTS: Cerebral blood flow increased to the same extent during ECC and CON, despite lower respiratory ($\dot{V}O_2$ 14±3 vs 17±3 ml·kg-1·min-1, P=0.019; $P_{ET}CO_2$ 27±3 vs 31±3 mmHg, P=0.031) and cardiovascular responses (SBP 151±18 vs 166±18 mmHg, P=0.032, RPP 18359±643 vs 20308±660 mmHg*bpm), with a hyperventilatory response (RR 29±5 vs 22±5 BMP, P=0.025; $\dot{V}t$ 1±0.2 vs 2±0.2 L, P<0.001) during ECC than CON. Similar physical RPE (14±2 vs 13±2, P=1.00) and workload (146±51W vs 89±51W, P=0.16) were reported, with higher reported mental RPE (14±2 vs 11±3, P=0.035) in ECC.

CONCLUSION:

CONCLUSION: When matched for HR, ECC cycling conferred similar cerebral blood flow velocity despite significantly lower physiological regulators such as $P_{ET}CO_2$, $\dot{V}O_2$ and SBP. This highlights the potential for ECC cycling as a beneficial mode of exercise to optimise cerebrovascular blood flow for individuals with reduced $\dot{V}O_2$, such as those with advancing age and clinical conditions, including cardiovascular disease.

OP-AP12 Analyses of Workload and performance

LONGITUDINAL EXAMINATION OF IN-SEASON EXTERNAL WORKLOAD IN WOMEN COLLEGIATE BASKETBALL ATHLETES

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INTRODUCTION:

Quantifying external workload provides insight into physical stress imposed upon athletes during training and games. By design, pre-season training should prepare athletes for the rigors of the competitive season, yet athletes often experience higher workloads in games than practice (1). Further, lower pre-season workloads are associated with a higher incidence of in-season injury (2). Substantial differences in workloads of primary and secondary players have been reported in sports other than women's collegiate basketball (3). Therefore, the purpose was to compare game external workloads of primary and secondary players, and categorize pre-season practices relative to game load.

METHODS:

National Collegiate Athletic Association Division I women collegiate basketball athletes (n=16, mean±SD age: 20.46±1.56 yr; body mass: 83.01±42.94 kg.; height: 176.95±3.17cm; bodyfat: 24.07±9.68%; VO2max:45.45±7.56mL·kg-1·min-1) participated. External load metrics included player load (PL), PL/min, high inertial movement analysis (IMA; >3.5 m/s2), and total jumps (TJ). Metrics were collected for two seasons of conference games (n=32), and pre-season practices (n=57) utilizing 10 Hz GPS/GNSS technology. Athletes were classified based upon game minutes played as primary (played ≥15 minutes/game) or secondary (played <15 minutes/game). Multivariate analyses of variance assessed differences in game metrics between primary and secondary players ($p<0.05$). Practice metrics were classified relative to game metrics as: high (>1 SD above the mean), medium (1 SD below the mean), low (2 SD below the mean), and very low (3 SD below the mean).

RESULTS:

During gameplay, primary players experienced greater PL (F=470.37, p<0.001, 612.50 ±144.69 vs. 295.32 ±210.64 AU), PL/min (F=453.91, p<0.001, 5.49 ±1.28 vs. 2.68 ±1.22 AU/min), IMA (F= 334.17, p<0.001, 40.27 ±15.76 vs. 13.53 ±11.40 #), and TJ (F= 61.20, p<0.001, 52.49 ±20.70 vs. 36.52 ±17.80 #) compared to secondary players. Compared to games, pre-season practice metrics were classified as: a) PL: 7% high, 44% medium, 42% low, 7% very low; b) PL/min: 12% high, 40% medium, 37% low, 10% very low; c) IMA: 2% high, 47% medium, 49% low, 2% very low; d) TJ: 42% high, 40% medium, 16% low, 2% very low.

CONCLUSION:

Findings indicate primary players experienced greater external game workloads than secondary players. Further, the majority of pre-season practices were of medium loads for PL and PL/min, low loads for IMA, and high loads for TJ, indicating game loads were not achieved consistently. It is recommended practitioners strategically plan pre-season practices in order to ensure athletes are prepared to sustain game workloads. In-season, supplemental training for secondary players may be useful to avoid detraining adaptations.

INDIVIDUALIZED HIGH-INTENSITY INTERVAL TRAINING IMPROVES SOME PHYSIOLOGICAL DETERMINANTS OF PERFORMANCE MORE THAN STANDARDIZED TRAINING IN DISTANCE RUNNERS

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INTRODUCTION:

Coaches often include high-intensity interval training (HIIT) sessions in their plan to develop specific physiological adaptations and enhance athletic performance in distance runners. The prescription is usually performed by a standardized and common empirical approach, in which runners of a similar level train together using the same exercise intensities. However, previous studies [1-5] showed that it is possible to target some physiological adaptations by individualizing HIIT prescriptions according to the physiological characteristics of the runners and their responses to exercise. As far as we know, there has been no investigation comparing the effects of an evidence-based individualized HIIT against a standardized HIIT in a large group of runners. Therefore, we compared the effects of these two different training prescription models on physiological adaptations and performance in distance runners.
METHODS:
Forty-five distance runners (35 men and 10 women, age: 36±8 yr, 10000-m performance: 44:06±5:01) were tested before and after 8 weeks of training. Maximal oxygen uptake (VO2max), running economy (RE), peak treadmill running speed (Vpeak), and lactate threshold (Dmod) were determined during an incremental test performed on a treadmill, followed by a verification test. 10000-m performance was measured on a 400-m track. The intervention consisted of replacing ~20% of the runners' habitual weekly training volume with 2 sessions of either individualized (IND; n=23) or standardized (STD; n=22) HIIT. Repeated intervals were performed at the speed halfway between Vpeak and Dmod, as described by [1-5]. HIIT prescriptions were individualized according to each runner's physiological values in IND, whereas the average group values were used for STD. IND and STD were matched for HIIT characteristics at the group level.
RESULTS:
VO2max significantly improved only in IND (+2.7 mL/kg/min, p=.003, 95% confidence interval [CI]: +1.0 to +4.5), with a statistical difference of 3.4 mL/kg/min (p=.038, 95%CI: 0.2 to 6.5) between the groups. RE significantly improved only in IND (-4.5 mL/kg/km, p=.030, 95%CI: -8.6 to -0.5), with no significant difference between the groups. Vpeak significantly improved only in IND (+0.4 km/h, p<.001, 95%CI: +0.2 to +0.6), with a statistical difference of 0.5 km/h (p=.022, 95%CI: 0.1 to 0.9) between the groups. No significant changes or differences were observed in Dmod and 1000-m performance.
CONCLUSION:
The present findings show that individualizing HIIT prescriptions according to the physiological responses to exercise induces superior adaptations for some physiological variables related to performance (VO2max and Vpeak) compared with standardized prescriptions in distance runners. These results may be helpful for coaches aiming to improve specific physiological attributes of their athletes during certain training phases.
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TRAINING LOAD MONITORING IN TEAM SPORTS: A PRACTICAL APPROACH TO ADDRESSING MISSING DATA

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INTRODUCTION:
Training load (TL) is a modifiable risk factor that may provide practitioners with opportunities to mitigate injury risk and increase sports performance. A regular problem encountered by practitioners however, is the issue of missing TL data. The purpose of this study was to examine the impact of missing TL data in team sports and to offer a practical and effective method of missing value imputation (MVI) to address this.
METHODS:
Session rating of perceived exertion (sRPE) data from 10 male professional soccer players (age, 24.8 ± 5.0 years; height, 181.2 ± 5.1 cm; mass, 78.7 ± 6.4 kg) were collected over a 32-week season. Data were randomly removed from the complete dataset at a range of 5 – 50% in increments of 5%. Data were then imputed using twelve MVI methods. These methods were theorized and examined based on their structure and their practicality (i.e. can be feasibly used by a practitioner working with a team). Additional metrics derived from sRPE data were calculated, and illustrated, to demonstrate the impact missing data has on their computation. The Normalized Root Mean Squared Error (NRMSE) and the Mean of Absolute Deviations (MAD), standard statistical metrics to measure model performance, were used to compare the performance of the MVI methods across the levels of missingness.
RESULTS:
The best-fitting MVI method was Daily Team Mean (DTMean) with NRMSE ranging from 0.42 – 0.46 across all levels of missingness. The MVI methods of Daily Team Median (DTMedian), Mixed Mean, Mixed Median, Mixed R4W Mean and Mixed R4W Median produced similar NRMSE values of 0.44 – 0.49. The methods of Player Mean (PM), Player Median, R4W Player Mean, R4W Player Median, Day of Week Mean and Day of Week Median were each a poorer fit with NRMSE values of 0.48 – 0.68. For all imputation methods, as the percentage of missing data increases so too does the MAD in a linear manner. At 5% missingness, the mean MAD value of all MVI methods is 9.2 while at 50% missingness this increased to 90.8. Additionally, not addressing missing sRPE data may lead to more inaccurate calculations of other TL metrics (e.g. acute chronic workload ratio, training monotony, training strain).
CONCLUSION:
Practitioners should strive to keep missing data at a minimum. However, when collecting TL data longitudinally, missing data is inevitable due to many factors. The DTMean MVI method offers practitioners, working with teams, a practical and effective method of addressing the negative consequences of missing TL data. The DTMean MVI method appears to be easy to use, quick to calculate, does not require specialist software or previous data collection. As the monitoring of TL is becoming more and more prevalent, the findings of this study address an ever increasing challenge for practitioners working with team sport athletes.

ASSUMING THE STANDARD 1 MET VALUE OF 3.5 ML/KG/MIN IN OLDER ADULTS MISCLASSIFIES TIME SPEND IN SB AND PA INTENSITIES.

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INTRODUCTION:
The metabolic equivalent of task (MET) provides a feasible approach for classifying physical activity (PA) intensity as a multiple of the resting metabolic rate (RMR). The RMR standard value of 1 MET is generally assumed as 3.5 ml/kg/min, a value that has been criticized for being inappropriate in the older adult population. This fact could represent an important bias when classifying the activity intensity and derived scientific conclusions. However, to our knowledge, it has hardly been investigated. Therefore, the aim of this work was to assess

the individual 1 MET value of older adults over 65 years old and to compare MET estimates and intensity allocation when applying the standard and individual value of 1 MET.
METHODS:
Twenty-one older adults (women n=11, 76±4.79yrs, BMI 28.0±2.96) were assessed for their RMR and energy expenditure during different activities of daily living (ADL). The RMR was used to estimate the individual value of 1 MET. Each participant was tested for 30 minutes while lying at rest under quiet, dimly lighted, and thermoneutral conditions, and after an overnight fast no stimulants ingestion and no PA. For 1 MET derivation, the first 5 minutes were discarded, and the most stable 5 minutes period, of the remaining 25 minutes, were selected (steady-state criteria: CV<10% for VO2, VCO2 and, VE; CV<5% for RER). Participants then completed a total of 9 ADL chosen as representative of sedentary behaviors (SB: ≤1.5 METs), light physical activities (LPA: >1.5-<3 METs), and moderate-to-vigorous physical activities (MVPA: ≥3METs). Both RMR and ADL were assessed using a portable indirect calorimeter (K5, Cosmed, Italy). Finally, a paired sample t-test was used to compare differences among both standard and individual METs estimates and Pearson X2 to compare intensity allocation.
RESULTS:
An individual average 1 MET value of 2.9±0.8 ml/kg/min was obtained from 21 older adults over 65 years old. Applying the standard value of 1 MET provided significantly different MET estimates during ADL performance than those derived applying the individual value of 1 MET (2.7±1.8 vs 3.7±2.9 ml/kg/min, respectively, $p<0.05$). In addition, when comparing time spent in SB, $X2(2, N =21) = 524.21$, $p<.001$), LPA, $X2(2, N =21) = 178.70$, $p<.001$ and MVPA, $X2(2, N =21) = 616.83$, $p<.001$, differences were also observed. Accordingly, assuming a standard value of 1 MET overestimated SB by 49% and underestimated LPA and MVPA by 24 and 11%, respectively, when compared to the individual value of 1 MET.
CONCLUSION:
The standard value of 1 MET (3.5 ml/kg/min) seemed to be overestimated in older adults over 65 years old. Consequently, METs estimates were different, with misclassification of time spent in SB, LPA, and MVPA. These results highlight important biases when using standardized methods for PA quantification and possibly misinterpreting association with health outcomes in this population. Further studies are needed to confirm these results.

THE U-SHAPED RELATIONSHIP BETWEEN ENERGY COST AND WALKING SPEED CAN BE EXPLAINED BY BELLY AND TENDON GEARING?

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INTRODUCTION:
In level walking, net energy cost (Cnet) shows a “U-shaped” response as a function of speed, with a minimum at about 4-5 km·h-1; when walking at faster or slower speeds Cnet increases (1). The inverted pendulum paradigm of walking predicts that Cnet will be the lowest when the exchange between potential and kinetic energy is maximized (and this also occurs at about 4-5 km·h-1): less muscle work is thus needed “to keep the pendulum going” allowing for metabolic energy savings. The present study combines in-vivo ultrasound measurements of vastus lateralis (VL) and gastrocnemius medialis (GM) with metabolic and kinematic measurements during walking at different speeds in order to investigate whether changes in Cnet could be explained by lower limb muscles behavior (e.g. belly gearing) and/or tendon behavior (e.g tendon gearing).
METHODS:
Fourteen (7M/7F) healthy subjects (age: 27.6 ± 4.6 years; body mass: 63.4 ± 11.6 kg; height: 1.69 ± 0.08 m) walked naturally on a treadmill at 7 speeds (from 2 to 8 km·h-1, with steps of 1 km·h-1) for at least six minutes at each step. During each trial, kinematic data of 49 markers (a customized full-body Plug in Gait) and muscle geometrical changes of GM and VL were collected using a 3D motion capture system (Vicon, Oxford, UK; sampling rate 200 Hz) and an ultrasound apparatus (Telemed MicrUs EXT-1H rev. D; sampling rate 115 Hz), respectively. Oxygen uptake was recorded by means of a breath by breath metabolimeter (K5, Cosmed, Italy). Total mechanical work at the whole-body level (Wtot) was calculated based on kinematic data. Cnet was calculated as the ratio between net oxygen uptake and walking speed. MTU length was calculated based on joint angles data. Belly gearing was calculated as the ratio between belly and fascicle velocity (vbelly/vfas) and tendon gearing as the ratio between and MTU and belly velocity (vMTU/vbelly) (2).
RESULTS:
Wtot increased linearly as a function of velocity ($P<0.001$) whereas Cnet followed a U-shaped function ($P<0.001$) with a minimum at 4.1 km·h-1. MTU, belly and fascicle velocity of GM and VL increased with walking speed ($P<0.001$). Tendon gearing was unaffected by velocity whereas belly gearing changed significantly with it in both muscles ($P<0.01$ and $P<0.001$ for GM and VL), showing a parabolic trend with a maximum around 4.7 km·h-1.
CONCLUSION:
Our results suggest that in walking, changes in energy cost could be explained by lower limb muscles behavior (e.g. belly gearing), whereas the elastic components (tendon gearing) play only a marginal role in determining the metabolic demands of walking (3).
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THE EFFECTS OF ABSOLUTELY-COMPARED TO RELATIVELY-DEFINED INTENSITY WALKING ON PHYSICAL ACTIVITY OUTCOMES: A SYSTEMATIC REVIEW WITH META ANALYSIS

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INTRODUCTION:
A metabolic equivalent (MET) is one of the most common methods used to objectively quantify physical activity intensity [1]. Although the MET provides an ‘objective’ measure, inter-individual differences in cardiorespiratory fitness are not accounted for [2,3]. In contrast, ‘relative’ measures of physical activity intensity, such as heart rate reserve (HRR), do account for cardiorespiratory fitness. The purpose of this systematic review with meta-analysis was to compare measures of absolute and relative physical activity intensity used to prescribe walking.

METHODS:
A systematic search of four databases (SportDiscus, Medline, Academic Search Premier and CINAHL) was completed. Keyword searches were: (i) step* OR walk* OR strid* OR "physical activity"; (ii) absolute OR “absolute intensity” OR mets OR metabolic equivalent OR actigraph* OR acceleromet*; (iii) relative OR “relative intensity” OR "heart rate" OR "heart rate reserve" OR “VO2 reserve” OR VO2* OR “VO2 uptake” OR HRmax* OR metmax. Categories i to iii were combined using ‘AND’. A series of Bayesian random intercept regression models were used to quantify the relationship between METs and %HRR, with a Bayesian random intercept logistic regression conducted to examine the agreement between methods. A modified Downs and Black checklist, incorporating 14 questions relevant to cross-sectional study design, was used to assess quality and risk of bias in all studies.
RESULTS:
A total of 16 papers were included in the systematic review. A comparison of means between absolute (METS) and relative (%HRR, %HRmax, %VO2r, %VO2max, HRindex) values in 13 studies (n=671 participants), across 27 walking trials, identified disagreement in the classification of physical activity intensity (light, moderate or vigorous) in 52% of the trials. We received raw data from three authors, incorporating three separate studies, totalling 289 participants. The best model, in terms of out-of-sample predictive performance, was a log-log regression model. It showed that for every 1% increase in METs, %HRR increased, on average, by 1.12% (95% CI: 1.10 – 1.14). Specifically, at the lower bound of absolute moderate intensity (3 METs), %HRR was estimated to be 33% (95%CI: 18 – 57) and at vigorous intensity (6 METs) %HRR was estimated to be 71% (38 – 100). The logistic regression showed that, in approximately 51% of cases, there was disagreement between intensity classifications.
CONCLUSION:
This study highlights the discrepancies between absolute and relative measures of physical activity intensity with large disagreement observed between methods and large variation in %HRR at a given MET. The large inter-individual differences associated with %HRR may indicate the need for personalised physical activity guidelines and monitoring. Future research should focus on the efficacy of relative measures of physical activity intensity.
1. Tudor-Locke et al., 2018; 2. Bryne et al., 2005; 3. Ianetta et al., 2021

IS-MH04 Physiological and psychological impact of High Intensity Interval Training (HIIT) on health and wellbeing

PHYSIOLOGICAL AND METABOLIC RESPONSES TO HIGH INTENSITY INTERVAL TRAINING (HIIT): INFLUENCE OF EXERCISE BOUT DURATION

BOGDANIS, G.

NATIONAL & KAPODISTRIAN UNIVERSITY OF ATHENS

Although the adaptations to HIIT have been largely examined during the last decade, most evidence come from exercise sessions using repeated 1 min or 4 min bouts of exercise at intensities around 90-100% of maximal oxygen uptake (VO2max) or repeated 5-30 s sprints. However, recent studies show that changing the exercise bout duration (e.g. from 30 s to 60 or 120 s) modifies not only the physiological and metabolic responses, but also psychological aspects, such as pleasure and enjoyment. Although there is limited information up to date, the available evidence shows large differences in aerobic and anaerobic contribution to energy supply during isoenergetic exercise formats with bouts of shorter and longer duration. By presenting the differences in metabolic and physiological responses to HIIT using different bout durations, this presentation will set the background for the next two talks that will focus of fat metabolism and psychological responses to HIIT. This information is useful for researchers and practitioners who will use it to manipulatebout and interval duration during HIIT, in order to achieve different effects and health benefits. Also, this evidence will help to explain the variability of adaptations and psychological responses to HIIT
3observed in the literature and will contribute to the work towards optimization and individualization of HIIT protocols aiming to promote health and wellbeing.

LIPID OXIDATION IN RESPONSE TO HIGH INTENSITY INTERVAL TRAINING

ASTORINO, T.A.

CALIFORNIA STATE UNIVERISTY SAN MARCOS

One hallmark adaptation to completion of moderate intensity continuous training (MICT) is enhanced reliance on lipid and reduced oxidation of carbohydrate (CHO) during endurance exercise. This adaptation is important considering the necessity to spare glycogen during prolonged exercise as well as the relationship between lipid oxidation, weight gain, and insulin sensitivity. Recent studies show that completion of high intensity interval training (HIIT) and its more intense form, sprint interval training (SIT), significantly increases maximal oxygen uptake, oxidative capacity, and insulin sensitivity similar to MICT. Nevertheless, a greater capacity to oxidize lipid and reduce reliance on CHO is not as commonly reported in participants undergoing HIIT and SIT regimens. For example, only 62 and 37 % of studies implementing HIIT and SIT reveal significant increases in lipid oxidation in response to training. These increases in lipid oxidation are typically concurrent with greater activity of β–HAD and citrate synthase as well as increases in muscle fatty acid binding protein. In this talk, potential explanations for the lower frequency of changes in lipid oxidation in response to interval training will be discussed, including the specific methods used to assess lipid and CHO oxidation as well as the day-to-day variability in these outcomes.

IS HIIT HOT OR HATED? THE VIABILITY OF HIGH-INTENSITY INTERVAL TRAINING FROM A PSYCHOLOGICAL PERSPECTIVE

JUNG, M.

THE UNIVERSITY OF BRITISH COLUMBIA

High-intensity interval training (HIIT) continues to garner much interest and popularity in mainstream media, but has been the target of much criticism and debate in exercise psychology. HIIT promotes similar health benefits as continuous moderate-intensity exercise in significantly less time, but its viability as a health promotion strategy is often questioned. In this talk, Dr. Jung will present the latest research from her laboratory and around the world examining the affective response, enjoyment, preference, tolerance, and intentions to HIIT in inactive and overweight adults. Supervised compliance, and free-living adherence, to HIIT versus traditional continuous exercise will

also be presented. Academic and exercise professionals who utilize HIIT in their research and/or with their clients will gain an understanding of, in relation to other types of exercise, how people feel during and after a bout of HIIT, how much they like HIIT, and whether they plan on and will actually do HIIT again in the future.

Live Sessions: Thursday, September 9, 2021

08:30 - 10:00

IS-PN05 Optimising the prescription of exercise to improve mitochondrial health

TITLE: OPTIMISING THE PRESCRIPTION OF EXERCISE TO IMPROVE MITOCHONDRIAL CHARACTERISTICS

BISHOP, D.

VICTORIA UNIVERSITY

Mitochondria are the energy-producing “power houses” of the cell, and increasing mitochondrial content and function has been associated with both improved health and endurance performance. However, despite many recent advances, we do not yet know the optimal exercise prescription to stimulate mitochondrial biogenesis (i.e., the generation of new mitochondrial components leading to increases in mitochondrial content and function). This talk will synthesise the latest literature on how A) Frequency, B) Intensity, C) Time, & D) Type of both a single exercise session and repeated exercise sessions (i.e., training) affect mitochondrial biogenesis. This overview will include a synthesis of the current literature, as well as unpublished transcriptomics and proteomics analyses that have recently been completed on both whole-muscle and single skeletal muscle fibres. The goal is to describe novel biological mechanisms for the effects of different ‘doses’ of exercise on mitochondrial biogenesis, and to translate this new knowledge into recommendations for more individualised exercise prescriptions to optimise improvements in mitochondria and health.

THE ROLE OF MITOCHONDRIA IN HEALTH

PILEGAARD, H.

UNIVERSITY OF COPENHAGEN

It is well established that aerobic exercise training is an important “medicine” to both prevent and treat disease, as well as improve many conditions linked topoor lifestyle choices and aging. New data is emerging that suggests many of the health benefits of exercise originate from changes in mitochondria. This presentation will focus on new findings related to how exercise influences mitochondria and how these exercise-induced changes in mitochondria can contribute to improved health. This topic will mostly be of interest to delegates interested in exercise and health, but will also be of interest to sport scientists.

NUTRITION AND EXERCISE-INDUCED MITOCHONDRIAL BIOGENESIS

HOLLOWAY, G.

UNIVERSITY OF GUELPH

Given the importance of mitochondrial biogenesis for skeletal muscle health and performance, considerable attention has been given to understanding the molecular cues stimulated by aerobic exercise that culminate in this adaptive response. In turn, this research has led to an interest in nutritional strategies to amplify exercise-responsive signalling pathways in skeletal muscle. This session will summarise the current evidence, and hypothesise future approaches, for nutritional strategies to amplify (or supress) exercise-induced mitochondrial biogenesis. While the focus will be on macronutrients, this presentation will also highlight novel nutritional bioactive ingredients that appear able to amplify exercise-induced mitochondrial biogenesis in skeletal muscle. This topic will be of interest to both exercise and sport scientists, as well as nutritionists.

IS-MH01 Exercise as medicine in psychiatric disorders

PHYSICAL ACTIVITY AND EXERCISE IN PEOPLE WITH PSYCHIATRIC DISORDERS: THE EXPERIENCE OF THE PYSCHIACTIVE PROJECT

BUENO ANTEQUERA, J.

UNIVERSIDAD PABLO DE OLAVIDE

Psychiatric disorders are among the leading causes of all-cause death, and disability worldwide. The global economic burden of psychiatric disorders in 2010 was similar to that of cardiovascular diseases and higher than that of cancer, chronic respiratory diseases and diabetes and expected to more than double by 2030. Therefore, reducing the growing burden of psychiatric disorders is a global health priority.
To try to close this gap, exercise physiologists from the Universidad Pablo de Olavide launched the PsychiActive project in 2013, an integrated approach to positive health behavior and a healthy lifestyle for people with psychiatric disorders from Spain.
This talk summarizes the main scientific contributions derived from the PsychiActive project. In summary, (1) A higher body mass index, a lower cardiorespiratory fitness and worse physical component score were associated with a more sedentary lifestyle in people with schizophrenia and body mass index, cardiorespiratory fitness and vitality were identified as determinants of sedentary behavior. (2) Low sedentary behaviour, high cardiorespiratory fitness, high muscular strength levels were associated with higher global cardiovascular health score, and only cardiorespiratory fitness remained significantly related independent of sedentary behaviour and muscular strength. (3) High levels of sedentary behaviour and low levels of physical activity and cardiorespiratory fitness were associated with a higher clustered-cardiometabolic risk, and only cardiorespiratory fitness remained significantly related independent of multiple confounders (including sedentary behaviour and physical activity) in people with psychosis. (4) People with psychiatric disorders spent 58% of waking time sedentary, primarily watching television. The self-reported method presented low validity compared to the objective method, being higher on weekdays for the overall group and for the younger, high illness duration and low antipsychotic medication groups. (5) A 18-month lifestyle

changes, primarily increasing time engaged in physical activity and eating healthier, improved cardiovascular health and fitness, and reduced sedentary behaviour, body weight, severity of psychiatric symptoms and mediation use in a woman with bipolar disorder. (6) A 12-week group-based intervention of supervised aerobic and strength exercise training was safe, feasible, and effective for improving cardiorespiratory fitness, muscular strength, and anthropometric parameters in psychiatric men inmates.
In conclusión, findings highlight the usefulness of sedentary behaviour, physical activity, fitness, and exercise as complementary tools in the treatment of people with psychiatric disorders.

ASSESSING PHYSICAL ACTIVITY IN CLINICAL POPULATIONS:DEVELOPMENT, VALIDATION AND IMPLEMENTATION OF THE SIMPLE PHYSICAL ACTIVITY QUESTIONNAIRE (SIMPAQ) IN PEOPLE WITH MENTAL ILLNESS

ROSENBAUM, S.

THE GEORGE INSTITUTE FOR GLOBAL HEALTH

Physical inactivity is a key contributor to the global burden of disease. Vulnerable populations, such as people living with mental illness engage in significantly less physical activity compared to the general population. Participation in physical activity is associated with improvements in symptoms of mental illness, improved cardiorespiratory fitness and a reduction in cardiometabolic risk. The Simple Physical Activity Questionnaire (SIMPAQ) was developed as an instrument for use within clinical settings and specifically in clinical populations at risk of engaging in high levels of sedentary behaviour. An international working Group developed the five-item SIMPAQ and conducted a validation study across 42 centres from 23-countries in patients with any DSM-5 diagnoses of a mental illness. Results demonstrated that the SIMPAQ has acceptable reliability and was a valid tool by which to assess moderate-vigorous physical activity in people with mental illness. The subsequent use of the tool as part of routine assessment within psychiatric settings along with qualitative feedback from the international Working Group will be discussed. Differences between low and middle income settings as well as high resourced settings will be presented as well as the implications for future research in the area of physical activity and mental illness.

KEEPING THE BODY IN MIND: INTEGRATING PHYSICAL HEALTH TREATMENT FOR PEOPLE WITH SEVERE MENTAL ILLNESS

MORELL, R.

UNSW, SYDNEY

Individuals with severe mental illness (SMI) have worse physical health than the general population including significantly higher rates of type 2 diabetes, cardiovascular disease and metabolic syndrome. Comorbidities that contribute to the onset of these chronic diseases arise as a result of lifestyle factors, disparities in health care provision, symptoms of SMI and side effects of psychotropic medications. Recent studies have shown that metabolic monitoring, lifestyle interventions including dietetic and exercise specialist support, smoking cessation programs and peer health coaching can be effective in improving the physical health of people with SMI. This presentation will outline the roll-out of such a multi-faceted approach in a state-funded mental health service in south eastern Sydney, Australia and the essential role of exercise specialists. It will describe the implementation of lifestyle interventions for mental health staff to improve cardiometabolic health confidence and knowledge; projects to improve metabolic monitoring and client lifestyle intervention programs. Data will be presented that attest to the ability of this integrated approach to deliver sustainable behaviour change. Implementing evidence-based lifestyle interventions in a public community mental health service is feasible and acceptable and the successful inclusion of such programs within routine mental health care should lead to a reduction in the life expectancy gap for people living with SMI.

OP-BM08 Muscle: Biomechanical properties

IMPACT OF SHORT-TERM PERTURBATION EXERCISE DOSE ON TRANSFER OF FALL-RESISTING SKILL ADAPTATIONS

WERTH, J.1, EPRO, G.1, SANTUZ, A.2,3, KÖNIG, M.1, SEELEY, J.1, ARAMPATZIS, A.2,3, KARAMANIDIS, K.1

1LONDON SOUTH BANK UNIVERSITY, LONDON, UNITED KINGDOM; 2,3HUMBOLDT-UNIVERSITÄT ZU BERLIN, BERLIN, GERMANY

INTRODUCTION:
The ability of the human motor system to transfer acquired stability improvements is essential to ensure safe locomotion in the face of various postural threats. The current study tested the hypotheses that transfer of fall-resisting skill adaptations from repeated gait perturbation exercise to untrained stability challenges is enhanced by an increase in perturbation exercise dose (1) but limited by distinct task-specific neuromotor control patterns (2).
METHODS:
Seventy-four adults (19 to 53 years) were assigned to three groups: a control group (unperturbed treadmill walking) and two exercise groups exposed to a single session of eight left-leg trip-like perturbations during treadmill walking – one group with a perturbation dose previously shown to improve retainable fall-resisting skills (low; 55N pull at lower limb; 3) and one group with increased perturbation dose (high; 140N). Following treadmill perturbations, all participants were subjected to a single untrained trip-like perturbation during overground walking at controlled speed and to an untrained lean-and-release task involving a loss of stability from a static forward-inclined position. Movement kinematics were tracked via motion capture (120Hz; Qualisys, Sweden) and dynamic stability control was assessed using the anteroposterior margin of stability (MoS; 3). Muscle activity of 13 right recovery-leg muscles was assessed by electromyography (1080Hz; Delsys, USA) and muscle synergies were extracted using non-negative matrix factorisation (2).
RESULTS:
Both exercise groups improved dynamic stability of the first recovery step after eight treadmill gait perturbations ($P<0.001$). Neither high- nor low-dose perturbation exercise groups showed enhancements to dynamic stability control for the lean-and-release task compared to controls. During the overground trip-like perturbation task, both exercise groups however showed an enhanced dynamic stability compared to controls ($P<0.05$), with no further effect of perturbation exercise dose on inter-task transfer performance. Whilst there was distinct synergistic muscular control (only one common muscle synergy) during the lean-and-release task, there were similar neuromotor control patterns for the recovery performance from overground and treadmill perturbations.
CONCLUSION:

The current work provides evidence that short-term perturbation exercise paradigms have the potential to improve human resilience to postural disturbances, but inter-task specificity of neuromotor control patterns may explain transfer of acquired stability improvements. An increase in perturbation exercise dose does not necessarily further enhance fall-resisting skill transfer.
REFERENCES:
1) Leech et al. (2018) Sci Rep
2) Santuz et al. (2018) Sci Rep
3) Epro et al. (2018) J Neurophysiol

EXTERNAL MECHANICAL WORK DURING SPRINT ACCELERATION IN UNILATERAL TRANSFEMORAL AMPUTEES

MURATA, H., HISANO, G., ICHIMURA, D., TAKEMURA, H., HOBARA, H.
TOKYO UNIVERSITY OF SCIENCE

INTRODUCTION:
The development of carbon fibred running-specific prostheses (RSPs) have enabled unilateral transfemoral amputees (uTFAs) to compete in sprint events. Despite maximal sprint acceleration being a crucial factor affecting overall sprint performance, little is known about the biomechanics in uTFAs wearing RSPs. When non-amputees perform maximal sprint acceleration, external mechanical work exerted by muscular activities accelerate the body center of mass (bCOM) during each step. Since uTFAs possess an asymmetric musculoskeletal system and mechanical properties between prosthetic and intact limbs, it is expected that uTFAs would perform sprint acceleration via an asymmetric strategy. The aim of this study was to evaluate the external mechanical work during sprint acceleration in uTFAs wearing RSPs.
METHODS:
Two uTFAs (uTFA1 and uTFA2, respectively) wearing RSPs were recruited. After performing warm-up exercises, both participants performed maximal sprint acceleration from standstill on a motorized instrumented treadmill, which was customized for on-demand acceleration. We then measured the ground reaction forces, from which the total mechanical energy of the bCOM (Eext) was calculated as the sum of the potential and kinetic energies in the sagittal plane. The net external mechanical work (Wnet) was also calculated based on the changes in the Eext with each step. We analyzed 12 consecutive steps and determined the total value of Wnet in 6 steps for both prosthetic and intact limbs during sprint acceleration.
RESULTS:
uTFA1 and uTFA2 achieved maximum running speeds of 5.65 and 6.15 m/s, respectively. The total values of Wnet in uTFA1 were 3.22 (prosthetic) and 6.17 (intact) J/kg. In uTFA2, the total values of Wnet were 2.51 (prosthetic) and 5.02 (intact) J/kg.
CONCLUSION:
Both uTFAs exhibited lower total Wnet values in the prosthetic limb than in the intact limb, indicating that uTFAs wearing RSPs perform sprint acceleration mainly using the intact limb compared with the prosthetic limb. Although both uTFAs wore RSPs with passive elastic storage/return function, their prosthetic limb would not perfectly compensate for their missing biological elastic components. Consequently, RSPs cannot generate and increase the potential and/or kinetic energy for a sprinter to the extent that an intact limb can. Therefore, coaches and practitioners should consider any potential biomechanical differences between limbs during sprint acceleration in uTFAs with RSPs. In conclusion, the results of the present study suggest that external mechanical work during sprint acceleration in uTFAs is essentially asymmetric between limbs.

TYPE II MUSCLE FIBRE PROPERTIES SHOW LITTLE ASSOCIATION WITH BALANCE RECOVERY FOLLOWING LARGE GAIT PERTURBATIONS IN YOUNG AND OLDER ADULTS

MCCRUM, C., GREVENDONK, G., SCHAART, G., MOONEN KORNIPS, E., JÖRGENSEN, J.A., GEMMINK, A., MEIJER, K., HOEKS, J.
MAASTRICHT UNIVERSITY

INTRODUCTION:
Muscle strength has been associated with falls incidence in older adults and a link has been reported between hip fracture history and Type II muscle fibre size (Kramer et al. 2017). Muscle fibre characteristics may be an important factor in balance performance but this has never been directly examined. In this study, we address whether Type II muscle fibre characteristics associate with reactive balance during walking.
METHODS:
This cross-sectional study included 48 participants (12 young [mean age: 23.9y; 7 male, 5 female]; 36 older [mean age: 69.2y; 21 male, 15 female] adults). Biopsy specimens were taken from the vastus lateralis and immunohistochemistry staining was performed. Muscle fibre size was determined by measuring the cross-sectional area (CSA) and fibre type distribution was expressed as a percentage with respect to the number of fibres and as a percentage of CSA (% fibre type I/II area relative to total CSA). Treadmill belt acceleration perturbations (simulating the effects of a trip) were applied once to the right leg and once to the left leg during walking and the margin of stability concept (using motion capture and a force plate-instrumented treadmill) was used to estimate the number of recovery steps required to recover and return to steady-state walking. Walking stability was normalised to ensure individuals were perturbed at a similar stability state (McCrum et al. 2019). Spearman correlations between the Type II fibre parameters and the number of recovery steps were conducted.
RESULTS:
The participants were diverse in terms of physical function (assessed by SPPB), steps per day and amount of high intensity physical activity (5 days ActivPAL activity monitoring), as well as in the muscle fibre characteristics and number of recovery steps needed. Despite this, no significant associations were found between the recovery steps needed post-perturbation and the type II fibre characteristics: Type II fibre percentage, Type II fibre CSA and the percentage of total CSA taken up by Type II fibres ($-0.125 \leq r \leq 0.202$, $0.17 \leq P \leq 0.86$). To check if the younger adults' data were unduly influencing these results, we repeated the analyses with only the older participants and found similar results, with only one of 12 associations being significant. Correlations between reactive balance recovery and upper leg muscle volume (assessed by MRI) and knee flexion and extension torque (assessed with a dynamometer) also only revealed one significant correlation out of 20.
CONCLUSION:
Type II muscle fibre proportion and dimension are not significantly associated with reactive balance recovery following walking perturbations. These results have implications for muscle strength testing and training in fall prevention, as muscle tissue properties may not be key factors in balance recovery.

References
Kramer et al. 2017 J Gerontol A Biol Sci Med Sci. 72(10):1369-1375.
McCrum et al. 2019 J Biomech. 87(18):48-53.

TOWARDS MORE EFFECTIVE TRAINING: A BIOMECHANICAL COMPARISON OF THREE HAMSTRING EXERCISES

VAN HOOREN, B.1, TERATSIAS, P.1, WILLEMS, P.1, ROSSOM, S.2, VANWANSEELE, B.2, MEIJER, K.1, DROST, M.1

1DEPARTMENT OF NUTRITION AND MOVEMENT SCIENCES, MAASTRICHT UNIVERSITY MEDICAL CENTRE+, MAASTRICHT, THE NETHERLANDS 2DEPARTMENT OF MOVEMENT SCIENCES, KU LEUVEN, LEUVEN, BELGIUM

INTRODUCTION:
Risk factors for hamstring injuries include low hamstrings strength, short biceps femoris fascicles, and altered intermuscular coordination between the medial and lateral hamstrings [1]. A variety of exercises is being used to modify these risk factors in an attempt to prevent injuries and improve performance. Knowledge on the individual muscle forces, relative load and activation as well as fascicle behavior during exercises is essential as this allows practitioners and researchers to target specific adaptations to maximize exercise effectiveness. However, there is little evidence on these aspects across different exercises. The aim of this study is therefore to characterize and compare lower-limb muscle forces, muscle activation, and biceps femoris muscle fascicle behavior between three hamstrings exercises: the Nordic hamstring exercise (NHE), the single-leg Roman chair (RCH), and the single-leg deadlift (DL).
METHODS:
Ten male participants performed the NHE, RCH and DL in a randomized order with a 1RM load, while full-body kinematics, ground reaction forces, lower-limb surface muscle activation (EMG) and biceps femoris muscle fascicle behavior were measured. Musculoskeletal modelling was used to determine the joint moments and muscle forces required to balance the moments were determined through dynamic optimization [2]. Linear-mixed models were used to compare outcomes between exercises.
RESULTS:
Biceps femoris fascicles remained quasi-isometric before actively lengthening during the NHE and RCH, while they lengthened and subsequently shortened in the DL. Hamstrings muscle activation peaked just before the eccentric phase in the NHE and RCH, and during the transition from eccentric to concentric phase in the DL. The increase in fascicle length was significantly larger in the NHC (30.8 ± 11.7 mm), compared to the DL or RCH (18.5 ± 5.2 and 17.8 ± 7.9 mm, respectively). Mean fascicle length was largest in the DL, followed by the RCH and NHC (130.1 ± 39.6, 92.8 ± 26.1 and 72.4 ± 14.6 mm, respectively), with all pairwise comparisons being significant. Peak knee flexor moments were highest for the NHE, followed by the RCH and DL (6.6 ± 1.2, 3.8 ± 1.3, 1.0 ± 0.4 N·m/kg, respectively). Peak hip joint moments and peak surface muscle activation did not significantly differ. Preliminary data suggest that peak muscle forces for all hamstring muscles were highest in the NHE, followed by the RCH and DL.
CONCLUSION:
The larger increase in fascicle length during the NHE, combined with a reduction in muscle activation during the phase of rapid fascicle lengthening suggests this exercise may be most effective to trigger fascicle length adaptation. The higher peak hamstring muscle forces in the NHE further suggest this exercise may be most effective to increase hamstrings strength.
REFERENCES:
[1] Bourne M. et al. (2020) Prevention and rehabilitation of hamstring injuries; Springer.
[2] De Groote et al. (2016) Ann. of Biom. Eng, 44: 2922-36.

EFFECTS OF A SINGLE PNF STRETCHING EXERCISE WITH AND WITHOUT SPECIFIC WARM-UP ON THE FUNCTION AND MECHANICAL PROPERTIES OF THE PLANTAR FLEXOR MUSCLES

REINER, M., TILP, M., KONRAD, A.

UNIVERSITY OF GRAZ

INTRODUCTION:
A single proprioceptive neuromuscular (PNF) stretching exercise can acutely increase the range of motion of a joint (2), but might also lead to a decrease in performance immediately after the stretch (1, 2). Post-Stretching-Activation (PSA) exercises are known as a possible tool to counteract such a drop in performance following a single static or dynamic stretching exercise (3). However, up to date no study has investigated the combination of PNF stretching with PSA. Thus, the aim of the study was to compare the effects of a PNF stretching with or without PSA on the function and mechanical properties of the plantar flexor muscles.
METHODS:
Eighteen male physical active volunteers (mean ± SD; 26.5±4.2 years; 81.6±8.4 kg; 184.8±8.3 cm) visited the laboratory on two separate days in a random order. Volunteers either performed 4 x 30 s of PNF stretching (5 s of contraction) followed by 2 x 3 exercises (straight leg jumps, skippings, and high knee running) with 20 or 40 fast ground contacts (PNF/PSA) or PNF stretching only (PNF). Before and after the interventions, passive shear modulus of gastrocnemius medialis (GM) and gastrocnemius lateralis (GL) was measured in neutral position with shear wave elastography (SWE). Maximum voluntary isometric contraction (MVIC) and maximum voluntary dynamic contraction (MVDC), dorsiflexion range of motion (ROM), and passive resistive torque (PRT) were measured with a dynamometer. After testing for normal distribution, we applied either a two-way repeated measures ANOVA or a Friedman test. Subsequently, we performed t-tests or Wilcoxon-tests for post-hoc analyses. The alpha level was set to 0.05.
RESULTS:
There was an increase in ROM following both interventions (PNF and PNF/PSA: +4%). Furthermore, following the PNF/PSA intervention, there was a significant decrease in PRT at a given joint angle (-7%) and a decrease in GM (-7%) and combined (GM+GL) shear modulus (-6%). Additionally, we found a significant decrease in MVIC values following the PNF intervention only (-4%).
CONCLUSION:
The results of the study showed, that a single PNF stretching combined with a PSA leads to an increased dorsiflexion ROM in the ankle joint, which likely can be explained by a more compliant muscle tissue. While MVIC and MVDC were not altered following PNF/PSA, PNF stretching alone led to a decrease in MVIC values. Therefore, we conclude that, following a PNF stretching during warm-up, a target muscle-specific PSA should be performed to counteract possible detrimental effects in strength performance.
References:
1.)Bradley et al. 2007, Journal of Strength and Conditioning Research 21(1): 223–26.
2.) Konrad et al. 2017, Scandinavian Journal of Medicine and Science in Sports 27(10): 1070–80.

3.) Samson et al. 2012, Journal of Sports Science and Medicine 11(2): 279–85.

RELATIONSHIP BETWEEN HAND PROPULSION AND PHYSICAL CHARACTERISTICS IN SPRINT FRONT CRAWL SWIMMING.

KOGA, D., TSUNOKAWA, T., NAKAZONO, Y., HOMOTO, K., SENGOKU, Y., TAKAGI, H.

UNIVERSITY OF TSUKUBA

INTRODUCTION:
In front crawl swimming, the swimmers exert propulsion by moving the upper limbs from the front to the back. It has been reported that there is a relationship between tethered force measured by swimming motion and the swimmers physical strength and power [1]. In addition, in water, it is also important to generate unsteady flow that is generated due to exerting force to water, which is a fluid rather than a rigid body. As the reason, the unsteady flow causes large pressure changes on the dorsal of the hand and contributes to exerting high hand propulsion [2]. Therefore, the purpose of this study was to clarify the relationship between physical strength and the palm / dorsal pressure.
METHODS:
Seventeen male university swimmers participated. This study consisted of two sessions. First, 25m front crawl with maximum effort. The resultant force acting on the hand is calculated by the product of the pressure difference between the palm and the dorsal of the hand and the area of the hand [3]. Therefore, six small pressure sensors were attached to the swimmers hand to measure the pressure on the hand. Since the propulsion is the force acting in the propulsion direction in the resultant forces, the ratio of the propulsion to the resultant force was also calculated (propulsion ratio). Second, bench press and back squat 1RM and Peak Power measurements. 1RM and Peak Power were estimated by regression of bar velocity and weight [4]. A barbell tracking system was attached to the bar to measure the bar velocity. The weight and number of trials were determined with reference to the method of Jidovtseff et al. (2011). In the statistical processing, the relationship between the pressure value and 1RM and Peak Power was verified by correlation analysis. In addition, multiple regression analysis was performed to determine the standardization coefficient in order to investigate the contribution of the palm, dorsal pressure and the propulsion ratio to the hand propulsion.
RESULTS:
Bench press and back squat Peak Power showed a significant positive correlation in palm pressure ($r = 0.668$, $p = 0.003$, $r = 0.660$, $p = 0.004$). No variable had a significant correlation with the dorsal pressure. On the other hand, the influence to the hand propulsion was the highest in the dorsal pressure, the second was the propulsion ratio, and the third was the palm pressure (standardization coefficient: -0.653, 0.514, 0.369).
CONCLUSION:
The main finding of this study was that Peak Power of physical strength is positively correlated with palm pressure. In other words, it can be inferred that the greater the muscular power (force x velocity) exerted by the swimmer, the higher the pressure in the palm. However, it is also important to identify of variables related to the dorsal pressure since the dorsal pressure has a higher influence on the height of the hand propulsion than the palm pressure.
1. Morouço et al. (2011) 2. Koga et al. (2021) 3. Takagi & Wilson. (1999) 4. Jidovtseff et al. (2011)

10:30 - 12:00

IS-SH01 Sport is more than a gold medal! The power of sport to insure social inclusion

SPORT –BRIDGE TO EDUCATION

PILZ BURSTEIN, R.

SPORT- A BRIDGE TO EDUCATION

Sport –Bridge to Education, an Israeli non-profit organization, chose sports and its values as a platform for empowering at-risk children and youth. Sport -Bridge to Education takes advantage of the duality existing in sports, in it being both a goal and a means, and uses sport as a tool to empower at-risk children and youth.Our sport-excellence program operation only in the 24/7 close surrounding of youth-villages,where it has the most impact on our participants and creates a "ripple effect" in the entire village. The Need: About 200,000 youth between the ages of 12and 18 out of a population of about 800,000 in this age bracket come from a socially deprived background and are defined as an at-risk population. Over 65,000 children and youth are currently residing in youth-villages in Israel. Many of them are blessed with talents and personal abilities, but due to familiar and environmental limitations and often a violent neighbourhood, these youth experienced only failures in their childhood; they are unable to express themselves and achieve self-realization. This is our targetpopula-tion, and sport which is known as a language that speaks to children and youth regardless of their background, is our tool. "For the first time in my lifeI feel Im worth something""I learned to believe in myself... theyre counting on me""The program developed me to what I am today(Y.)" "The program taught me discipline, so I quit smoking. I never believed that I will finish school, I was a street child.... (B.)"
These are just some of the sentences we hear from the children. Today, after five years of operating our Excellence Program, we can see a significant change in educational-social and behavioural aspects in these young children. Whats in our program?-Professional sports train-ing sessions: 3-4 times a week-Integrating values of sport within the training sessions: self-discipline, responsibility, striving for excellence, gender equality and national pride -Mental and nutritional support -Bi-annual training camps, regional and national sports competitions -Meeting with leading figures as role models Currently Sport –Bridge to Education operates in 6 youth-villages across Israel. As stated by Neve-Amiel youth-village director: "The Sports Excellence Program changed our state of mind: instead of talking about"survival", we now dare to speak in terms such as "Excellence" and "Leadership"". Dr. Rutie Pilz-Burstein, the founder of this NGO, served as the General Director of the Wingate Institute, the Israel National Institute for Physical Education and Sports, in 2008-2013.

SPORT-THE BRIDGE ETHIOPIA

AHMED BECHU, L.

UNITY UNIVERSITY, ADDIS ABEBA ETHIOPIA

Sport-The Bridge (STB) is a non-religious, non-political and not-for profit organization, founded in 2002 in Switzerland with the aim of using sport to build bridges between people and to promote the personal development of children. In 2004 the organization established a project in Addis Ababa, Ethiopia with the aim of using sport pedagogy to rehabilitate street children in order to reunify them with their family.Sport-TheBridge Ethiopia uses sport as a tool to teach social values and life skills to street children who are 7 to 13 years old. And recently as developing the work, it is involved with teenagers who are studying in government school which are based in poor areas of the city in order to protect them from school dropping and its related social crises consequences through life skill education using sport as a means of teaching. Other teenagers are also participating in football and martial art training who are socially empowered through these sports. The issue of street that our country is facing now a day is calling Sport-The Bridge and everybody to act on it to save the young generation. Though it is always difficult to study the population of this target group, a study in 2018 estimate them more than 50,000 in Addis Abeba. Since the establishment, STB managed to work with and get solution for more than 1,000 street children and about 1,500 disadvantaged children in its prevention program. The organization has been doing important development as well as humanitarian activities via care, support and building the capacity of abandoned children and their parents and/ or guardians who are at risk. Sport pedagogy and other life-skill development programs proved to be important tools in achieving this goal. After several years of experience in reintegrating street children with their families, STB has an impressive number of success stories to present. This success is a direct outcome of the organizations philosophy, which focuses on the beneficiaries and puts them at the centre of its work. The approach of STB aims to challenge the child to rethink her/his situation and to make a positive move towards a more prosperous future, to develop and discover her/his own talents. This is in keeping with the best interests of the child and emerging capacity principals that are engrained in the United Nations Convention on the Rights of the Child. Moreover to the ample experience in the field of sport for development and children, Sport-The Bridge has a background of award in 2011 from IOC that pushes us forward to give services for the society in order to tackle the existing problems in the community. As an organization it has developed manuals to transfer the knowledge and skill to children.

TRANSFORMING YOUNG STARS OF AFRICA (TYSA)

GICHUKI, F.

KENYATTA UNIVERSITY, NAIROBI KENYA

Transforming Young Stars of Africa (TYSA) is an NGO that facilitates the development of young leaders, provides mentorship and nurtures innovations using the power of football for good. Over the last 18 years, TYSA has been informed, inspired and guided by its theory of change, which appreciates individuals in driving social transformation through team sport; football. We have used Football for social transformation to impact over 2 million young people directly since our establishment in 2001. We effectively utilize our experience in Football 3 methodology and arts among other approaches to motivate learning, healthy life styles, character building, gender inclusivity, citizenship and exposure to limitless opportunities for children and young peopleTYSA's theory of change is anchored on the premise that every childis unique and posses' different abilities and talents and therefore should not be condemned and or ridiculed as a result of societal assumptions, beliefs, expectations and stereotyping. At TYSA we commit to working with and reaching out to children and young people who are marginalized, those that slip through already weak social safety nets and those most vulnerable to abuse, violence, illiteracy, exploitation and disease through football for good.We believe in continuous sustainable transformation for our individual target group as well as their society, and that this is possible when individual talents and abilities are identified and nurtured; when education is made accessible; when children and young people are offered safe spaces and are given a voice in decision making.To TYSA, the child's self-discovery, realization and advancement is key and football for good is the unique and dynamic vehicle to which its interventions are hinged.

IS-BM03 Neuromuscular plasticity to explosive-type exercise: Consequences and implications for training-induced gains in rate of force development

INFLUENCE OF MODULATIONS IN MOTOR UNIT DISCHARGE CHARACTERISTICS ON THE RATE OF TORQUE DEVELOPMENT ANDTRAINING-RELATED ADAPTATIONS DURING RAPID CONTRACTION

DUCHATEAU, J., BAUDRY, S.

UNIVERSITE LIBRE DE BRUXELLES

The changes in corticospinal excitability during the preparation of a rapid (ballistic) contraction are unique and differ from a slow contraction (Baudry & Duchateau, 2021). The delayed and more abrupt increase in cortical excitability prior to a ballistic contraction may be part of the conditions required to provide spinal motor neurones with synchronised excitatory synaptic input at the onset of the upcoming ballistic contraction. This behaviour likely favour greater motor unit discharge rate (Desmedt & Godaux, 1977; Van Cutsem et al., 1998) and briefer recruitment interval (Del Vecchio et al., 2019), leading thereby to rapid development of force at the initial stage of the contraction (Duchateau & Baudry, 2014). Importantly, the maximal rate of motor unit discharge appears to vary depending on the initial conditions during which the ballistic contraction is performed (Van Cutsem & Duchateau, 2005) and may ultimately lead to specific training-related adaptations. This lecture will describe the time course of modulation in cortical and spinal excitability before the onset of a rapid contraction, demonstrate the acute changes in the maximal rate of motor units discharge during a ballistic contraction as a function of the initial conditions, and discuss how the modality of training can influence the gains in rate of motor unit discharge and torque development.

RESISTANCE TRAINING SPECIFICITY: EFFECT OF EXPLOSIVE-TYPE VS. SLOW-TYPE RESISTANCE EXERCISE ON RATE OF FORCE DEVELOPMENT

FOLLAND, J.

LOUGHBOROUGH UNIVERSITY

Explosive strength, most often measured as rate of force development (RFD), is widely considered to be important during various athletic tasks (i.e. sprinting and jumping, the completion of daily living activities, and joint stabilization following mechanical perturbation and thus

the prevention of falls/injury. Resistance training (RT) can over time elicit profound improvements in physical and neuromuscular function, including strength, power and rate of force development, and is thus widely recommended for competitive athletes, prevention and rehabilitation of injury and illness, as well as healthy ageing. RT guidelines typically recommend 'slow-type' RT i.e. a slow controlled lift over 2-seconds. However there is extensive evidence that the adaptations to resistance training are specific to the nature of the training task undertaken, and thus conventional slow-type RT may not be ideal for the development of explosive strength/RFD. In fact there remains some debate over the efficacy of slow-type RT to enhance RFD, whereas there is evidence that 'explosive-type' RT i.e. increasing force as quickly as possible, has been found to be significantly more effective for developing RFD (Tillin & Folland, 2014; Balshaw et al., 2016).
This presentation will review recent evidence for the enhancement of RFD through training, the importance of explosive-type contractions and the underpinning adaptations that may account for the task specificity of RT.

MOTOR UNIT POPULATION BEHAVIOR AND RATE OF FORCE DEVELOPMENT

DEL VECCHIO, A.

IMPERIAL COLLEGE LONDON

The rate of force development of a muscle depends on 1) neural and muscular properties of the motor units, and2) the synaptic input strength from efferent supraspinal and spinal pathways that determines the all-or-none responses of the motoneurons. Studying the behaviour of the discharge timings from the human motor unit pool during fast motor actions provides direct information on the neural strategies of force control. Recent studies suggest that the discharge timings from the human motoneuron pool behaves in a non-linear way when compared to slow isometric contractions and that this non-linear behaviour is not uniformly distributed across the motoneuron pool. This lecture will discuss recent results obtained from high-density surface and intramuscular EMG recordings during fast contractions. Moreover, the motor unit responses after strength training during contractions at maximal rate of force development will also be discussed, including novel data obtained with motor unit computational models

OP-PN07 Muscle

NEAR INFRA-RED SPECTROSCOPY ESTIMATION OF COMBINED SKELETAL MUSCLE OXIDATIVE CAPACITY AND O2 DIFFUSION CAPACITY IN HUMANS

PILOTTO, A.M.1, ADAMI, A., MAZZOLARI, R., BROCCA, L., CREA, E., PELLEGRINO, M.A., BOTTINELLI, R., ZUCCARELLI, L., GRASSI, B., ROSSITER, H.B., PORCELLI, S.

UNIVERSITY OF UDINE

INTRODUCTION:
Muscle oxygen uptake (mV'O2) depends on both O2 supply (convective and diffusive O2 delivery) and O2 demand (ATP utilization rate and mitochondrial function). The diffusing capacity for O2 (DmO2) may limit O2 supply where the apposition muscle capillary red blood cells to endothelium is low. Capillary-to-fiber ratio (C:F) is therefore a proxy for DmO2. The mV'O2 recovery rate constant (k) measured by near-infrared spectroscopy (NIRS), in the presence of non-limiting O2 availability, provides a non-invasive assessment of muscle oxidative capacity in vivo. The comparison of k in conditions of non-limiting (tissue saturation index TSI>50%;HIGH) and limiting (TSI<50%;LOW) O2 availability may therefore allow for non-invasive assessment of DmO2 in vivo. The aim of this study was to: i)compare k obtained at HIGH and LOW TSI conditions with ex-vivo mitochondrial function; ii)evaluate the association between C:F and the difference in k between HIGH and LOW conditions.
METHODS:
12 moderately trained participants (28±5yrs;64.3±10.2kg;173±7cm;V'O2peak from 34.6 to 47.2ml*kg-1*min-1) visited the lab on four non-consecutive days. On day 1, they performed a cycle ergometer incremental exercise test to the limit of tolerance. On days 2 and 3, k of the vastus lateralis (VL) was measured twice using NIRS during 10-15 repeated arterial occlusions performed immediately after moderate intensity constant work-rate exercise tests. The duration and timing of the repeated occlusions were defined by the investigator to maintain TSI in a range of 10% change both below (LOW) and above (HIGH) the 50% of functional range obtained during a prolonged occlusion. On day 4, muscle samples from the VL were collected for measurement of C:F and of maximal O2 flux using saturating substrates for complexes I+II by high-resolution respirometry (HRR).
RESULTS:
O2 flux in biopsy samples was 37.7±10.6 and 56.8±19.8 pmol*s-1 per mg wet weight in maximal ADP-activated state of oxidative phosphorylation and maximal noncoupled state respiration, respectively. C:F ratio ranged from 2.15 to 2.49. k measurements performed on different days were significantly correlated (r=0.67,ICC=0.68). In HIGH, k was significantly greater (3.15±0.45min-1) than in LOW (1.56±0.79min-1,p<0.0001). The difference in k between HIGH and LOW ranged from 0.19 to 3.19min-1, and was significantly inversely correlated with C:F ratio (r= –0.68). In HIGH, k was significantly associated with both HRR measurements (r=0.69–0.72), but not in LOW (r=0.06–0.08).
CONCLUSION:
These preliminary data show that mV'O2 recovery rate constant (k) does not reflect muscle oxidative capacity under conditions of limited O2 availability, i.e.TSI<50% of the functional range. Moreover, the difference in k obtained between O2 non-limiting and O2-limiting conditions was associated with C:F ratio, a proxy of DmO2. Thus, assessment of muscle k by NIRS under HIGH and LOW TSI conditions provides a non-invasive window on both muscle oxidative capacity and muscle O2 diffusive capacity.

FAST ACTIVATION/DEACTIVATION OF THE NFKB SIGNALLING PATHWAY IN HUMAN SKELETAL MUSCLE: ROLE OF OXYGENATION AND METABOLITE ACCUMULATION.

GALLEGO SELLES, A., GALVAN ALVAREZ, V., MARTINEZ CANTON, M., PEREZ REGALADO, S., SANTANA, A., DORADO GARCIA, C., MARTIN RODRIGEZ, S., GARCIA PEREZ, G., MORALES ALAMO, D., MARTIN RINCON, M., CALBET, J.

UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA AND, COMPLEJO HOSPITALARIO UNIVERSITARIO INSULAR-MATERNO INFANTIL DE LAS PALMAS DE GRAN CANARIA

INTRODUCTION:

The NFκB signalling pathway plays a critical role in inflammation, immunity, cell proliferation, apoptosis and muscle metabolism and is activated by extracellular signals and intracellular changes in Ca2+, Pi, H+, metabolites and reactive oxygen and nitrogen species (RONS). Studies in rodents have reported NFκB activation by exercise, with the scarce data in humans reporting contradicting findings. Cell culture experiments have shown that NFκB and STAT3 are stimulated by hypoxia, which exacerbates RONS production. However, it remains unknown whether metabolite accumulation, muscle oxygenation and hypoxia influence NFκB signalling in response to acute exercise in human skeletal muscle. We hypothesized that RONS production during incremental exercise to exhaustion (IE) would upregulate NFκB signalling depending on metabolite accumulation, with a more exacerbated response in Hypoxia (Hyp) than normoxia (Nx).
METHODS:
Eleven active men performed IE to exhaustion in Nx and Hyp (PIO2:73 mmHg). Immediately after IE, the circulation of one leg was instantaneously occluded (300 mmHg). Muscle biopsies from m. vastus lateralis were taken before (PRE), and 10s (POST, occluded leg) and 60s after exercise from the occluded (OC1M) and non-occluded (nOC1M) legs simultaneously, and blood samples were taken throughout from the femoral vein. Protein expression of key markers in the NFκB and MAPK signalling pathways (Western Blot) and muscle metabolites (fluorometry) were measured. Statistical analysis was performed with repeated-measures ANOVA.
RESULTS:
At post, muscle lactate augmented 25% solely in OC1M ($P<0.05$) while PCr was reduced by 94 and 48% in OC1M and nOC1M, respectively ($P<0.005$) regardless of PIO2. PO2 in the femoral vein was 21.1±2.0 and 10.6±2.8 mmHg at Wmax, in Nx and Hyp, respectively ($P<0.001$). The ratios pTyr705/Total STAT3 and pSer176-180/Total IKKβ, pSer536 NFκB p65, and the total amount of NFκB p65, p50 and p105 NFκB were significantly elevated at POST, collectively indicating activation of NFκB. This was facilitated by the phosphorylation of IkBb at Thr19-Ser23, which releases its inhibitory action on NFκB. Post-exercise ischemia maintained these changes (OC1M), while these signals were reverted to the pre-exercise condition after one minute of recovery with free circulation. The expression of IL-6 and the phosphorylation state of ERK1/2 and p38 did not change significantly. All responses were similar regardless of exercise PIO2.
CONCLUSION:
This study shows that NFκB signalling is activated in human skeletal muscle to a similar degree during incremental exercise to exhaustion in normoxia and severe hypoxia. The fact that post-exercise ischemia maintained the activation of NFκB suggests that reoxygenation after exercise is necessary to deactivate NFκB. Our results indicate that the metabolites accumulated during the exercise or the lack of O2 may play a role in maintaining NFκB signalling.
Grants: DEP2015-71171-R; DEP2017-86409-C2-1-P

ASSOCIATIONS OF IRON STATUS RELATED TMPRSS6 RS855791 T/C POLYMORPHISM WITH MUSCLE FIBER COMPOSITION AND PHYSICAL PERFORMANCE

TAKARAGAWA, M.1, MIYAMOTO MIKAMI, E.1, TOBINA, T.2, SHIOSE, K.3, ICHINOSEKI SEKINE, N.4, KAKIGI, R.5, TSUZUKI, T.6, MURAKAMI, H.7, MIYACHI, M.8, KOBAYASHI, H.9, NAITO, H.1, FUKU, N.1

1 JUNTENDO UNIV., CHIBA, JAPAN, 2 NAGASAKI PREF. UNIV., NAGASAKI, JAPAN, 3 MIYAZAKI UNIV., MIYAZAKI, JAPAN, 4 THE OPEN UNIV. JAPAN, CHIBA, JAPAN, 5 JOSAI INTL UNIV., CHIBA, JAPAN, 6 MEIJO UNIV., AICHI

INTRODUCTION:
Human muscle fiber composition, a critical physiological characteristic that influences physical performance such as endurance and sprinting, is determined by genetic and environmental factors. A previous study has reported that experimentally induced iron deficiency in rats increases the distribution of fast-twitch muscle fibers and decreases that of slow-twitch muscle fibers (Esteva et al, 2008). Reportedly, iron status is affected by genetic factors, and a previous genome-wide association study has revealed that rs855791 T/C polymorphism in transmembrane protease, serine 6 gene (TMPRSS6) is associated with iron status (Seiki et al, 2018). Therefore, in the present study, we aimed to examine the associations of iron status related TMPRSS6 polymorphism with muscle fiber composition together with physical performance.
METHODS:
Study 1: To examine the association between TMPRSS6 rs855791 T/C polymorphism and muscle fiber composition, a total of 211 healthy individuals, comprising 104 males and 107 females, were recruited in the study. Biopsy samples were obtained from the vastus lateralis muscle to analyze the proportion of myosin heavy chain (MHC) isoforms (MHC-I, MHC-IIa, and MHC-IIx) as indicators of muscle fiber composition. Study 2: To examine the association between rs855791 T/C polymorphism and iron status in athletes, a total of 149 male athletes were recruited in the study. Study 3: To examine the association between TMPRSS6 rs855791 T/C polymorphism and elite athlete status, a total of 540 healthy individuals, comprising 405 controls and 135 international athletes (57 sprint/power and 78 endurance athletes), were recruited in the study. For all studies, rs855791 T/C polymorphism was analyzed using TaqMan SNP Genotyping Assay.
RESULTS:
Study 1: For all subjects, the proportion of MHC-IIa was significantly lower in subjects with T allele than in those with C allele under the additive genetic model ($P = 0.032$). This trend was stronger in females, with a lower proportion of MHC-IIa ($P = 0.025$) and a higher proportion of MHC-IIx ($P = 0.012$). Study 2: Serum iron and mean corpuscular hemoglobin (MCH) levels were significantly lower and hepcidin/ferritin value was significantly higher in subjects with T allele than in those with C allele under the additive genetic model ($P = 0.005$, 0.046, and 0.030, respectively). Study 3: Low serum iron and fast fiber related T allele frequency was significantly higher in elite sprint/power athletes than in controls ($P = 0.044$) and tended to be higher in elite sprint/power athletes than in elite endurance athletes ($P = 0.081$) under the additive model. This trend was stronger in females ($P = 0.003$ and 0.011, respectively).
CONCLUSION:
rs855791 T/C polymorphism in TMPRSS6 is associated with not only muscle fiber composition but also elite sprint/power athlete status, especially, in females.

MUSCLE DAMAGING EXERCISE INCREASES MYOFIBRILLAR CA2+ SENSITIVITY

HANDEGARD, V., SCHEIE, A.W., PAULSEN, G., SEYNNES, O., ØRTENBLAD, N., RAASTAD, T.

NORWEGIAN SCHOOL OF SPORT SCIENCES

INTRODUCTION:
Unaccustomed eccentric contractions induces long-lasting force depression, spanning several days. The mechanisms driving this force depression are not fully elucidated, but sarcomere disruptions, impaired excitation-contraction coupling and altered myofibrillar Ca2+ sensitivity are all contributing. Ca2+ sensitivity is influenced by oxidative stress in a seemingly bell-shaped relationship (1). Consequently,

increased oxidative stress imposed by muscle damaging exercise can theoretically both increase and decrease Ca2+ sensitivity in muscle fibers depending on the basal redox state. The aim of this study was to investigate changes in contractile properties after eccentric contractions.
METHODS:
Healthy, untrained individuals (n=15, 26±4 yrs) performed 50 unilateral eccentric biceps curls. The maximal force-generating capacity of the elbow flexors were tested prior to eccentric contractions, and after 5 min, 3, 24, 48, 72, and 96 hours of recovery. Biopsies were collected at 2 and 48 hours after exercise from the resting (control) and exercised arms. Single fibers (n=86) from five participants were isolated, chemically skinned and mounted between a force transducer and a pin, before being immersed in increasing Ca2+ solutions (pCa) to obtain force-Ca2+ relationship. Fibers were then treated with a reducing agent, Dithiothreitol (DTT), before being immersed in Ca2+ solutions again to investigate if oxidation influenced the force-Ca2+ relationship. Fibers were saved for subsequent analysis of myosin heavy chain (MHC) isoform. Analysis of variance using a mixed model was performed to investigate effects of eccentric contractions, fiber type and DTT treatment on all single fiber outcomes. All data are expressed as mean change with 95% CI.
RESULTS:
Forty-eight hours after eccentric contractions the maximal force-generating capacity of the elbow flexors was reduced by 36% (14% to 57%; p=0.001). The maximum single fiber specific force in MHCII-fibers was reduced after being treated with DTT (p<0.0001); however, there was no difference between exercise and control, and no change was detected for MHCI-fibers. MHCII-fibers from exercised arm increased their Ca2+ sensitivity (-0.106, -0.208 to -0.004; p=0.04), while no change was observed in MHCI-fibers when compared to the control arm. This increase in Ca2+ sensitivity was reversed by DTT (0.098, 0.067 to 0.129; p<0.0001).
CONCLUSION:
Although the force-generating capacity was reduced in the exercised arm, we found no difference between exercise and control in single fiber specific force. Ca2+ sensitivity was increased in exercised MHCII-fibers, with no effects in MHCI-fibers. This was fully reversed by subsequent treatment with a reductant, strongly indicative of an oxidative modulation. Our results indicate that eccentric exercise results in long lasting oxidation, probably of the cysteine residues at the fast troponin I isoform (2), improving Ca2+ sensitivity in MHCII-fibers.
1) Lamb & Westerblad, 2011
2) Mollica et al., 2012

THE DUAL ABILITY OF LOW-LOAD BLOOD FLOW RESTRICTED EXERCISE: SIMILAR MUSCLE GROWTH BUT AUGMENTED INCREASE IN MITOCHONDRIAL PROTEINS, COMPARED TO HIGH LOAD RESISTANCE EXERCISE

LANDER, E.1, DAVIDS, C.2,3, NÆSS, T.C.1, MOEN, M.1, CUMMING, K.T.1, ROBERTS, L.2,4, RAASTAD, T.1

1: NORWEGIAN SCHOOL OF SPORT SCIENCES, DEPARTMENT OF PHYSICAL PERFORMANCE. 2: THE UNIVERSITY OF QUEENSLAND. 3: LATROBE UNIVERSITY. 4: GRIFFITH UNIVERSITY

INTRODUCTION:
Exercising with low loads (20-40% 1RM) combined with blood flow restriction (LL-BFR) has been shown to promote muscle hypertrophy in a similar manner as high-load resistance training (HL-RT, >70% 1RM) (1, 2). Interestingly, LL-BFR seems to have a dual ability to enhance both muscle fiber growth and muscle fiber oxidative metabolism (3). There is, however, limited information about the mitochondrial adaptations to LL-BFR training. The aim of this study was therefore to compare the effect of LL-BFR and HL-RT on changes in muscle mass, mitochondrial enzymes and muscular endurance.
METHODS:
20 strength trained males and females (24±3 years) performed nine weeks of lower body strength training (2-3 exercises, 3/week) with either LL-BFR (30-15-15-15 reps, 30% of 1RM, n=10) or HL-RT (4 x 8 reps, 75% of 1RM, n=10). Before and after the intervention, cross sectional area (CSA) of quadriceps was quantified with MRI, and muscular endurance was assessed as total work during 50 sequential isokinetic knee extension contractions at a speed of 90°s-1. Biopsies were obtained from m. vastus lateralis before and after the 9-week training period. Homogenized samples were analyzed for the mitochondrial proteins HADH, Citrate synthase and COX4 using western blots. Data was analyzed using a two-way ANOVA for repeated measures.
RESULTS:
CSA of quadriceps increased after LL-BFR (7.4±4.3%, p<0.01) and HL-RT (4.6±2.9%, p<0.01) with no differences between groups. LL-BFR increased muscle endurance (10.8±8.1%, p<0.01) whereas no significant changes were observed after HL-RT (2.6±11.8%), and with a tendency for group effect in the relative change between groups (p<0.1). A time and group interaction effect (p<0.05) was found for the relative change in mitochondrial enzymes, where LL-BFR increased whereas HL-RT decreased the enzyme levels causing a different relative change between the two training interventions for HADH (15±29 vs. -20±34%, p<0.01), COX4 (48±55 vs. -12±51%, p<0.01) and Citrate synthase (21±33 vs. -21±18%, p<0.01). Furthermore, there was a significant correlation between the change in COX4 levels and the change in muscular endurance (r=0.60, p<0.01).
CONCLUSION:
Our results confirm that LL-BFR has a similar hypertrophic potential as HL-RT, and more interestingly, verify the dual ability of LL-BFR by the simultaneous increase in levels of mitochondrial enzymes. Furthermore, the observed increase in mitochondrial enzymes translated into altered muscular function evident by the observed improvement in muscular endurance with LL-BFR and with the positive correlation. The similar effect on muscle mass and the distinct difference in mitochondrial changes highlights the importance of considering both aspects when exercise guidelines are given to athletes and clinical populations.
1. Fry et al., J Appl Physiol (1985). 2010 May;108(5):1199-209
2. Lixandrão et al., Sports Med. 2018 Feb;48(2):361-378.
3. Vissing et al., Exerc Sport Sci Rev. 2020 Oct;48(4):180-187.

IS-BM02 Biomechanical analysis of athletes' wheelchair mobility performance through wearable sensors

WEARABLE SENSORSFOR MOVEMENT ANALYSISIN SPORTS: STRENGTHS AND WEAKNESSES OF MAGNETO-INERTIAL MEASUREMENT UNITS

BERGAMINI, E.

UNIVERSITY OF ROME "FORO ITALICO"

Driven by hardware miniaturization, as well as by advances in computing power, storage capacity, network connectivity, and software capabilities, the use of wearable sensors is becoming increasingly widespread in sports sciences and industry. In this context, magneto-inertial measurement units (Mimus) are among the most used sensors in the field of sports biomechanics. Mimus measure movement-related data, i.e. linear and angular motion, and openedup new perspectives for motor performance evaluation and monitoring also in sports for persons with disability.This lecture presents the working principles and the potential for the use of MIMUsfor the assessment of athletes' wheelchair mobility performance in para-sports. Special emphasis will be placed on the challenge of taking in due account sensors limitations, and on good practice rules for a better exploitation of their potential.

PROPULSION PERFORMANCE ANALYSIS IN WHEELCHAIR SPORTS BASED ON MAGNETO-INERTIAL MEASUREMENT UNITS: POSSIBILITIES AND LIMITATIONSOF CURRENT METHODS

SAURET, C.

INSTITUTION NATIONALE DES INVALIDES / ARTS ET MÉTIERS SCIENCES ET TECHNOLOGIES

Magneto-inertial measurement units are now miniaturized sensors that can be easily embedded on a wheelchair and on the athlete. Through the adoption of simple mechanical models, it is possible to access to instantaneous linear and angular velocities of the wheelchair and on the inclination of the user trunk that are critical parameters for wheelchair sport performance analysis. This constitutes an important opportunity to make measurements out of the laboratory, directly over ground and even during competition. However, this is possible only through underlying hypotheses that need to be satisfied to ensure results accuracy. This lecture will focus on the description of the current models and associated hypotheses, on the evaluation of these parameters against motion capture system, and on the possibilities and limitations for wheelchair sports analysis from the current methods.

THE APPLICATION OF INERTIAL MEASUREMENT UNITS TO MEASURE BIOMECHANICAL OUTCOME PARAMETERS DURING TRAINING AND COMPETITION

VEGTER, R.

UNIVERSITY OF GRONINGEN

The purpose of this presentation is to describe and explore an inertial measurement unit-based method to analyse useful biomechanical outcome parameters in the field. Although kinematics can be assessed reasonably well, getting from these to kinetic parameters, such as the estimation of power output can be trickier. An overview of the different applications of IMU use within the current WheelPower project,implemented over all Dutch wheelchair sports,will be given. Three main themes will be addressed. First, the use of IMU's on the wheelchair only, connected through an app for data collection during training and competition. Secondly, the possibility of measuring power output through coast-down tests. Finally, some preliminary result from additional IMU on the trunk will be presented.

12:30 - 14:00

PS-PL02 Producing force and sensing strain – where biomechanics and molecular biology meet

THE HISTORY DEPENDENCE OF MUSCLE ACTION–HIGHLY RELEVANT BUT MOSTLY NEGLECTED

HAHN, D.

FACULTY OF SPORT SCIENCE, RUHR-UNIVERSITÄT BOCHUM

Humans have a remarkable ability to perform various movement tasks, ranging from powerful movements for athletes to dexterous movements for musicians. To meet the requirements of these countless tasks, skeletal muscles can act as motors, brakes, springs, and struts. This intriguing ability is based on the neural control strategies and the intrinsic properties of muscle-tendon units both of which are essential for sports, mobility, posture and individual health. Despite its crucial importance, our understanding of in vivo human muscle function is far from complete and current standard neuromusculoskeletal models fail to accurately predict muscle forces. Our fundamental understanding of skeletal muscle function is based on the sliding filament and cross-bridge theories. This framework gives rise to the idea that muscle length, the velocity of potential length changes, and the neural activation level determine the resulting force output that a skeletal muscle produces. However, these three determinants are not able to predict force accurately during and following active muscle length changes. This severely undermines our ability to understand in vivo human muscle function, especially as human movement requires the combination of isometric, lengthening and shortening muscle actions.One major reason why we often fail to accurately predict skeletal muscle force output is that any active muscle length change itself immediately affects a muscle's ability to produce force. That is, compared with our predictions, muscle shortening or lengthening leads to long-lasting depressed or enhanced force output, respectively, which is known as the history dependence of muscle action. In this keynote presentation, it will be shown how the history dependence of muscle action affects force production and neuromuscular control. Examples will further demonstrate that the history dependence of muscle action has the potential to both, increasing and decreasing neuromuscular performance during human locomotion and sporting activities. Finally, the history dependence of muscle action changes with ageing and preliminary data suggests that it also shows changes to training and therefore might affect sports performance. It is hoped that this keynote will inspire and motivate young researchers to investigate the history dependence of muscle action from different perspectives and on all structural levels of muscle, with the overall goal to improve our understanding of in vivo human neuromuscular function.

INSIDE OUT AND OUTSIDE IN –MOLECULAR STRUCTURES MEDIATING THE MUSCULAR CROSSTALK WITH ITS ENVIRONMENT

WESSNER, B.

UNIVERSITY OF VIENNA

Besides the well-known role of the skeletal muscular system during movement, its contribution to many physiological processes has been highlighted. Furthermore, skeletal muscle tissue is remarkably malleable to various conditions ranging from exercise to disuse. Traditionally, a high proportion of research attempting to explore these adaptation processes have focused directly on muscle cells. However, it is a frequently overlooked fact that muscle fibers reside in a three-dimensional scaffolding that consists of various collagens, glycoproteins, proteoglycans and elastin, commonly referred to as extracellular matrix (ECM). In interaction with other cells, such as fibroblasts, immune cells or adipocytes, the ECM regulates muscle development, growth and repair and is essential for effective muscle contraction and force transmission. Changes in the ECM have been associated to age-related impairments of muscle function as well as to metabolic diseases and obesity. Furthermore, physical training leads to extensive remodeling of the ECM supporting training adaptations. With the aim to stimulate increased efforts to study this still poorly understood tissue, this lecture will summarize the current body of knowledge on (i) the composition and structure of the ECM, (ii) molecular pathways involved in ECM remodeling, (iii) the physiological roles of muscle ECM, (iv) dysregulations of ECM with aging and disease as well as (v) the adaptations of muscle ECM to training and disuse.

14:30 - 16:00

IS-SP01 EFFECTIVE FEEDBACK OF INFORMATION TO COACHES: LESSONS FROM THE FIELD – sponsored by CATAPULT

TITLE: FEEDBACK OF PERFORMANCE DATA WITHIN PROFESSIONAL SOCCER IN ENGLAND: PERCEPTIONS OF COACHES, PERFORMANCE STAFF, AND PLAYERS

ANDREW, M.

LIVERPOOL JOHN MOORES UNIVERSITY

In professional soccer, coaches must provide their players with feedback to improve their motor, psychological, and physical skills to triumph in competition (Williams and Reilly, 2000). Furthermore, many professional clubs employ performance staff (i.e., sport scientists) to collect, analyse and feedback data to evaluate and improve current practices and decision-making (Buchheit, 2017). However, it is not currently well understood how feedback of this performance data is transferred within professional soccer between coaches, performance staff and players, or how it is utilised to evaluate and inform decision-making. To that end, the objective of this presentation is to provide an overview of several studies that quantitatively and qualitatively evaluated the landscape of feedback
of performance related data in professional soccer in England (e.g., Nosek et al., 2021). The evaluation of perceived effectiveness of performance related feedback from key stakeholders, as well as a pilot study designed to increase the perceived effectiveness of feedback are also included.

THE INFLUENCE OF TRAINING DATA FEEDBACK ON THE DAILY DECISION-MAKING PROCESS OF COACHES

HECKSTEDEN, A.

SAARLAND UNIVERSITY

Individualized monitoring of recovery needs and estimation of injury risk
In many sports, fully utilizing the limits of bearable training load is a prerequisite of top performance.
Coaches are required to guide athletes along this edge while preventing them from eventually tipping over into accumulating recovery deficits. For reliably achiving this, decisions have to be based on meaningful data, precise standards of interpretation, and proven pipelines. This is comparable to other highly competitive environments such as finance or business development. However, while the challenges of individualized, multivariate interpretation of monitoring data are a fascinating topic for scientists, many reports fail to impact on the coaches daily decisions. This may be due, at least in part, because the high level of abstraction and complexity (scientists are so proud of) has to be hidden away to provide actionable information fitting seamlessly into the daily coaching process. We therefore argue, that while sophisticated analytical techniques are undoubtedly required for precise inferences from monitoring data, editing and communicating results is an equally challenging task and the key for influencing the daily decision-making of coaches. This includes adapting the whole pipeline – from the choice of parameters to the visualization of results – to the framework and requirements of the individual use case. In this talk I will illustrate this approach by discussing the development of a
monitoring system over the past years, its subsequent tailoring to the requirements of different sports, as well as remaining areas of improvement.

IS-AP02 Elite cycling – from talent identification to learning from field data

WHAT CAN WE LEARN FROM FIELD DATA OF ELITE CYCLISTS

LAMBERTS, R.

STELLENBOSCH UNIVERSITY

With the development of accurate monitoring tools, such as HR monitors and power meters, as well as the willingness of the elite cycling world to shar this data with scientists, a unique possibility has risen to study highly successful elite cyclists in the field. Through this we can study differences between the highly successful elite athletes and lesser successful elite riders. In addition, case studies can provide a unique insight to the capabilities and power profile of highly successful elite cyclists. The aim of this presentation focusses on what we can

learn from this field data. The presentation will include data ranging from what makes a sprinter highly successful in the Tour de France to what are the differences between a male and female Giro d'Italia / Giro Rossa winner as well as what the effect of fatigue is on performance in elite cyclists.

TALENT DEVELOPMENT IN ELITE CYCLING

ELFERINK GEMSER, M.

UNIVERSITY OF GRONINGEN, UMCG

Not only is road cycling one of the most popular sports worldwide, but it is also considered to be one of the most grueling sports on the planet with elite-level cyclists reporting exertion pain as the greatest psychological demand of the sport (Kress & Statler, 2007). Professional cyclists cover distances ranging from 30,000 to 35,000 kilometers every year during training and competition (Lucía et al., 2001). Only a small number of athletes are able to withstand the tremendous physical and mental demands of the sport. Consequently, becoming a world-class cyclist requires one to bea truly exceptional athlete.Theoretical models of talent development, such as the Groningen Sport Talent Model (GSTM) can be used to understand the secret behind world-class athletic success. Data from a cohort of talented cyclists whose performance has been monitored from youth throughout their cycling career for a decade will be presented in this presentation. Results clearly show the importance of the combination of physical, cognitive and psychological factors for success. Specific attention will be paid to the essential role of tactical skills for performance, an area of research which is relatively unexplored.

THE USE OF HRV TO OPTIMIZE THE TRAININGPROCESSIN ELITE CYCLISTS

JAVALOYES, A.

UNIVERSIDAD MIGUEL HERNANDEZ

Road cycling is considered to be one of the hardest endurance sports in the world, with high physiological demands during training and competition. Elite cyclists often accumulate a large amount of training and racing within a season, which makes maintaining a healthy balance training/recovery balance a challenge. Measuring the response to training and other life stressors during the training process is a key factor to optimize increases in performance. With the growth of new methodologies and technologies in the past decade, the possibilities to objectively monitor athletes has substantially grown. This development also has created the opportunity to individualize and adapt training programs to prescribe the most effective training programs. In this regard,heart rate
variability (HRV; a non-invasive measure of the autonomous nervous system) has been proposed as a powerful measure to detect positive and negative responses to training. This presentation will aim to offer practical applications and key considerations to implement the latest HRV advances into the monitoring process of elite cyclists. In addition, real-world data from this population will be showed to illustrate its usefulness to optimize performance increases.

16:30 - 18:00

IS-BM04 Blood Flow Restriction Training: From Myotendinous and Neuromuscular Adaptations to Clinical Applications

BLOOD FLOW RESTRICTION TRAINING: AN EVIDENCE-BASED SUMMARY ON MUSCULAR AND TENDINOUS ADAPTATIONS

CENTNER, C.

UNIVERSITY OF FREIBURG

Since the first publications about the combination of resistance exercise with blood flow restriction in the late 1990s, research about this training regimen has progressively increased. In this presentation, an evidence-based summary on muscular adaptations following blood flow restricted (BFR) exercise will be given. In this context, potential underlying mechanisms are presented before effects of relevant training specific parameters (e.g.:cuff pressure, intermittent vs. continuous BFR) are discussed. Additionally, within the last two years, new findings have demonstrated that BFR training might also have substantial impact on tendon properties, although such adaptations have previously been observed only following higher training loads. This is of particular importance for individuals who are contraindicated for high training loads but still aim for improvements in myotendinous function.

SHORT AND LONG-TERM NEUROMUSCULAR ADAPTATIONS TO EXERCISE WITH BLOOD FLOW RESTRICTION

COOK, S.

UNIVERSITY OF NEW HAMPSHIRE

Resistance training at low-loads with blood flow restriction leads to acute neuromuscular changes that can contribute to positive training adaptations. Oftentimes, these acute changes and adaptations may resemble those that occur following high-load resistance exercise leading to researchers and clinicians to employ blood flow restricted resistance training during periods of disuse or injury or in certain populations where high-load resistance training is contraindicated. In this presentation, an evidence-based summary of central and peripheral neural factors related to strength and muscle cross-sectional area will be discussed as it occurs following single or multiple blood flow restricted resistance training sessions.

EFFECTIVENESS OF BLOOD FLOW RESTRICTION TRAINING IN MUSCULOSKELETAL REHABILITATION

PATTERSON, S.

ST MARYS UNIVERSITY

Blood flow restriction (BFR) exercise is a novel training technique used for increasing skeletal muscle mass and strength. This BFR technique restricts muscle blood flow through the application of an external pressure, typically using a pneumatic tourniquet/cuff system applied to

the most proximal section of the upper or lower limbs. Importantly, the gains in skeletal muscle size and strength with BFR training have been typically demonstrated when using light exercise loads/intensities (e.g. 20-30% one repetition maximum), therefore, making it an attractive application during periods when loading of a joint should be limited, such as following injury. The aim of this presentation is to discuss the evidence and potential utility of BFR for rehabilitation and to consider some of the important safety and programming guidelines for this type of exercise.

IS-MH02 Now the drugs don't work (adverse exercise-drug interactions)

ANTIHISTAMINES AND THE ROLE OF HISTAMINERGIC SIGNALLING IN EXERCISE ADAPTATION

DERAVE, W.

GHENT UNIVERSITY

Histamine plays an important role in the sustained elevation of muscle perfusion and recovery after acute exercise. We recently added to this that chronic pharmacological blockade of histamine H1/H2 receptors by common over-the-counter antihistamines led to marked impairments of microvascular and mitochondrial training adaptations in human muscle. Consequently, functional adaptations in exercise capacity, whole-body glycemic control and vascular function were blunted. This work suggests that histamine H1/H2 receptors are important transducers of the integrative exercise response in humans. This lecture will critically review our current understanding of how histaminergic signalling is involved in the acute and chronic adaptations of skeletal muscle and the cardiovascular system to exercise.

THE IMPACT OF RESVERATROL ON EXERCISE TRAINING INDUCED CARDIOVASCULAR ADAPTATIONS

HELLSTEN, Y.

UNIVERSITY OF COPENHAGEN

The polyphenol resveratrol is a natural compound which is believed to improve health and retard the effects of aging on tissues including the cardiovascular system. The described beneficial effects of resveratrol in the cardiovascular system range from increased nitric oxide production to increased antioxidant capacity and mitochondrial biosynthesis. Exercise training is known to improve the cardiovascular system in multiple ways and it has been theorized that a combination of training and resveratrol would induce synergistic health promoting effects, particularly in aged individuals in whom oxidative stress may be elevated. However, evidence for a beneficial effect of resveratrol supplementation on the cardiovascular system in humans is weak and studies have even shown that resveratrol can reduce exercise training induced cardiovascular adaptations. This talk will briefly cover how resveratrol and exercise training may affect cardiovascular function per se, and will then mainly focus on what is known with regard to the influence of resveratrol on exercise training induced adaptations in humans.

EXERCISE AND METFORMIN INTERACTIONS IN SKELETAL MUSCLE

MILLER, B.

OKLAHOMA MEDICAL RESEARCH FOUNDATION

Exercise and metformin are often prescribed as first line therapies for type II diabetes. Regular exercise is a well-established therapeutic strategy to increase healthspan, while metformin is receiving increased attention for such purposes. Because of this increased attention to the positive effects of metformin, there are some individuals who have added metformin to their already healthy lifestyle, which may include regular exercise. Therefore, there are a number of individuals, both metabolically unhealthy and healthy, that may be taking metformin while on a regular exercise program. In this talk we highlight recent evidence that adding metformin to regular exercise may not have added benefits, and at times may be detrimental. This talk will also emphasize the role of antecedent health on metformin outcomes, and potential mechanisms of positive or detrimental actions. Although the liver is the primary site of the benefits of metformin for glucoregulation, this talk will discuss effects in skeletal muscle. It is hoped that this talk will underline the importance of considering drug-exercise interactions when prescribing therapeutic interventions.

IS-MH05 Exercise and Nutrition Before, During and After Disuse to Support Muscle Health in Older Adults

PREHABILITATIONTO COUNTERACTDISUSE-INDUCED MUSCLE DETERIORATION: WHAT WORKS BEST?

BREEN, L.

UNIVERSITY OF BIRMINGHAM

As a runner would prepare for the demands of a marathon, exercise and dietary interventions could help individuals withstand the physiological and metabolic stress of disuse (e.g. elective surgery). 'Prehabilitation' capitalizes on a better physical and emotional condition compared with peri-or post-disuse, and could benefit for a number of clinically relevant outcomes. In some clinical populations, multimodal prehabilitation has been shown to offset the decline in function during disuse and enhance recovery during rehabilitation. Evidence forthe effectiveness of prehabilitation on muscle health outcomes is inconsistent, due to large heterogeneity in training and nutrition parameters across studies, including the length of intervention. This presentation will provide an overview of the evidence-base and effectiveness of prehabilitation strategies implemented before issue for muscle health and function. This talk will focus on resistance training prehabilitation as a key interventionto protect against disuse-induced muscle deterioration, and will highlight evidence for macronutrient, micronutrient and nutraceutical approaches. We will communicate "what works best"for building sufficient reserves of muscle mass and function to buffer against the consequences of disuse and optimize recovery. We will also discuss whether short-term prehabilitation strategies could offset disuse-induced muscle deterioration.

REHABILITATIONTO REVERSE DISUSE-INDUCED MUSCLE AND STRENGTH LOSS IN THE OLD

SUETTA, C.

RIGSHOSPITALET, UNIVERSITY OF COPENHAGEN

Loss of muscle mass, muscle strength and physical function are common phenotypic traitsof hospitalisation (e.g.bed rest, immobilisation) and ageing. Repeated cycles of disuse-induced atrophy followed by incomplete muscle recovery has been suggested to be a contributor to the development of age-related muscle loss (i.e. sarcopenia), increased morbidity and mortality. The aim of the present talk is to review our current understanding of how resistance exercise and other treatment strategies implemented after disuse can be used to reverse muscle and strength loss in the old when. We have previously demonstrated, the loss of muscle mass starts within the first days of immobilisation and aging significantly affects the molecular regulation of human disuse and regrowth. Apart from a reduced regenerative capacity of myogenic stem cells (satellite cells) in ageing skeletal muscle the recovery of losses in muscle mass and muscle strength is often very slow and many elderly patients fail to regain their level of function without specific exercise interventions. It is therefore paramount to gain a better understanding of the ability of human skeletal muscle to recover from disuse-induced atrophy which has important implications for the development and implementation of effective countermeasures against physical frailty in the increasing population of elderly.

COUNTERMEASURES TO MUSCLE ATROPHY DURINGPERIODS OF DISUSE AND INACTIVITY

DIRKS, M.

UNIVERSITY OF EXETER

Short periods of muscle disuse(e.g. bed rest or limb immobilization) are often required for the recovery from illness or injury. Such periods lead to a substantial decrease in muscle mass, muscle function, and metabolic health. Importantly, as older individuals have an impaired recovery from muscle disuse, it is suggested that the accumulation of multiple periods of muscle disuse throughout the life span is largely responsible for the muscle loss observed with ageing. The attenuation of muscle atrophy during periods of muscle disuse will likely lead to improved short-and longer-term outcomes. The decline in muscle mass is attributed largely to a decline in postabsorptive and postprandial muscle protein synthesis rates. We will discuss potential interventional strategies to stimulate muscle protein synthesis and thereby alleviate muscle disuse atrophy, including dietary protein feeding and the (re-)introduction of muscle contraction e.g. via neuromuscular electrical stimulation (NMES). As such, this presentation will include will present potential interventional strategies that support muscle mass maintenance during periods of physical inactivity.

Live Sessions: Friday, September 10, 2021

08:30 - 10:00

IS-SH02 Sustainable Sport and Outdoor Recreation

CAN SPORTIFICATION BE SUSTAINABLE?

SVENSSON, D.

MALMÖ UNIVERSITY

Outdoor life and environmentalism have strong historical connections (Sandell & Sörlin 2008), but the same cannot be said for sports. While many sports were born as sportified versions of traditional mobility (skiing, swimming, running, bicycling, horse-riding etc.), their environmental impact has grown tremendously over time through increased use of long-distance transport and specialized equipment. In sport studies, the concept sportification (e.g. Guttmann 1978; Yttergren 1996; Sandell et al. 2011; Svensson 2016; Heere 2017) has been used as a tool for analyzing how most sports tend to develop toward increased regimentation, standardization, specialization, and rationalization. In skiing, wooden skis and home-made wax have been replaced by fiberglass skis, fluoride-based wax, artificial snow, and standardized arenas. In soccer, expanding domestic leagues and international competitions have meant more long-distance travel. While sportification has contributed to increasing performance, the techno-scientific revolution (Haake 2009; Fouché 2017) has so far also led to a growing ecologic footprint. The question is: Can sportification be sustainable?

THE ROLE OF SUSTAINABILITY ISSUES IN PE AND PETE

HOFFMANN, A.

XXX

In this presentation a problematization of the educational context of PEand PETE and issues of environmental sustainability will be discussed. In many cases, environmental sustainability issues have not yet trickled down to the actual teaching even though sport and outdoor recreation leave considerable environmental footprints (cf. Mikaels 2017; Backman 2010). An understanding of factors influencing the construction and re-contextualization of pedagogic discourses (Bernstein 1990, 2000) for sport and outdoor activities in PE and PETE, and their potential for environmental sustainability, is therefore crucial.

A SUSTAINABLE ADVENTURE?

BEAMES, S.

NORWEGIAN SCHOOL OF SPORT SCIENCES

In this presentation Beames will explore how adventure sport practices can be considered more deeply through theoretical discourses of capitalism and sustainability. Through an analysis of consumption ideas and patterns sustainability issues will be problmatized and scrutinized.

IS-PN01 The emerging use of Cannabidiol (CBD): the real deal or another magic bullet?

WHAT IS CANNABIDIOL (CBD), WHY ARE ATHLETES TURNING TO IT AND WHAT ARE THE ASSOCIATED RISKS?

CLOSE, G.

LIVERPOOL JOHN MOORES UNIVERSITY

Cannabidiol (CBD) is one of over 140 cannabinoids found in the cannabis plant which has been claimed to have beneficial effects on pain management, sleep and recovery. It is therefore of little surprise that there are a growing number of athletes turning to CBD for pain management and recovery purposes, however, the efficacy and safety of such practices still remains unknown. In a recent large scale study in rugby, we reported that 26% of professional rugby players have either used or currently use CBD on a regular basis. This number increased to almost 40% in players >28 years of age with the major reasons cited for use including pain management and improved sleep. Despite CBD being removed from the WADA prohibited list in 2018, all other cannabinoids remain prohibited and given that small amounts of these cannabinoids are usually found in CBD products, the use of CBD poses a serious risk to athletes. This presentation will look at the emerging use of CBD in professional athletes and discuss the risks from both an anti-doping and health perspective. Finally, the presentation will highlight questions that need to be addressed prior to recommending the use of CBD in sport.

POTENTIALAPPLICATIONS FORCANNABIDIOL (CBD) IN SPORT

MCCARTNEY, D.

UNIVERSITY OF SYDNEY

Cannabidiol (CBD) is a non-intoxicating cannabinoid derived fromCannabis sativa. CBD initially drew scientific interest due to its anticonvulsant properties but increasing evidence of other therapeutic effects has attracted the attention of additional clinical and non-clinical populations, including athletes. While these individuals may not be eligible to access regulated, prescription CBD (e.g., Epidiolex®), a wide range of low dose 'nutraceuticals' are now readily available online and over-the-counter. A narrative review and small pilot study were conducted to evaluate CBD's utility of in supporting athletic performance.The physiological and psychological effects of CBD that may have relevance to sports performance were reviewed. Preclinical studies have observed robust anti-inflammatory, neuroprotective, and analgesic effects

of CBD in animal models. Preliminary preclinical evidence also suggests that CBD may protect against gastrointestinal damage associated with inflammation and promote healing of traumatic skeletal injuries. However, further research is required to confirm these observations. Early-stage clinical trials suggest that CBD may be anxiolytic in stress-inducing situations and in anxiety disorders. While some case reports indicate that CBD improves sleep, robust evidence is lacking. Cognition and thermoregulation appear unaffected by CBD, however, its effects on metabolic and cardiovascular function require further study. The effects of CBD on exercise physiology were investigated in a small pilot trial. On two separate occasions, nine endurance-trained males (VO2max: 57.4±4.0mL·min-1·kg-1) ran for 60-minutes at fixed, moderate-intensity (70% VO2max) before completing an incremental run to volitional exhaustion. Participants received a single oral dose of CBD (300 mg) or placebo 1.5-hours prior to the onset of exercise on each occasion in a randomized, double-blind design. Oxygen consumption (VO2) was measured continuously between 24–32, 37–45 and 50–58-minutes of submaximal exercise; heart rate (HR), ratings of perceived exertion (RPE), ratings of pleasure–displeasure and blood glucose and lactate concentrations were also measured at 20-minute intervals. Venous blood was drawn to measure plasma CBD concentrations and probe other markers of inflammation, muscle damage and gastrointestinal damage. CBD tended to increase submaximal VO2 (+24±13mL·min-1, p=0.094).No accompanying changes in HR, RPE, blood glucose or lactate concentrations, or respiratory exchange ratio were observed (p's>0.10). VO2max(+1.5±2.8mL·min-1·kg-1, p=0.121) and TTE (+39±85sec, p=0.204) were also similar (if not mproved) under the CBD treatment. In addition, CBD tended to increase subjective ratings of pleasure at 20-(p=0.050) and 40-(p=0.065) but not 60-minutes (p=0.782) of submaximal exercise. (Biomarkers are still under investigation).

CANNABIDIOL(CBD) AND RECREATIONAL ATHLETES

JAMES, L.

LOUGHBOROUGH UNIVERSITY

Since the removal of cannabidiol (CBD)from the World Anti-Doping Agency's prohibited list in 2018, there has been much interest in its use in the context of sport and exercise. This, in part, has led to the wide-spread growth in the availability (and marketing) of CBD for sports people and the general consumer alike, with products available on the high street and online through numerous large and small retailers. These products are purported to have many health and/or performance benefits, and whilst there is emerging research demonstrating some beneficial effects in clinical populations, the typical dose administered is large, making these type of dosing regimens costly for the user. Clearly, in some athletic settings (e.g. certain professional sports) these cost considerations will not be prohibitive or may be balanced by the perceived potential for athletic success, but for many,including recreational exercisers, they will not. However, it is likely that most exercising CBD consumers are not professional/elite athletes, but rather those who exercise for recreation and/or health purposes. Whilst some of the goals of these recreational exercisers might be similar to those of elite athletes (e.g. optimising performance, recovery and/or body composition), they may also have other goals, including those related to managing energy, maintenance/improvement of metabolic health and promotion of general well-being.This presentation will consider goals relevant to the recreational exerciser and where and how CBD might (or might not) be of benefit. It will particularly focus on the use of economically realistic doses in this large and important, but often forgotten, group of exercisers.

IS-PN03 Novel Products and Real-world Solutions for Elite Athletes to Beat the Heat

THE USE OF COOLING HEADWEAR IN ELITE SPORT

STEVENS, C.

SOUTHERN CROSS UNIVERSITY

Cooling the head and face with water spraying has led to large improvements in physical performance including a 51% increase in cycling time to exhaustion and a 3% improvement in performance time in a 5 km running time trial. These large improvements have been attributed to a psychophysiological mechanism involving enhanced thermal sensation and thermal comfort due to the high density of thermal afferents in the face, as well as improvements in the serotonin:dopamine ratio that activates reward centres in the brain and contributes to increased motivation. The powerful effects of face and head cooling during exercise is apparent from watching any athlete or exerciser in the heat pouring water on their head and face at any opportunity, however, cooling headwear products have only recently become available. This presentation will describe the science behind the use of novel cooling headband technology, neck cooling collars and ice pack headwear.

CURRENT PRACTICE OF HEAT PREPARATION AND COOLING STRATEGIES IN ELITE ATHLETES

TAYLOR, L.

LOUGHBOROUGH UNIVERSITY

Despite an explosion of original and review-based data, discussion,and conjecture regarding heat acclimation/acclimatisation (HA) and body cooling interventions for athletic training and competition in the heat, only a small fraction has focused upon elite athletes and major competitions. The volume of such articles has only intensified given Tokyo 2020 was widely anticipated to be the hottest Olympics to-date. Despite most practitioners knowing precisely what they 'should' do regarding HA and cooling interventions when training and competing in the heat, less is known about 'what they actually do' within the logistical and practical constraints of major athletic events. Using available evidence and first-hand experience from the World Rugby Sevens Series, IAAF (now World Athletics) Doha 2019 World Championships and the Tokyo 2020 Olympics, the reality of what actually happens' and is 'effective' regarding these approaches at major sporting events will be discussed.

DEVELOPMENT OF 'COOLING' MENTHOL SPORTS NUTRITION PRODUCTS

ROSS, M.

AUSTRALIAN CATHOLIC UNIVERSITY

Internal application of menthol can be ergogenic for athletes, and hence, addition of menthol to sports nutrition products may be beneficial for athletes. Recently, scientists and athletes have been experimenting with menthol beverages, swills and energy gels and a range of

menthol products are now commercially available. This presentation will describe the development of a menthol ice slurry mixture and a menthol energy gel for athletes. Both lab-based and field-based studies on menthol sports nutrition products have been completed to assess the acceptability, preferences, physiological responses and performance outcomes of these products. This presentation will present the science and development of these menthol products with industry, data from the lab and feedback from elite athletes using menthol products in training and competition.

10:30 - 12:00

IS-AP03 Integrating data science and monitoring to improve athlete performance and health

CONTINUOUS MONITORING OF ATHLETE PERFORMANCE AND HEALTH IS WORTH IT -EVEN THOUGH IT DOES NOT COME CHEAP NOR EASY

VERHAGEN, E.

VU UNIVERSITY MEDICAL CENTER

When it concerns performance enhancement, many funds and effort are being put in –amongst others –the development of new training methods, training materials, and equipment. All to make our athletes stronger, faster, and better. What is generally neglected is that for athletes to (fully) benefit from newly developed and improved training methods, they have to remain in full health. Developments in the continuous registration of injuries have shown that injuries are a constant and performance-limiting problem in sports, and it has become apparent that athletes compete while injured. This results in inefficient training and suboptimal performance. This presentation outlines an integrated approach towards healthy and optimal performance, integrating independent components on load, load capacity, performance and health. Via data science and machine learning approaches, the strength and temporality between these components can be assessed. Such continuous and prospective monitoring is the cornerstone of performance while managing the risk of adverse effects and inefficient loading in near-real-time. This presentation will illustrate with practical and scientific examples the value of such intense monitoring in recreational sports, professional sports, as well as performing arts.

HOW IS ATHLETE MONITORINGBEING USED TO OPTIMISE PERFORMANCE AND REDUCE INJURY RISK IN HIGH-LEVEL TEAM SPORTS?

MCCALL, A.

UNIVERSITY OF LILLE2

Athlete monitoring is well established and widely implemented in high-level sports teams such as football, rugby, American Football, Basketball, Australian Rules Football. Controlling the training load and managing the training week for these athletes can be one strategy among several to help optimise player (and by inference, the team) performance and potentially reduce the risk of injury. Over the last decade, there has been an exponential rise in both the popularity of its use in practice and the number of published research articles on the topic, particularly in team sports. Unfortunately, this explosion of information has also brought some confusion with some dogmas being created. Now,in the age of so-called 'Big Data,' we need to understand the useful information (i.e. the signal) and what is not useful (i.e. the noise). In the performing arts,e.g. dance, monitoring load is not yet as widespread in practice nor does it have the research base that we see in high-level team sports, however, it is picking up momentum fast. Dr. Alan McCall will share his experiences as a practitioner and researcher in high-level football (soccer) both at the individual team level and multi-team large scale. Alan will focus on the lessons learned from team sports and how these can help guide the future of load monitoring. Alan will focus particularly on the complex, dynamic and multifactorial nature of load and its analysis to optimise performance and minimize injury risk.

MONITORING THE HEALTH OF ATHLETES AND ARTISTS: FACTORS INFLUENCING IMPLEMENTATION

STUBBE, J.

AMSTERDAM UNIVERSITY OF APPLIED SCIENCES

Athletes and dancers have at least two things in common: they have to perform well in high-pressure situations and face challenging physical demands. There is barely any time to recover, making athletes and dancers prone to injuries due to overload. Self-report measures such as questionnaires and diaries are suggested to be a simple and cost-effective approach to monitor an athlete's response to training. However,their efficacy is dependent on how they are implemented and used. Codarts Rotterdam has developed the Performing artist and Athletes Health Monitor (PAHM) to monitor athletes and dancers health. Over 1,000 athletes and performing artists use this monitor, including soccer players from the Dutch Premier League club Feyenoord and dancers from the Dutch National Ballet. Dr. Janine Stubbe will share her experiences with large scale injury data collection across both sport and dance. She will focus on developing, implementing,and evaluating her online tool for monitoring the physical and mental health of athletes and dancers. She will discuss some of the factors influencing the response rate and the implementation of health monitoring tools. Janine will present the lessons learned from more than 10 years of health data collection in sports and dance to close.

IS-PN02 Thought we knew everything about eccentric muscle loading? Think again

TEMPORAL RESPONSE OF HUMAN SKELETAL MUSCLE TO HIGH LOAD ECCENTRIC EXERCISE TRAINING.

GREENHAFF, P.

UNIVERSITY OF NOTTINHAM

It has been reported that high load eccentric exercise training results in augmented muscle hypertrophy (1, 2). However, the mechanisms that could underpin such adaptation are not well understood. Focus has been directed towards the greater work done during eccentric

muscle loading being a mechanistic driver of increased muscle hypertrophy (3), together with eccentric exercise induced potentiation of muscle inflammation (4) and satellite cell proliferation (5). However, whether high-load eccentric exercise training does indeed induce greater muscle hypertrophy than concentric exercise training alone is controversial. Importantly, few studies have examined the temporal response of skeletal muscle to high load eccentric exercise training, particularly under conditions where muscle-centric mechanisms that might underpin purported greater muscle adaptation have been studied in tandem. This presentation will focus on evidence demonstrating neither the greater amount of work done over the course of chronic high-load eccentric or combined concentric and eccentric training, nor clear differences in mRNA abundance responses during the early phase of training, impact on muscle hypertrophy compared to concentric training alone. Time permitting, further work focussed on the impact of dampening muscle inflammation throughout 12 weeks high load resistance exercise training will also be considered.

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CONNECTIVE TISSUE REGENERATION IN SKELETAL MUSCLE AFTER ECCENTRIC CONTRACTION

MACKEY, A.

UNIVERSITY OF COPENHAGEN AND BISPEBJERG HOSPITAL

Connective tissue regeneration in skeletal muscle after eccentric contraction
Abigail L. Mackey
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Xlab, Center for Healthy Aging, Department of Biomedical Sciences, Faculty of Health and Medical Sciences, University of Copenhagen, Denmark
Human skeletal muscle has the potential to regenerate completely after injury induced under controlled experimental conditions. Examples of models suitable for humans include voluntary eccentric contractions or contractions induced by neuromuscular electrical stimulation (NMES). The major difference between these two models appears to be the proportion of muscle fibres damaged to the point of necrosis, with voluntary contractions rarely leading to muscle fibre necrosis in prime mover muscles (1). In studies where NMES has been employed, approximately the proportion of necrotic fibres has been reported to range from 15-40% (1, 2, 4). While the events inside the myofibers as they undergo necrosis, followed closely by satellite cell-mediated myogenesis, have been described in detail (3), much less is known about the adaptation of the connective tissue structures surrounding the myofibres throughout this process. The role of individual muscle matrix components and their spatial interaction during adaptation to eccentric contractions is an unexplored field in human skeletal muscle and may provide insight into the optimal timing of rest vs. return to activity after muscle injury. This not only relates to restoration of the muscle belly, or mid-portion, but also to the interface between the muscle fibres and the tendon – the myotendinous junction MTJ. In general, it appears that the muscle connective tissue takes longer to recover after contraction induced damage than the muscle fibres themselves, which may explain the high rate or re-injury recorded after an initial strain injury. On this background, further work on the connective tissue components of skeletal muscle, including at the myotendinous junction, is warranted.

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ECCENTRIC EXERCISE IN PEOPLE WITH COPD

STEINER, M.

UNIVERSITY OF LEICESTER

Exercise limitation due to breathlessness is a fundamental and burdensome symptom for people with COPD, usually due to a pathological limit to pulmonary ventilation during exercise that results from abnormal respiratory pathophysiology. A consequence of COPD is reduced skeletal mass and function (particularly in the locomotor muscles) principally due to inactivity resulting from the aforementioned chronic breathlessness. Exercise training is a highly effective therapeutic intervention for people with COPD but for this to be effective, high relative exercise intensities are required in order to provoke physiological adaptation at a muscle level. This can be uncomfortable for patients to undertake and in practical terms can be a barrier to the successful completion of progressive exercise rehabilitation. Eccentric exercise modalities have the potential to enhance the benefits of rehabilitation because eccentric contraction produces higher muscle specific contractile force at a lower cardio-respiratory cost. In this lecture I will consider the physiological impact of eccentric exercise in the context of pathophysiology of COPD and review the evidence to support the clinical efficacy and practical implementation of eccentric exercise strategies during exercise rehabilitation in COPD.

IS-PN04 Impact of hyperthermia and dehydration on pulmonary function and the respiratory response to exercise

ADAPTATIONS OF THE RESPIRATORY SYSTEM TO PHYSIOLOGICAL CHANGES INDUCED BY EXERCISE IN NORMOTHERMIC ENVIRONMENTAL CONDITIONS

SPENGLER, C.

ETH ZURICH

In the course of exercise, the respiratory system needs to adapt, not only to increased metabolic demand of the working muscles and to changes in the cardiovascular system but also to challenges to homeostasis. In particular, increases in core body temperature (already

present under normothermic conditions)and threads to the acid-base balance are driving respiratory responses during exercise. In this presentation, various aspects of respiratory adaptations –positive, but also possibly detrimental –will be assessed, in the context of differing exercise intensities, durations,and fitness levels. Further, mechanisms of changes in these respiratory adaptations throughout the lifespan will be explored.

HYPERTHERMIA CAUSES HYPERVENTILATION DURING PROLONGED EXERCISE IN THE HEAT

FUJII, N.

UNIVERSITY OF TSUKUBA

Ventilation during sub-maximal moderate-intensity exercise is tightly regulated to meet metabolic demands. However, as exercise continues, ventilation gradually increases. This response is markedly augmented when exercising in the heat wherein body temperatures gradually increase (so called hyperthermia-induced hyperventilation). An early work in our laboratory demonstrated that core, but not skin, temperature plays a major role in mediating hyperthermia-induced hyperventilation. Typically, a 1°C elevation in core temperature leads to 8-10 L·min-1increase in exercise ventilation. Subsequently, we demonstrated that there is a core temperature threshold for inducing hyperthermia-induced hyperventilation. This hyperventilation accompanies hypocapnia (lowered arterial CO2partial pressure), thereby reducing cerebral blood flow. Chemoreflex appears to be involved in the regulation of hyperthermia-induced
hyperventilation. Our recent work also demonstrated that caffeine exacerbates hyperthermia-induced hyperventilation, whereas sodium bicarbonate attenuates the hyperventilation. The attendees will gain insight into the characteristics of hyperthermia-induced hyperventilation during exercise in the heat.

EFFECTS OF SYSTEMIC AND LOCAL (AIRWAY) DEHYDRATION ON PULMONARY FUNCTION AND VENTILATORY RESPONSES TO EXERCISE

KIPPELEN, P.

BRUNEL UNIVERSITY LONDON

The effects of exercise-induced dehydration on thermoregulatory, cardiovascular, metabolic and neuroendocrine functions have been extensively investigated; however, little attention has been given so far to pulmonary function. This is striking in that water transport and local (airway) hydration are critical for the normal functioning of lungs and airways. Dr Kippelen will share her latest findings demonstrating that i) mild and moderate dehydration (induced by exercise in the heat or prolonged periods of fluid restriction) lead to negative alterations in resting pulmonary function in healthy, normally active individuals, and in trained young adults with and without asthma; ii) dehydration-induced pulmonary alterations can be rapidly reversed by fluid consumption but not local airway rehydration; iii) the functional implications of dehydration-induced pulmonary alterations seem limited in endurance-trained athletes, as evidenced by the lack of significant change in ventilatory response, pulmonary gas exchange and respiratory discomfort with progressive dehydration.

12:30 - 14:00

IS-EX03 ECSS-FEPSAC: The development and use of subjective measures in performance and training monitoring

MULTIMODAL AND MULTIDIMENSIONAL MONITORING:THEPRINCIPLE OF CONVERGING EVIDENCE

BERTOLLO, M.

UNIVERSITY G. DANNUNZIO OF CHIETI-PESCARA

A multimodal and multidimensional assessment based on the integration of different subdisciplines is becoming more and more prominent to measure performance in daily training routine and many scholars are looking for a grand unified theory in sport science. Assessment includes self-reports, behavioural and kinematic observations, as well as physiological recordings. More recently, this holistic approach has been implemented in performance optimization to study body-mind interaction processes and their interplay with the environment to monitor and improve human performance and monitor training. In the analysis of performance dynamics, psychophysiological monitoring and intervention provide useful information to athletes (and their coaches) about their mental status (e.g.,stress-response) and how to self-regulate their processes for optimal performance.The analysis of the processes surrounding performance is guaranteed at different levels of motor behaviour, including the relationship among person, task, and environment. Although a huge amount of data is collected sometimes coaches forget to apply the principle of converging evidence and utilize the best information for monitoring training and performance.

PSYCHOLOGICAL APPROACHES TO MEASUREMENT: THE IMPORTANCE OF CONSTRUCT VALIDITY

KAVUSSANU, M.

UNIVERSITY OF BIRMINGHAM

Questionnaires or self-report measures are commonly used in sport science to measure psychological variables such as affect, mood, stress, and burnout. However, the importance of ensuring that the measures used are valid and reliable is overlooked. Validity refers to the degree to which an instrument assesses what is meant to assess and captures the target construct and its dimensions adequately. The most common type of reliability is internal consistency; however,this cannot be assessed in single-item measures. In this presentation, I will focus primarily on the importance of construct validity. I will explain what is construct validity, what are its components and why it is important for a measure to have high construct validity. Throughout the presentation I provide examples of psychological measures used in sport, with a particular focus, on affect, stress, and mood. I will also discuss the dangers of using single item measures that do not fully capture the construct that one intends to measure.

CLINIMETRIC ANALYSIS OF THE WELLNESS ITEMS USED TO MONITOR TRAINING: ARE THEY VALID? [SPOILER: THEY AREN'T]

IMPELLIZZERI, F.

UNIVERSITY OF TECHNOLOGY OF SYDNEY

In sport science athlete reported outcome measures(self-reports) are nowadays commonly used to monitor training, and part of customised or commercially available athlete management system. Among these, the most frequently used are the so-called wellness items, claimed to measure using single items (sometimes combines in a single score) constructs such as stress, mood, fatigue, sleep quality, etc. A recent systematic review examining the psychometric properties of these instruments using international clinimetric guidelines: COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN). While support to the use for the instruments developed in the area of psychology was found, no studies appropriately and purposefully validating these single items were found. Areas of concerns that warrant methodologically sound future investigations are: lack of reference framework, no operational definitions of target constructs, examination of
construct validity, proper selection of response option, reliability and agreement determination.

IS-SH03 Youth Sports and Combat Sports: A re-examination

SPARRING: THE SWEET SCIENCE OF REFLEXIVE SOCIAL COOPERATION

LEWANDOWSKI, J.

UNIVERSITY OF CENTRAL MISSOURI

Global participation in the sport of boxing is widespread among youth, especially in urban areas with high concentrations of ethno-racial division and socio-economic marginalization. Generally speaking, boxing in such contexts is viewed as a sport in which youngsters (mostly male) are able to channel the arbitrary violence and aggression of their everyday lives in the controlled violence of an organized sport. Youth boxing, in other words, is construed as a sport that fosters self-discipline, structure, and respect, and, moreover, can serve as an antidote to the random violence of 'the street' for urban youngsters. This paper challenges such a stereotypical account of youth participation in the sport of boxing, especially in the urban milieu. While boxing may teach the art of controlled violence, for health reasons (e.g., repeated concussive head injuries) youngsters—especially those from impoverished backgrounds—should not compete in the sport of boxing. But, the paper goes on to argue, there is a place for the practice form of boxing known as 'sparring' in the framework of youth sport and community development. Indeed, the practice of sparring in a combat sport such as boxing teaches forms of social cooperation and mutual collaboration that youngsters may not otherwise learn outside of the gym.

SHOULD BOXING BE PART OF OLYMPIC EDUCATION?

LOLAND, S., COELHO, R.

THE NORWEGIAN SCHOOL OF SPORT SCIENCES

Boxing is morally contested terrain, in particular in its professional or knock out versions. Amateur versions emphasizing technical and tactical skills are less contested but still controversial as they include and reward landing blows to the head and body of an opponent. Traditional moral arguments revolve around health, aggression/violence and respect for persons, and the socializing effects of boxing. Indeed, recent analyses conclude that the aims of boxing do not fall in line with the ideals of Olympic education, and hence argue that the sport should be discontinued as a component of the Youth Olympic Games (YOG). This paper largely shares that view but maintains that the moral potential of amateur boxing must be recognized. To that end, the paper provides a review of the goals of the YOG. Secondly, the paper argues that boxing can be modified in ways that make the sport not only morally acceptable but particularly potent in the realization of YOG goals. An outline of modifications and adaptations in which collaboration and mutual respect between boxers are constitutive elements is developed. The paper concludes with the assertion that boxing in such modified form should be an obligatory part of Olympic educational programs and a core sport within the YOG.

AESTHETIC AND ETHICAL SYNERGIES IN YOUTH COMBAT SPORTS

ÁVILA DA COSTA, L., ANDERSEN, W.

UNIVERSIDADE DO PORTO

While combat sports are typically associated with violence, this paper seeks to explore the aesthetic and ethical dimensions of such sports. Combat sports, on this account, have little to do with violence. Instead, like other sports, combat sports are rich with narrative and drama permeated by certainty and uncertainty, predictability and unpredictability, the expected and the unexpected, the pleasant and the repulsive. In this regard the tension between the narrative of combat and the ethical obligation to show respect and esteem for an opponent is especially acute in combat sports. Indeed, how can one simultaneously show respect and esteem for an opponent while trying to excel in knocking him/her unconscious? Combat or fighting sports challenge athletes to find ways to move aesthetically and ethically, not merely violently. This paper explores the pedagogical potential of combat sports among youth with an eye toward the synergy of aesthetics and ethics of combat. The paper examines different combat sports, and considers how combat sports foster learning at young ages and can contribute to an aesthetic-ethical way of competing and, indeed, existing, by enriching youngsters lives and providing an alternative to utilitarianism and hedonism.

IS-MH03 Advancing understanding of the inclusion of people with intellectual disabilities in sport and exercise

PARTICIPATION IN PHYSICAL ACTIVITY AND SPORTS IN INDIVIDUALS WITH DOWN SYNDROME: A NEW METHODOLOGICAL APPROACH

VANNOZZI, G.

UNIVERSITY OF ROME FORO ITALICO

Down Syndrome (DS) is one of the most frequent chromosomal disorders and is characterized by a variety of phenotypic features such as intellectual disability, congenital heart disease, respiratory disorders, ligament laxity and muscle hypotonia, and delayed motor development. All these phenotypic features may contribute to limit the amount of daily physical activity which, in this population, falls below the recommended daily levels leading to the well-known risks in terms of well-being, personal health andmedical costs for the national health systems. In this context, further knowledge of the factors fostering a reduction of the inactivity levels in this population is of utmost importance. These factors are associated with, and possibly related to, the delayed acquisition of gross motor functions such as walking, running, and jumping. In this context, a reduced motor competence induces a vicious circle in further lowering physical activity levels. This talk will focus on the results of an ongoing EU project called IKONS. Motor competence in DS individuals will be characterized and discussed offering a new methodological viewpoint to assess PA levels and investigating how specific Karate training program designed and implemented within IKONS could enhance PA levels generating a virtuous circle towards a better quality of life

THE IMPACT OF COGNITION AND INTELLECTUAL IMPAIRMENT ON PACING, PERFORMANCE AND PARTICIPATION IN SPORT AND EXERCISE

HETTINGA, F.

NORTHUMBRIA UNIVERSITY

Elite athletes with intellectual impairments often struggle with pacing, self-regulation and decision-making in sports, as has been demonstrated in for example athletics and basketball. Also young children and talented young athletes demonstrate a development in their pacing behaviours throughout adolescence, thus confirming that pacing skills need to be developed over time, and seem to be related to cognitive skills.Also for exercise engagement and motivation, the lack of adequate pacing and self-regulation skills seems to result in barriers to physical activity behaviour for persons with intellectual impairments, though research on this is scarce. Personal (eg motivation) as well as environmental (eg social interactions and encouragement of others) factors, and the impact of their impairment on physical activity behaviour, should be better understood to be able to facilitate stimulation of an active lifestyle for this population. This presentation will overview current research on the impact of cognition and intellectual impairment on pacing, performance and participation in sport and exercise, and will explore how with current understanding of underpinning mechanisms, we can aim to facilitate exercise engagement and optimal performance in sports for persons with intellectual impairments.

THE PSYCHO-SOCIAL BENEFITS FOR INDIVIDUALS WITH INTELLECTUAL DISABILITIES OF ENGAGING IN PHYSICAL ACTIVITY

BURNS, J.

CANTERBURY CHRIST CHURCH UNIVERISTY

In this presentation I will review the growing body of research demonstrating the positive impact on the psychological well-being and social outcomes for people with intellectual disabilities engaging in physical activity. I shall describe why this group can be a harder to reach group, but also why the benefits can be greater. I will also draw on a number of research projects both within the Special Olympics and other UK charities which have demonstrated how some of the barriers to engagement can be overcome. One of the specific challenges in this area is the diversity of needs in this population, and that many of the adaptations made focus largely on those with less severe limitations. I will also discuss what some of the specific needs might be for those with more severe ID, and with dual diagnosis such as autism, and some of the approaches taken to increase engagement in physical activity.

16:30 - 17:45

PS-PL03 Celebrating 100 years of insulin: Highlighting the gains in diabetes longevity and physical fitness a century after this landmark discovery

THE SECRETS OF THE LONGEST LIVING PEOPLE WITH TYPE 1 DIABETES: EVOLVING ROLES OF INSULIN, DIET, AND EXERCISE ON HEALTH AND FITNESS OVER THE LAST CENTURY

COLBERG OCHS, S.

OLD DOMINION UNIVERSITY

Before insulin became commercially available as a lifesaving medication for individuals with type 1 diabetes, early mortality was inevitable. Prior to insulin, life was sustained for days to a few years with a low-carbohydrate, starvation-type diet, and physical activity was discouraged or impossible to perform. The discovery of insulin in 1921 saved the lives of countless individuals but brought with it a unique set of challenges related to glycaemic management, dietary regimens, physical activity participation, and health concerns. In particular, insulin users must balance food intake and circulating insulin levels to acutely prevent hypoglycaemia or hyperglycaemia related to physical activity. Blood glucose is a critical fuel for active muscles, the brain,and the nervous system. In active individuals without diabetes, reductions in muscle and liver glycogen stores to maintain euglycaemia during exercise can lead to decreases in performance, an inability to continue the activity, and even hypoglycaemia. For individuals who use exogenous insulin, a failure to maintain glycaemic balance before, during, and after any exercise with appropriate regimen changes can not only impact performance and participation, but also acutely result in a medical emergency, hospitalization, and potentially death. Sheri Colberg will provide an overview of the evolution of insulin use that has led to

breakthroughs in nutritional and exercise training practices that have helped countless individuals with type 1 diabetes live longand active lives. She will outline all of the lifestyle management tools now employed by such individuals to optimize their health, with an emphasis on physical activity and fitness and the challenges and benefits associated with being active with insulinuse.

THE PROFESSIONAL ATHLETE WITH TYPE 1DIABETES: APPLYING KNOWLEDGE FROM CLINICAL RESEARCH TO IMPROVE PERFORMANCE AND HEALTH IN THIS UNIQUE GROUP OF ATHLETES

SCOTT, S.

UNIVERSITY OF BERN

Professional road cycling is one of the most physically demanding sports; combining extremes of exercise duration, intensity and frequency. Road cycling involves high training volume, long seasons with frequent competition days (60-100 per year), with races up to 6-8 hours and stage races ranging from 5 days to 3 weeks. Professional riders are required to regularly compete alongside multiple uncontrollable variables such as changing weather and road conditions, variable team tactics and different altitudes. This is compounded by tight race schedules, travel distances between race days, with frequent domestic and international flights. Individuals with type 1 diabetes have considerable glycaemic control challenges, particularly around exercise, due to their inability to rapidly change circulating insulin levels with the rapid changes in metabolism caused by exercise, nutrition and physiologic and emotional stress. An individual with type 1 diabeteswishing to compete in professional road cycling competitions has the monumental task of managing their blood glucose alongside challenges of the training and races. In this presentation, Sam Scott will provide a talk on the unique challenges of working with professional athletes living with type 1 diabetes, which he knows first-hand by working with Team Novo Nordisk, who are the first and only professional cycling team comprised of elite athletes with type 1 diabetes. In particular, he will discuss how to translate findings from both clinical research and applied sport science to improve the health and performance in this group of athletes, including best nutritional and physical training practices.

Pre-recorded Oral presentations

OP-AP01 Running

STATIC AND DYNAMIC STRETCHING DURING WARM-UP AMELIORATES RUNNING ECONOMY AND DECREASES THE PERCEPTION OF EFFORT IN RECREATIONAL ENDURANCE RUNNERS.

FAELLI, E., PANASCÌ, M., FERRANDO, V., BISIO, A., RUGGERI, P., BOVE, M.

UNIVERSITY OF GENOA

INTRODUCTION:
Athletes and amateur runners commonly perform warm-up before an endurance exercise as it is considered essential to achieve optimal performance1. Stretching is frequently used by endurance runners as a part of warm-up routine and static stretching (SS) and dynamic stretching (DS) are the most investigated2 but their effectiveness in improving running economy and running performance is still debated3. In the present study, we examined, in recreational runners, acute effects of different pre-exercise stretching modalities on physiological and metabolic responses, endurance performance and perception of effort, during a time to exhaustion test.
METHODS:
Eight recreational male runners (mean age 36±11) were enrolled. A randomized-crossover trial consisting of a cardiopulmonary exercise test (CPET) and three endurance running sessions, differentiated by the warm-up stretching content: static stretching (SS) dynamic stretching (DS), or no-stretching (NS), was designed. In the SS and DS sessions, the warm-up consisted of 10min of running plus 5min of SS or DS exercises, respectively, while in the NS session, subjects performed 15min of running-only warm-up. All running sessions consisted of 15min of warm-up, followed by 5min of rest and a time to exhaustion test at a running velocity corresponding to 100% of maximal oxygen uptake (VO2max). All the experimental sessions were performed in laboratory, on a treadmill. Oxygen uptake (VO2), respiratory exchange ratio (RER), heart rate (HR), and blood lactate ([La]+) were measured to describe physiological and metabolic responses, while time to exhaustion (TTE), total running distance (TRD) and running economy (RE) were assessed as indices of endurance performance. The perception of effort was derived from rating of perceived exertion (RPE) at iso-time. ANOVA was applied to statistically evaluate normally-distributed parameters, whilst non parametric statistical analysis were applied to not-normally distributed data.
RESULTS:
Statistical analysis showed that RPE values were significantly lower in SS ($p<0.05$) and DS ($p<0.01$) sessions and RE values were significantly improved in SS ($p<0.05$) and DS ($p<0.01$) sessions than in NS session without no significant differences between SS and DS sessions. Finally, no differences in both physiological and metabolic responses among the three running sessions were found.
CONCLUSION:
This study showed that, both SS and DS exercises during warm-up ameliorated running economy and decreased the perception of effort during a running to exhaustion, with no effect on running performance. Thanks to the positive effects induced by pre-exercise stretching, we recommend to recreational runners the application of stretching exercises within warm-up, in order to optimize the running energy cost and make the training session more enjoyable.
1 Bishop, D. Sport Med (2003) 2 Behm DG et al. Eur J Appl Physiol (2011) 3 Konrad A et al. Frontiers in Physiol (2021)

EFFECTS OF CONCURRENT ENDURANCE AND STRENGTH TRAINING: PLYOMETRIC VS ISOMETRIC

LUM, D.1,2, BARBOSA, T.M.2,3, AZIZ, A.R.1, BALASEKARAN, G.2

1SINGAPORE SPORT INSTITUTE, 2 NANYANG TECHNOLOGICAL UNIVERSITY, 3 POLYTECHNIC OF BRAGANCA

INTRODUCTION:
Plyometric (PLY) and isometric strength training (ISO) were reported to improve running performance (Albracht and Arampatzis, 2013; Paavolainen et al., 1999). However, no study has compared the effects of both training modes on running performance. The aim of the study was to compare the effects of PLY and ISO on running performance.
METHODS:
Twenty-four endurance runners (age 36±6 yrs, stature 1.70±0.05 m, body mass 61.6±8.0 kg) were recruited. Pre- and post-test included countermovement jump test (CMJ), isometric mid-thigh pull (IMTP), 2.4 km run time trial (2.4kmTT), running economy test (RE) and a graded exercise test. During the RE tests, participants ran for 4 min at 10.0 km/h and 12.0 km/h for female, and 12.0 km/h and 14.0 km/h for male. They were randomly assigned (n=8/group) to control (CON), PLY or ISO group and completed either circuit training, PLY or ISO twice a week for six weeks, while continuing to perform their running training. Circuit training included 3 sets of body weight squat, lunge and arabesque performed for 30 s with 30 s rest. PLY included 2-4 sets of 5 repetitions of depth jump, single leg bounding and split jump. ISO included 2-3 sets of 3-5 repetitions of IMTP and isometric ankle plantar flexion with 3 s sustained contraction per repetition.
RESULTS:
PLY and ISO resulted in significant improvement in 2.4kmTT ($P<0.001$, $d=0.21$ and $P=0.02$, $d=0.24$, respectively), maximal aerobic speed (MAS) ($P=0.006$, $d=0.35$ and $P=0.001$, $d=0.56$, respectively) and CMJ height ($P<0.001$, $d=0.40$ and $P=0.005$, $d=0.40$, respectively). Significant improvement in RE1 ($P=0.019$, $d=0.40$), RE2 ($P=0.01$, $d=0.38$) and IMTP peak force ($P=0.002$, $d=0.43$) was observed in ISO only. No significant change in any variable was observed in CON. When percentage change in measured variables were compared, significant differences between CON and PLY, and CON and ISO were observed for 2.4kmTT ($P=0.001$, $d=1.82$ and $P=0.006$, $d=1.90$, respectively), MAS ($P=0.001$, $d=1.23$ and $P=0.028$, $d=1.88$, respectively) and CMJ height ($P=0.019$, $d=2.18$ and $P=0.048$, $d=1.39$, respectively) (Figure 1). Significant difference in percentage change in CMJ height was observed between PLY and ISO ($P<0.001$, $d=1.04$). While significant difference in percentage change in IMTP peak force was observed between CON and ISO, and PLY and ISO ($P<0.001$, $d=2.02$ and $P=0.006$, $d=1.30$, respectively).
CONCLUSION:
The study showed that ISO and PLY resulted in similar improvement in 2.4kmTT and MAS in concurrent with improved CMJ height. But these improvements were not present in CON. This indicates that the improvement in the ability to express force ballistically may benefit endurance running. The concurrent improvement of IMTP peak force, RE1 and RE2 observed in ISO indicates that RE may be influenced by lower limb strength. This findings indicate that PLY and IST resulted in improved running performance via different mechanisms. Runners may, therefore, choose to perform either modes of training to enhance running performance.

BIOMECHANICAL LOAD QUANTIFICATION IN LINEAR SPRINTING USING A NOVEL LOWER EXTREMITY INERTIAL SENSOR SETUP FOR FOOTBALL PLAYERS: COMPARISON TO LOCAL POSITIONING MEASUREMENTS AND SELF-REPORT.

BASTIAANSEN, B.J.C.1, VEGTER, R.J.K.1, LEMMINK, K.A.P.M.1, BRINK, M.S.1

1 CENTER FOR HUMAN MOVEMENT SCIENCES, UNIVERSITY MEDICAL CENTER GRONINGEN, UNIVERSITY OF GRONINGEN, GRONINGEN, THE NETHERLANDS

INTRODUCTION:
Training load quantification is important for training prescription and optimizing performance [1]. Training load can be described in terms of physiological and biomechanical load [2]. However, current monitoring systems do not focus on biomechanical load of the lower extremities and thereby potentially neglect important information. Cumulative hip and knee accelerations measured by a new inertial sensor setup could add to commonly used practices, such as local positioning measurement (LPM) and self-report [3], focusing on physiological load. Therefore, the current study aims to quantify lower extremity biomechanical load with new indicators from a novel inertial sensor setup and explore relationships with indicators derived from LPM and self-report during a linear sprint test.
METHODS:
Fifteen male amateur football players (22.4 ± 1.7 y, 183.0 ± 6.3 cm, 75.7 ± 5.1 kg, 13.2 ± 4.6 years' experience) performed a 30-meter linear sprint test. An inertial sensor setup [3], LPM, and self-report (Borg's CR10®) were used to collect training load data. Cumulative angular accelerations were used to quantify new biomechanical load indicators of the lower extremities based on two sensors (Hip load, or Knee load), or one sensor (Hip segment load, and Knee segment load). Principal component analysis was conducted to assess relationships between training load indicators and determine if the inertial sensor setup provided unique insights.
RESULTS:
Three principal components were identified, explaining 82% of the variance. Lower extremity biomechanical load indicators contributed to the same component (PC3) and were different to physiological load indicators related to volume (PC1; HIRD, PL) and high intensity (PC2; VELmax, HIAD, HIDD). Hip related variables contributed more (HL: 0.86; HLseg: 0.80) to the principal component than knee related variables (KL: 0.75; KLseg: 0.75).
CONCLUSION:
The new indicators to quantify lower extremity biomechanical load provide a unique source of information during linear sprinting in football players. Thus, the inertial sensor setup adds information to current monitoring systems in this task. Hip related indicators contributed more than knee indicators, which might be explained by the force production of hip muscles in order to increase stride frequency and maintain high sprint velocity [4]. Future research should further examine relationships during changes of direction, ball kicking and jumping.
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DETERMINATION OF ACCELEROMETER ENMO´S INTENSITY THRESHOLDS COMPARED TO STANDARD VENTILATORY THRESHOLDS IN INCREMENTAL RUNNING EXERCISE TEST

SCHÜTZENHÖFER, M., BIRNBAUMER, P., HOFMANN, P.

UNIVERSITY OF GRAZ

INTRODUCTION:
Usually accelerometers (ACC) are placed on hip, waist [1,2], or wrist [3,4] to determine overall activity, however, different placings gave different activity patterns [5]. As the stride pattern varies with intensity of movement, we thought to investigate shinbone-based measures in order to determine thresholds comparable to standard spirometric thresholds [6]. Hypothesis 1: The time course of ACC counts from shinbone is comparable to physiological variables and therefore allows to determine two thresholds in all subjects. Hypothesis 2: Thresholds obtained from ACC counts from shinbone are not significantly different from standard spirometric first (VT1) and second ventilatory (VT2) thresholds.
METHODS:
16 trained participants (7 women; 23,1 ± 3,1 years, 176,6 ± 7,7 cm, 69,2 ± 8,8 kg) were tested. Subjects performed an incremental running test on a 400m outdoor track starting at 6 km/h. Running speed (RS) was increased by 0,5 km/h every 100 m up to individual maximum [7]. Heart rate (HR) and spirometric data were measured continuously. Participants were equipped with three ACCs fixed at the left (ACC L) and right (ACC R) shinbone using a standard soccer shinbone safer design as well as on the right hip (ACC H) for comparison. Vector magnitude was calculated from raw triaxial accelerations with Euclidian norm minus one (ENMO = v(ax2+ay2+az2)-1g). Multilinear regression analysis was performed to detect of the first threshold a between the start of the exercise and 66% of vmax. The region of interest for the second threshold was set between the first threshold and vmax. Ventilation (VE) and ventilatory equivalents for oxygen (VE/VO2) and carbon dioxide (VE/VCO2) served to determine thresholds. VT1 was defined as the first increase of VE accompanied by an increase in VE/VO2 without an increase in VE/VCO2 for VT1 and VT2 was defined as the second increase in VE accompanied by an increase in both VE/VO2 and VE/VCO2 [8].
RESULTS:
Maximal values for HR (190,3 ± 8,3 bpm), RS (15,4 ± 1,8 km/h) and oxygen uptake (VO2max) (54,8 ± 7,3 ml/kg/min) were within normal limits for highly active subjects. ACC L TP1 (7,6 ± 0,4 km/h, r= 0,87; p<0.0001) and ACC R TP1 (7,8 ± 0,4 km/h, r= 0,9; p<0.0001) showed a strong correlation to velocity at VT1 (7, 8 ± 0,4 km/h), but were slightly, but significantly different (p=0,0135). ACC L TP2 (10,5 ± 0,8 r=0,96; p<0.0001) and ACC R TP2 (10,7 ± 0,9 r=0,94; p<0.0001) were also significantly related to VT2 (10,6 ± 1,0 km/h). ACC H counts didn´t change over time and were not related to VT1 and VT2.
CONCLUSION:
ACCs placed on shinbone allow to detect two ENMO intensity thresholds and these intensity thresholds are comparable to standard ventilatory thresholds and may serve as an easy to apply tool in performance diagnostics.
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GUIDED EXPLORATION THROUGH THE DUTY FACTOR IN THE DUAL-AXIS MODEL FOR RUNNING STYLES: INSTRUCTING STANCE TIME OR FLIGHT TIME?

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INTRODUCTION:
According to the recently published dual-axis model [1], the running style adopted by a runner at a certain running speed can be comprehensively described using the step frequency and the duty factor, i.e. the ratio of stance time to flight time. In accordance with this model, runners can be guided through different running styles by instructing them to change their step frequency and stance time to flight time ratio. A common method of instruction for modulating the step frequency is acoustic pacing [2,3]. For the ratio between stance and flight time, no such instruction method is readily available. The question is whether verbal instruction on stance time or flight time works best to increase or decrease the duty factor.
METHODS:
In this study we compared the effectiveness of modulating stance time versus flight time via verbal instruction as a means to alter the duty factor at a fixed running speed and cadence. Twelve participants completed a short training protocol with verbal instruction on either stance or flight time, resulting in either an increase or decrease of the duty factor. Effectiveness was assessed as the difference in the duty factor between the start and the end of the training.
RESULTS:
Preliminary analyses of the data indicated that verbal instruction on the flight and stance time is an effective method to modulate the duty factor. The results showed that the instructions to increase stance time (or decrease flight time) in order to increase the duty factor were more effective than the instructions in order to decrease the duty factor. For a majority of the participants, the instructions to increase stance or flight time were more effective than the instructions to decrease stance and flight time.
CONCLUSION:
Based on the preliminary results, verbal instruction to increase the stance time should be used to increase the duty factor, and verbal instruction to increase flight time should be used to decrease the duty factor. The combination of these two instructions can be used to guide a runner through the dual axis model. The most effective instruction will be implemented in a digital running coach and subsequently tested in the field.
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PHYSIOLOGICAL DETERMINANTS OF PERFORMANCE IN TRAIL RUNNING RACES OF DIFFERENT DISTANCES.

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INTRODUCTION:
The physiological determinants of road running have been widely studied, and it is well known that performance is mainly determined by VO2max, cost of running and endurance. The physiological determinants of trail running performance are not well researched, especially the differences between races of different distances. The aim of our study was to determine the physiological predictors of trail running performance in races of different distances in similar terrain and weather conditions.
METHODS:
Seventy-five trail runners participating in one of the races of the Ultra-Trail du Mont-Blanc® were recruited. Previous to the race, each runner was evaluated with (i) an incremental treadmill test (INCR) to determine VO2max, peak aerobic velocity (vPeak), ventilatory thresholds, cost of running and substrate utilisation, (ii) a power-force-velocity profile on a cycle ergometer, (iii) maximal voluntary contractions of the knee extensors and plantar flexors and (iv) anthropometric characteristics. Twenty-four runners finished a SHORT (40 or 55 km), 16 finished a MEDIUM (101 km), 14 finished a LONG (>145 or 170 km) race, while 21 runners did not finish their event. Performance was normalized to men's winning time of each race. Correlations and multiple linear regressions were used to find the determinants of performance for each distance.
RESULTS:
Finishing times were 8:38±2:20 h for SHORT, 20:27±3:49 h for MEDIUM and 37:08±6:38 h for LONG races, which corresponded to 192±42%, 195±36% and 188±29% of the men's winning times. Performance in SHORT correlated with VO2max ($r=-0.856$, $p<0.001$) and vPeak ($r=-0.847$, $p<0.001$), as well as fat utilisation ($r=-0.593$, $p=0.006$) and CHO oxidation rate ($r=0.65$, $p=0.002$) at 10 km/h, body fat percentage ($r=0.749$, $p < 0.001$), KE MVC ($r =-0.567$, $p=0.005$), F0 ($r=-0.574$, $p=0.003$), and Pmax ($r=-0.422$, $p=0.040$). Performance in MEDIUM correlated with VO2max ($r=-0.924$, $p<0.001$) and vPeak ($r=-0.898$, $p<0.001$), body fat percentage ($r=0.830$, $p<0.001$), Pmax ($r=-0.690$, $p=0.006$), F0 ($r=-0.6359$, $p=0.015$) and KE MVC ($r=-0.545$, $p=0.036$). Performance in LONG was only related to vPeak ($r=-0.563$, $p=0.036$). Multiple linear regression showed that performance in SHORT was explained by VO2max and lipid utilisation at 10 km/h ($r2=0.824$, $p<0.001$). Performance in MEDIUM was determined by VO2max, maximal strength, lipid utilisation and body fat percentage ($r2=0.980$, $p<0.001$). A linear model could not be applied in LONG due to the homogeneity of the performances of the participants.
CONCLUSION:
The main physiological predictor of performance in races up to 101 km was VO2max. Performance in SHORT was also predicted by fat utilisation, while performance in MEDIUM was predicted by the ability to produce force and power. More research is needed to establish the determinants of performance in races of very long distance and duration, >145 km and >30 h. The present study can help athletes and practitioners design training programs to prepare for trail running races of different distances.

EFFECTS OF A 2-WEEK HIIT MICROCYCLE ON RUNNING AND NEUROMUSCULAR PERFORMANCE

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INTRODUCTION:

High-intensity interval training (HIIT) has been suggested to be an effective method to improve endurance performance. While traditional HIIT protocols have incorporated 2-3 weekly HIIT-sessions into a typical training prescription of participants, also short-term microcycles of more frequent HIIT-sessions have improved maximal endurance performance. The purpose of the present study was to examine the effects of a 2-week HIIT-microcycle on running and countermovement jump performance (CMJ) in recreationally trained endurance athletes.
METHODS:
Fifteen recreationally trained subjects (9 males, 6 females) performed a two-week microcycle of 10 HIIT-sessions. The HIIT-sessions were prescribed as 6 x 3 min intervals, performed at maximal sustainable effort with 2 min active recovery. Performance in 3000 m time trial was assessed on an indoor track before the training period (Pre) and one day after the training period (Post). CMJ performance was tested on a contact mat before the 3000 m time trials, and all HIIT-sessions. Changes in running (3000 m and interval sessions) and CMJ performance (pre 3000 m and pre HIIT) were assessed by paired samples t-test with Bonferroni correction, and correlations between interval and 3000 m running performance were analyzed with Pearson correlation coefficient.
RESULTS:
Running time in 3000 m decreased by -1.8 ± 1.6 % after the training period (Pre 12:19 ± 1:32 vs. Post 12:06 ± 1:32 min:s, $p = 0.01$) and at the same time, average heart rate during the test decreased by 4.1 ± 3.5 bpm ($p < 0.001$). Average running speed during the intervals increased from the first to the last session by 2.5 ± 2.6 % ($p = 0.03$), while average heart rate during the same interval sessions decreased by 4.6 ± 4.5 bpm ($p = 0.01$). CMJ performance remained unaffected at Pre-Post comparison (33.0 ± 6.2 vs. 32.6 ± 5.6 cm) and during the training period (31.7-32.3 cm). A very high significant correlation was found between the running speed of the intervals and running speed during the 3000 m running test ($r = 0.98$, $p < 0.001$), and a significant correlation was found between changes in 3000 m time and changes in running speed during the intervals ($r = -0.638$, $p = 0.011$).
CONCLUSION:
Based on the improved running performance and maintained CMJ performance, training load of the current HIIT-microcycle seemed somewhat suitable for recreational athletes. Interestingly average heart rate during the running test and interval sessions decreased, which possibly relates to changes in the cardiac sympathetic nervous system regulation. In conclusion, a 2-week HIIT-microcycle seems to be an efficient method to improve maximal endurance performance in a short period of time in recreational athletes. Furthermore, interval sessions that are performed at maximal sustainable effort may allow estimation of the current 3000 m running performance quite accurately. A longer recovery period after the microcycle may be recommended to fully restore cardiovascular capacity during maximal efforts.

POST-COMPETITION BLOOD LACTATE CONCENTRATIONS IN ELITE MIDDLE AND LONG DISTANCE RUNNERS – ARE THERE SEX OR DISCIPLINE DIFFERENCES?

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INTRODUCTION:
The peak blood lactate concentration (LApeak) after middle and long distance running is an important parameter to characterise the physiological profile [1]. However, research is limited through non-competition settings or non-elite participants [2], the number of included disciplines and participants [1] or the lack of women [3]. Therefore, the aim of this study was to determine sex differences as well as discipline differences in relation to LApeak in elite middle and long distance runners.
METHODS:
The study is based on the determination of LApeak during the elite German championships (outdoor) from 1999 to 2019 (heats and finals). It includes 800 m (men: n = 40, 1:49.08 ± 0:01.54 min; women: n = 37, 2:05.58 ± 0:02.23 min), 1500 m (men: n = 34, 3:45.05 ± 0:03.06 min; women: n = 27, 4:16.18 ± 0:04.70 min), 3000 m steeplechase (men: n = 19, 8:43.54 ± 0:07.79 min; women: n = 17, 10:04.87 ± 0:16.96 min) and 5000 m (men: n = 19, 13:59.88 ± 0:08.39 min; women: n = 18, 16:08.10 ± 0:24.71 min). Athletes competed at national to international level. If possible, the best result of each athlete was included. 3 min, 6 min and 10 min after competition, a sample of 20 µl of arterialized capillary blood was taken from the earlobe. The samples were diluted in a haemolytic solution and analysed using Super GL (Dr. Müller Gerätebau GmbH Freital). Due to different sample sizes and a lack of equality of variance, statistical analysis was performed with one-way ANOVA to analyse the discipline differences within the sexes and T-test for independent samples to analyse the sex differences within the disciplines. Significant main effects were followed-up by Hochberg (women) and Games-Howell (men) post-hoc procedures. A statistical level of $p < 0.05$ was accepted. All data are expressed as mean ± standard deviation.
RESULTS:
Despite slightly lower LApeak in women, there are no significant sex differences within the disciplines. However, significant differences are observed for all disciplines (within the sexes), except 800 m vs. 1500 m ($p = 0.24$, $p = 0.84$) and 3000 m steeplechase vs. 5000 m ($p = 0.08$, $p = 0.44$) both for men and women. The LApeak in 800 m, 1500 m, 3000 m steeplechase and 5000 m is 18.96 ± 3.66, 17.68 ± 2.02, 14.53 ± 3.40, 12.21 ± 2.13 mmol/l for men and 18.14 ± 2.66, 17.38 ± 2.72, 13.14 ± 2.72, 11.60 ± 2.65 mmol/l for women.
CONCLUSION:
This study offers coaches a reference for LApeak in elite middle and long distance runners. The LApeak after competition in elite runners are higher than those reported in studies with non-elite athletes and non-competition settings [2, 3]. Due to the kinetic of blood lactate (LApeak maybe after 10 min) and racing tactics, LApeak could be slightly higher than reported in the present study, especially in middle distance running.
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OP-AP02 Power Strength

THE EXPERT'S EYE: POWERLIFTERS ARE MORE ACCURATE THAN NAÏVE IN EVALUATING WEIGHT LIFTED IN DEADLIFT EXERCISE

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Background

Action observation of known movements or motor skills leads to motor resonance, namely the activation of observer's motor system (1). This mechanism is not evoked in those subjects who did not develop the observed skill. Most of the studies focused on movement kinematics recognition, but did not test how the match between the own motor repertoire and the observed motor behavior impacts on the evaluation of the loads lifted by an observed actor (2). The purpose of this study was to investigate if motor experience influenced the ability to evaluate the amount of weight lifted by a powerlifter.
Methods
Seventeen powerlifters (mean age: 34±14, mean years of experience: 8±2) and 19 naïve participants (mean age: 32±8 years) were required 1) to fill a questionnaire aimed at evaluating the experience gained in powerlifting or other sports and 2) to observe five videos (repeated 16 times) showing a powerlifter performing a deadlift with different weight, corresponding to five percentages of his one-repetition maximum (1RM): 60%, 80%, 90%, 95%, 100% of 1RM. Each video lasted about 4 seconds. At the end of each video, a question about the lifted load appeared (e.g., "Has he lifted the 60% of 1RM?"). Subjects performed a TRUE-FALSE task as soon and as accurate as possible. For each weight, there were 8 TRUE and 8 FALSE conditions. The experiment was administered online. Accuracy and reaction time were considered as outcome variables to compare naïve and powerlifters' responses. Within comparisons were performed by means of Friedman test, whilst Mann-Whitney test was used to compare the two groups.
Results
Accuracy in both groups was above the chance level. Taken as a whole, powerlifters showed higher accuracy than naïve participants ($p=0.002$), and also in both TRUE ($p=0.008$) and FALSE conditions ($p=0.017$). Considering TRUE condition at the different weights, powerlifters were more accurate to detect the 80% ($p=0.013$) and 90% ($p<0.0002$) of 1RM. About FALSE condition, significant differences between groups appeared on 80% of 1RM ($p=0.01$). Controls showed a lower ability to recognize the 90% vs 60% ($p=0.000$), vs 80% ($p=0.006$), vs 100% ($p=0.000$). Powerlifters had a better accuracy to detect the 60% vs 90% ($p=0.003$) and vs 95% ($p=0.040$). The reaction time was not statically different between groups.
Conclusion
Accuracy in evaluating the amount of weight was higher in powerlifters than in naïve participants. In particular, significant differences were found at 80% and 90% of 1RM. This result suggests that motor resonance mechanisms were activated in powerlifters and allowed the prediction of the lifted weight. This test might become a useful tool for powerlifters and trainers to assess and improve their ability to evaluate the feature of the observed movement and lifting technique.
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RESEARCH ON INDIVIDUAL DIFFERENCES OF STRENGTH TRAINING EFFECTS AND PREDICTIVE MODELS

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INTRODUCTION:
The skeletal muscle mass of sedentary adults with low mobility decreases by 3%-8% every 10 years, accompanied by varying degrees of muscle strength decline [1]. Low muscle strength was independently associated with elevated risk of all-cause mortality [2]. Strength training is the preferred method to improve muscle mass and strength, but there are individual differences in the effects of strength training. The purpose of this study was to address the question of interindividual variation in responsiveness to strength training and to establish a predictive model of strength training effects through simple indicators.
METHODS:
193 participants who exercise irregularly completed 12 weeks of low-intensity strength training (LIST), 53 of them participated in 36 weeks of detraining period (DP), and 29 of them received 12 weeks of high-intensity strength training (HIST). Body composition（DEXA）, muscle thickness（Ultrasound）, and one-repetition maximum （1RM） tests were conducted before and after each intervention, as well as diet and physical activity questionnaire. Paired-sample t-test method was used to compare the percentage change of 1RM (Δ1RM), and Cohen's d effect size (ES) was calculated. Strength training effect prediction model was construct through multiple linear stepwise regression.
RESULTS:
(1) Δ1RM squat and bench press increased by 46.19% (-20.00%-196.67%, $p<0.01$, ES=1.15) and 36.25% (-31.25%–176.92%, $p<0.01$, ES=0.72) respectively following LIST. (2) Δ1RM squats and bench press were reduced by an average of -32.03% (-392.16%-0%, $p<0.01$) and -19.87% (-251.57%-0%, $p<0.01$) respectively following DP. (3)Δ1RM squats and bench press increased by an average of 33.89% (3.03%–71.43%, $p<0.01$, ES=1.13) and 31.32% (-4.41%–72.73%, $p<0.01$, ES=0.93) respectively following HIST. (4) Prediction model of Δ1RM squat ($R2=0.41$, $p<0.05$) contains the following independent variables: initial value of 1RM squat (beta=-0.765), training program (beta=-0.214), trunk muscle content (beta=0.278), body fat content (beta= -0.106). Prediction model of Δ1RM bench press ($R2=0.43$, $p<0.05$) contains the following independent variables: initial value of 1RM bench press weight (beta=-0.849), upper limb muscle content (beta=0.425), rectus femoris and intermediate femoris thickness (beta=-0.189).
CONCLUSION:
There are obvious individual differences in strength training, and participants can choose different training program to get the best benefits. The initial value of 1RM squat/bench press weight, training program, trunk muscle content, total body fat content, upper limb muscle content, rectus femoris and intermedius femoris thickness can predict about 40% of individual differences in Δ1RM squat and bench press.
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ULTRASOUND INSPECTION OF LUMBAR EXTENSOR MUSCLE MORPHOLOGY BEFORE AND AFTER ONE SET OF HEAVY LOADED ISOLATED LUMBAR EXTENSOR RESISTANCE TRAINING

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INTRODUCTION:

It is well established that chronic pain conditions in the lower back region correlate with local muscle atrophy and fatty infiltration in the paraspinal extensor muscles [1]. Machine-based isolated extension resistance exercise (ILEX) including a specific pelvic restraint system has shown good clinical results and those clinical improvements correlate with the amount of isometric extension strength increase [2]. However, the underlying mechanisms behind these clinical results are not fully understood yet. The aim of this study was therefore to examine immediate effects of one set of ILEX exercise on muscle size and muscle composition.
METHODS:
Twenty-eight healthy individuals (14 men, 14 women) with a mean age of 28.12 years ±6.82 and no history of back related pain performed one set of ILEX with full muscle exhaustion after 12 to 15 repetitions within a range of motion of 12°-42°. Before and immediately after the training a standardized ultrasound examination protocol (GE LOGIQ S7 Expert) was applied. Multifidus muscle cross sectional area (CSA), muscle thickness (MT) and ultrasound ecogenicity (grey scale from 0 = pure black to 255 = pure white) was quantified and analyzed at L4 level by two researchers using ImageJ.
RESULTS:
At baseline the mean CSA was 7.58 cm2 ±2.23 (4.27 - 13.54) and 0.109 cm2/kg ±0.022 (0.058 – 0.149) bodyweight. After the intervention CSA significantly increased by 12.46 % to 8.40 cm2 ±2.28 (4.89-15.33) ($p < 0.001$) and to 0.121 cm2/kg ±0.022 (0.080 – 0.172) ($p < 0.001$). Baseline MT was 2.90 cm ±0.46 (1.65 – 3.87) and 0.042 cm/kg ± 0.007 (0.031 – 0.059) bodyweight. After the intervention MT significantly increased by 7.81 % to 3.10 cm ±0.391 (2.165 – 3.841) ($p < 0.001$) and to 0.045 cm/kg ± 0.006 (0.035 – 0.057) ($p < 0.001$). In addition, there was a trend ($p = 0.178$) towards a lower grey scale value shown by a reduced pixel intensity from 71.99 to 71.06. There was also a strong trend ($p = 0.053$) towards men exhibiting higher CSA (8.65 cm2 ±2.68) than women (6.66 cm2 ±1.23) at baseline.
CONCLUSION:
To our knowledge, this is the first study investigating on muscle size and muscle composition after heavy loaded ILEX training using ultrasound imaging. The results show that ILEX is an appropriate tool for selectively strengthening the multifidus muscle which may possibly explain the good results in clinical studies. Further studies should focus on long-term morphological adaptions in the multifidus muscle after an ILEX based rehabilitation program.
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ASSOCIATION BETWEEN FORCE-VELOCITY PROFILE WITH BODY COMPOSITION, PHYSICAL FUNCTION AND INSULIN SENSITIVITY IN OLDER ADULTS WITH TYPE 2 DIABETES

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INTRODUCTION:
Force-velocity (F-V) profile is a newfangled and important tool to explain the mechanisms leading to a decreased muscle power in older adults [1]. Force and velocity deficits could affect differently in this population and both have been demonstrated to decrease function ability [2]. Given the critical importance of maintaining muscle mass and functions in older adults with T2DM for metabolic control, the studys main objective was to establish the relationship between different F-V profiles with body composition, physical function, and glucose homeostasis.
METHODS:
F-V profile and maximal muscle power (Pmax) were assessed in the leg press exercise using a lineal position encoder (TForce System, Ergotech, Spain). Three deficit groups were created to classify our sample according to their F-V profile: non-deficit (ND), force deficit (FD), and velocity deficit (VD). Body composition was evaluated by means of bioimpedance (Tanita Corp., Tokyo, Japan) and physical function using standardized field tests (1 repetition maximum, 1RM; Short physical performance battery, SPPB). Glucose (GLC) and glycosylated hemoglobin (HbA1c) were determined in fasting blood samples as indices of glycaemic control. Significant main differences were run by ANOVA test. The significance level was set up at $p < 0.05$.
RESULTS:
Participants were 59 older adults with T2DM, mean age 74.3 years, and 55.9% of females. 24 participants showed ND, whereas 17 and 18 subjects were allocated to the FD and VD groups, respectively. Deficit groups showed lower Pmax in comparison to ND (FD=176.7 ± 62.6; VD=177.9 ± 86.4 and ND=244.8 ± 90.9 W; $p <0.05$). ND group presented higher fat and muscle mass in the lower and upper extremities than FD and VD (group interaction $p <0.05$). FD displayed lower 1RM than ND (54.2 ± 12.6 vs 69.8 ± 14.0 kg, $p <0.01$) but not VD. GLC, HbA1c, and SPPB results were similar among groups.
CONCLUSION:
Older adults with T2DM exhibit variable F-V profiles leading to diminished muscle power when a deficit in either force or velocity is observed. Furthermore, force and velocity deficits are related to low muscle mass, but not glycaemic control or physical performance. Our results suggest focusing on maximal dynamic strength training when a maximal force deficit is present.
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EFFECT OF DIFFERENT LOAD VIBRATION TRAINING ON BLOOD LACTATE AND CREATINE KINASE

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INTRODUCTION:
Vibration training is widely used in public fitness and professional training institutions around the world. Compared with traditional resistance training, vibration training can effectively improve muscle strength and explosive force with a small load. However, there are few studies on the changes of blood biochemical indicators after vibration training, which is not conducive to the scientific definition of the

intensity of vibration training and affecting the scientific formulation of the vibration training plan. The purpose of this study was to investigate the difference between vibration resistance training and traditional resistance training on blood lactic acid and creatine kinase.
METHODS:
Eight healthy male college students were selected as subjects, and each of them carried out four experiments (20% and 40% body weight load traditional resistance training, 20% and 40% body weight load vibration resistance training). The order of the four experiments was determined by drawing lots, and the interval of each experiment was at least 72 hours. In the morning, the subjects went to the laboratory to collect blood on an empty stomach to test the blood lactate and creatine kinase in a quiet state before exercise. Then they had a unified meal and had a rest for 60 minutes. After the rest, the subjects completed 6 sets of barbell squat exercises 10 times in each set. The metronome was used to control the movement rhythm (1.5 s up and 1.5 s down). The completion time of each group was 30 s, and the interval time between groups was 60 s. In vibration resistance training, the vibration frequency is 30Hz and the amplitude is 2mm, and the rest is consistent with the traditional resistance training. Finger blood was collected at 1, 3, 5, 7, and 10 minutes after training to test blood lactate, and venous blood was collected at 6 and 24 hours after training to test creatine kinase.
RESULTS:
The results showed that: (1) the creatine kinase levels of 20% body weight load vibration squat and 40% body weight load traditional squat for 6 hours were significantly higher than the quiet level ($P < 0.05$), the creatine kinase levels of 40% body weight load traditional squat for 6 hours were significantly higher than that of 24 hours ($P < 0.05$). (2) The level of blood lactic acid at 1min, 3 min, 5 min, and 10 min after 40% body weight load traditional squat was significantly higher than that of 20% ($P < 0.05$); The level of blood lactic acid at 3 min after 40% body weight load vibration squat was significantly higher than that of 20% ($P < 0.05$). (3) There was no significant difference in heart rate and RPE between vibration squat and traditional squat ($P > 0.05$).
CONCLUSION:
(1) Vibration has no significant effect on blood lactate and creatine kinase levels after low load resistance training (20% or 40% body weight load). (2) The anaerobic energy supply of 40% body weight load resistance training is higher than that of 20% body weight load resistance training.

THE EFFECT OF HYPOXIA ON CRITICAL POWER AND THE RESPIRATORY COMPENSATION POINT

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INTRODUCTION:
Under normoxic conditions, there is a close association between the respiratory compensation point (RCP) occurring during incremental exercise, and the maximal metabolic steady state which manifests during sustained constant load exercise, and can be estimated from the critical power (CP). This suggests a common underlying mechanism, however if the control of breathing were altered, such as in hypoxia, it may be expected the RCP could be dissociated from CP. The aim of this study was to examine the relationship between CP and RCP in normoxia and hypoxia.
METHODS:
Eleven well-trained male cyclists volunteered for this study (age: 27 ± 6.6 yr; height: 179 ± 7.5 cm; body mass: 78.5 ± 7.9 kg). Following a familiarization session, participants returned to the laboratory on two occasions to complete the experimental protocol, once in normoxia (NORM: $FiO_2 \approx 0.21$), and normobaric hypoxia (HYPO: $FiO_2 \approx 0.155$). Order of condition was randomized and counterbalanced, and all testing was single-blinded. The experimental protocol consisted of a ramp incremental test to determine RCP and VO_2max. Then, after a 30 min recovery period a 3 min all-out test (3AOT) was completed to determine CP. Pearson correlation and Bland-Altman plots were used to examine the relationship between CP and RCP.
RESULTS:
In NORM, CP was significantly correlated to RCP with a strong effect size ($r^2=0.87$; $P<0.001$). Mean bias (CP – RCP) was +11.6 W and limit of agreement (LoA) was ± 9.0 W. In HYPO, the correlation between CP and RCP was not significant and there was only a moderate effect size ($r^2=0.32$; $P=0.07$). Mean bias remained similar to NORM (+12.4 W), whereas LoA was substantially larger (± 22.9 W). Interestingly, the correlation between CP and VO_2max remained similar in both NORM ($r^2=0.67$; $P=0.002$), and HYPO ($r^2=0.71$; $P=0.001$).
CONCLUSION:
Our results confirm the close association between CP and RCP in NORM, which suggests the existence of a common underlying mechanism, however caution should be used when inferring cause and effect since in HYPO the relationship was dissociated, whereas the relationship between CP and VO_2max remained similar. This supports the theory that the RCP arises via mechanisms related to ventilatory control, as opposed to metabolic control.

EFFECTS OF FLYWHEEL SQUAT TRAINING ON STRENGTH LEVELS AND MUSCLE BALANCE IN FEMALE SOCCER PLAYERS: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION:
Resistance training (RT) has been shown to be effective in improving female soccer players performance [1]. In recent years, the interest in the use of flywheel resistance training devices (FRTD) has increased [2]. FRTD showed to increase strength levels and muscle balance (i.e. the concentric hamstrings:quadriceps -H:Q- ratio) in male soccer players [3]. A low H:Q ratio is considered a hamstrings injuries risk factor [4] and a determinant factor in the strain on the anterior cruciate ligament usually experienced by women [5]. However, no studies to date have assessed the strength levels and muscle balance adaptions in female soccer players following a FRTD training program. Therefore, the aim of this study was to analyze the effects of a 6-week in-season RT program using FRTD on strength and muscle balance levels.
METHODS:
Twenty female soccer players competing at a national level voluntarily participated in the present study. Players were randomly assigned to a flywheel training group (FWTG) or a control group (CG). FWTG performed an extra biweekly RT using a FRTD (Kbox 3, Exxentrix AB, Stockholm, Sweden) based on squat exercise for 6 weeks. Both groups continued their usual field training during the intervention. Quadriceps and hamstings concentric and eccentric peak torque were measured using an isokinetic dynamometer (Biodex Medical System, Shirley, New York, USA) at 60º·s-1. H:Q concentric ratio was also determined. Paired t-tests were carried out to detect pre-post changes within each group in the variables analyzed. Between-groups differences were assessed by a two-way ANOVA with repeated measures:

group (FWTG and CG) and time (pre-post). Effect size was calculated using Cohen's d and nominally classified [6]. Significance was set at p<0.05.
RESULTS:
FWTG showed a significant pre-post increase in quadriceps concentric peak torque (p-value = 0.027; ES small), hamstring concentric peak torque (p-value < 0.001; ES large), quadriceps eccentric peak torque (p-value < 0.001; ES moderate) and H:Q ratio (p-value = 0.004; ES large). ANOVA with repeated measures showed significant time by group interactions in quadriceps concentric peak torque (p-value = 0.002), hamstring concentric peak torque (p-value = 0.037) quadriceps eccentric peak torque (p-value = 0.002) and hamstring eccentric peak torque (p-value = 0.008), with no interactions in H:Q ratio.
CONCLUSION:
Our results showed that 6 weeks of a biweekly in-season training program (i.e., squat exercise) based on FRTD significantly improved strength levels in female soccer players to a greater extent than their usual training routine. Further, from the perspective of reducing the risk of injury incidence, this training has proven to be effective in improving concentric H:Q ratio.
1. Pacholek & Zemková (2020) 2. Núñez et al. (2020) 3. Coratella et al. (2019) 4. Lee et al. (2018) 5. Heinert et al. (2020) 6. Hopkins et al. (2009)

LIGHTER- VERSUS HEAVIER-LOAD TRAINING WITH EQUAL POWER OUTPUTS: EFFECTS ON THE FORCE VELOCITY PROFILE OF SQUAT AND BENCH PRESS

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INTRODUCTION:
Although the optimal power load (OPL) occurs at different relative intensities for different upper and lower body exercises, resistance training with an OPL can result in positive training adaptations. However, as the load-power curve is an inverted-U, high levels of power output can be produced with loads that are lighter and heavier than the OPL. As such, it is possible that isopotential loads (i.e., different loads of equal power output) could result in similar training adaptations, but according to the load-velocity relationship, isopotential loads to the right of the OPL could favour force-related adaptations whereas loads to the left of the OPL could favour velocity-related adaptations. Therefore, the purpose of this study was to determine how training with isopotential loads affect the load-velocity profile of the upper body and lower body.
METHODS:
Ten women and 35 men -18-30 years old, physically active sports science students with at least 3 months of resistance training participated in this randomized controlled trial design. All participants completed two familiarization sessions, one pre-session (i.e., 1RM testing), and one post-training session (i.e., 1RM). During the 1RM tests, a force-velocity profile was created and extrapolated to identify the theoretical maximal force at zero velocity (F0), the theoretical maximal velocity (V0), and the slope (S) that corresponds to F0/V0 [1]. Consequently, maximum power output (Pmax) was calculated as Pmax = (F0V0)/4 [2] and was expressed relative to body mass (Prel). After the pre-test, the participants were assigned to an experimental group that performed 10 training sessions over 5 weeks with either a lighter load (LL) or a heavier load (HL). Both groups performed 4-6 sets of 4-6 repetitions of the Smith machine bench press and Smith machine parallel back squat using isopotential loads on opposite ends of the power-load curve, that corresponded to the same power output (98% of Pmax). Despite both groups being equated for power output, the percentage of 1RM at which each group lifted was different, 42.94±11.32% 1RM (LL) and 58.57±9.93% 1RM (HL) for bench press and 53.02±4.15% 1RM (LL) and 71.56±3.95% 1RM (HL) for the squat.
RESULTS:
For the bench press, the LL group experienced significant increases for the V0 (P = 0.033), whereas the HL group experienced significant increases for Pmax (P = 0.001) and Prel (P <0.001). For the squat, both groups experienced similar changes of the force-velocity profile (no shift of the S, but with greater F0 and V0).
CONCLUSION:
Although isopotential loads improved the force-velocity profile of the upper body and lower body, the loads to the right of the OPL did not entirely favour force-related adaptations, nor did the loads to the left of the OPL entirely favour velocity-related adaptations.
References:
1) Samozino et al., Int J of Sports Med, 2012
2) García-Ramos et al., J App Bio, 2016

AIN'T JUST IMAGINATION! EFFECTS OF MOTOR IMAGERY TRAINING ON STRENGTH AND POWER PERFORMANCE OF ATHLETES DURING DETRAINING

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INTRODUCTION:
Detraining is the partial loss or reversal of training-induced adaptations caused by the interruption of training, with negative effects on physical capabilities and impaired athletic performance. Interruption of training routines may occur as an adverse consequence of illness and injury, be systematically designed during the off-season breaks, or due to quarantine measures as recently occurred following the unexpected COVID-19 pandemic outbreak. In view of the negative effects on physiological characteristics and performance arising from long-term interrupted or insufficient training, alternative forms of active training are recommended to avoid detraining. However, while these solutions are easy to implement under normal circumstances, a few logistical and practical constraints especially during COVID-19 home confinement. A viable substitute strategy to counteract and reverse the effects of detraining is motor imagery (MI), namely the practice of mental representation of an overt action without any concomitant active body movement. However, evidence on the effectiveness of MI training among professional athletes is limited. Therefore, this study investigated the effects of MI training on strength and power performances of professional athletes during a period of detraining caused by the COVID-19
METHODS:
Thirty male professional basketball players (age = 26.1 ± 6.2 years) were randomly assigned to three counterbalanced groups: two MI training groups, who completed imagery training by mentally rehearsing upper and lower limbs resistance training exercises loaded with either 85% of one maximum repetition (85%1RM) or optimum power loads (OPL), or a control group. For six consecutive weeks, while all groups completed two weekly sessions of high-intensity running, only the MI groups performed three additional MI sessions a week. Max-

imal strength and power outputs were measured through 1RM and OPL assessments in the back squat and bench press exercises with a linear positioning transducer. Vertical jump and throwing capabilities were assessed with the countermovement jump and the seated medicine ball throw tests, respectively. Kinesthetic and visual imagery questionnaires, chronometry and rating of perceived effort scores were collected to evaluate MI vividness, MI ability, and perceived effort
RESULTS:
Physical performances improved significantly following both MI protocols (range: ~2% to ~9%), but were reduced in the control group, compared to pre-intervention ($P \leq 0.016$). Moreover, interactions (time × protocol) were identified between the two MI groups ($P \leq 0.001$). While the 85%1RM led to greater effects on maximal strength measures than the OPL, the latter induced superior responses on measures of lower limbs power. These findings were mirrored by corresponding cognitive and psychophysiological responses
CONCLUSION:
During periods of forced detraining, MI practice seems to be a viable tool to maintain and increase physical performance capacity among professional athletes.

EFFECTS OF A 25-WEEK PERIODIZED TRAINING MACROCYCLE ON MUSCLE STRENGTH, POWER, MUSCLE ARCHITECTURE AND PERFORMANCE IN HIGHLY-TRAINED TRACK AND FIELD THROWERS

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INTRODUCTION:
Long-term training studies on collegiate and young track and field throwers revealed that periodized training have a positive effect on competitive track and field throwing performance as well as on strength and power production (Zaras et al., 2016; Stone et al, 2003). Additionally, significant increases occurred for muscle architecture characteristics mainly in muscle thickness and fascicle length. However, scarce data exists regarding the effect of a long macrocycle on competitive track and field throwing performance in highly-trained track and field throwers. The purpose of the study was to investigate the effect of a 25-week macrocycle on strength, power, vastus lateralis (VL) muscle architecture and competitive track and field throwing performance, in highly-trained track and field throwers.
METHODS:
Twelve highly-trained track and field throwers (age: 24.3±5.5 years, mass: 96.6±9.9kg, height: 1.82±0.02m), competing in all throwing events participated in the study. All athletes followed a 25-week periodized training macrocycle divided into three training phases: the hypertrophy/maximum strength phase, the maximum strength/power phase and the power/speed phase. Measurements were performed at the beginning of the training period (T1), after the first training phase (T2), and after the end of the training macrocycle (T3). Measurements included: competitive track and field throwing performance, shot-put throws, maximum strength (1-RM) in snatch, clean and squat, countermovement jump (CMJ) and VL muscle architecture. The level of significance was set at $P \leq 0.05$.
RESULTS:
Competitive track and field throwing performance and shot-put throws increased from T1 to T3 by 10.9±3.2% ($p=0.001$), and 5.1±6.4% ($P=0.049$), respectively. Maximum strength in snatch and squat increased significantly from T1 to T3 by 9.7±8.9% ($p=0.001$) and 9.9±7.1% ($p=0.002$), respectively. CMJ increased only from T1 to T2 by 10.9±11.8% ($p=0.026$). Significant increase was found for VL fascicle length between T1 and T3 (9.6±11.1%, $p=0.049$), while no significant changes occurred for VL muscle thickness and fascicle angle. Strong correlations were found between the percentage increase of competitive track and field throwing performance with the percentage increases of 1-RM in snatch ($r=0.571$, $p=0.046$) and shot-put throws ($r=0.715$, $p=0.001$).
CONCLUSION:
Twenty five weeks of training may increase competitive track and field throwing performance, strength, power and VL fascicle length while percentage increases in snatch and in shot-put throws were correlated with competitive track and field throwing performance in highly-trained throwers. These results suggest that coaches should regularly use snatch and shot-put exercises during the year-round training to enhance competitive track and field throwing performance, while increases in VL fascicle length may partly explain the changes in power and throwing performance.

EFFECTS OF CLUSTER SET CONFIGURATION IN THE BENCH PRESS EXERCISE ON METABOLIC RESPONSE AND MECHANICAL PERFORMANCE

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INTRODUCTION:
Cluster training is as an effective method to reduce the involuntary decrease in velocity and strength during the set (1). Cluster training is characterized by implementing short rest periods between repetitions within the same set (2). By contrast, this approach requires longer training sessions (3). Therefore, finding balance training protocols that are beneficial for maintaining performance and do not require excessive time to be completed is mandatory. Thus, the aim of this study was to investigate the effects of different cluster set configurations on mechanical performance and metabolic response acute.
METHODS:
Twenty-two resistance-trained men (mean ± SD, age: 25.3 ± 4.4 years; height: 1.77 ± 0.08 m; body mass: 75.4 ± 8.5 kg) participated in this study. All subjects performed three training protocols in a randomized order and separated by one week, which differed in the set configuration as follows: (a) traditional (TR) consisted of 3 x 12 bench-press repetitions at 60% of 1RM with 4 minutes rest between sets, (b) cluster-1 (CL1) used the same structure as TR (i.e., 3 x 12 repetitions at 60% of 1RM with an interset rest of 4 minutes) with an additional 30 seconds intraset rest after the 6th repetition of each set; and (c) cluster-2 (CL2) used the same structure as TR with an additional 30 seconds intraset rest after the 2nd, 4th, 6th, 8th, and 10th repetition of each set. In order to analyze the acute mechanical and metabolic responses to each protocol, the maximal isometric force (FIM) and maximal rate of force development (RFDmax) during a maximal isometric bench-press contraction as well as the blood lactate were measured before and after each protocol. Moreover, the mean propulsive velocity (MPV) was recorded for all repetitions by a linear velocity transducer (T-Force System, Spain). The percentage of velocity loss was calculated from the fastest to the slowest VMP in each set and as an average of the 3 sets. A 3 (protocol) x 2 (time) (Pre vs. Post) repeated measures analysis of variance with Bonferroni's post hoc comparisons was conducted. Significance was accepted at $p \leq 0.05$.
RESULTS:

A significant "protocol x time" interaction for the blood lactate (P<0.001). The CL2 induced smaller increases in lactate than TR and CL1 at Post. No significant "protocol x time" interactions were observed for the mechanical parameters (i.e MIF, P=0.21; RFDmax, P=0.60). Velocity loss within the set differed significantly among groups: 51.9 ± 13.5%, 45.3 ± 13.4%, and 25.5 ± 7.8% for TR, CL1, and CL2, respectively. Likewise, the average mean propulsive velocity attained during the entire session increased as the number of intraset rests increased (TR < CL1 < CL2)
CONCLUSION:
The introduction of shorter but more frequent intraset rest periods alleviate training-induce fatigue assessed by lower velocity loss within the set and attenuated increases in blood lactate.
1 Tufano et al., J Strength Cond Res 2017
2. Haff et al., J Strength Cond Res 2003
3. Jukic et al. Sports Med 2020

MECHANICAL AND METABOLIC ACUTE RESPONSES TO DIFFERENT RESISTANCE TRAINING CONFIGURATIONS WITH A VOLUME LOAD-EQUATED

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INTRODUCTION:
Quantifying workloads in resistance training (RT) allows coaches to modulate training stressors and recovery–adaptation process which leads to a greater potential for optimizing performance [1]. In an attempt to estimate the workload, the volume load (VL) is generally calculated as follows: VL (arbitrary units, AU) = number of sets (S) x number of repetitions (R) x relative intensity (%1RM) [2]. VL is related to measures of internal workload and physiological stress [3]. However, the same VL can be obtained with different RT configurations. Therefore, the aim of this study was to investigate the acute mechanical and metabolic responses to RT sessions with different loading configurations but the same VL.
METHODS:
Following the assessment of one-repetition (1RM) strength and full load-velocity relationship in the bench-press exercise, eighteen resistance-trained men performed, in a randomized order, four different RT sessions [S x R (%1RM)] in the bench-press exercise: 1) 3x16 (40% 1RM); 2) 6x8 (40% 1RM); 3) 3x8 (80% 1RM); 4) 6x4 (80% 1RM), with five minutes inter-set rest. Selected mechanical (velocity against a 60% 1RM load, V60-load) and metabolic (blood lactate) variables were assessed before and after exercise.
RESULTS:
The actual VL (obtained from: S x R x %1RM) for each protocol differed between 3x16 (40% 1RM) and 3x8 (80% 1RM) protocols, while no significant differences were found between the rest protocols. Significantly higher lactate concentrations were observed for 3x16 (40% 1RM) and 3x8 (80% 1RM) compared to 6x8 (40% 1RM, $P \leq 0.05$). The 6x8 (40% 1RM, $P \leq 0.05$) protocol showed higher V60-load values than the rest of RT sessions. Similarly, 6x4 (80% 1RM) showed significantly higher mean velocity than the 3x8 (80% 1RM) protocol ($P = 0.02$).
CONCLUSION:
The main findings of this study revealed higher lactate concentrations and magnitude of velocity loss (V60-load) for RT configurations with fewer sets and more repetitions, while no significant differences were observed in total volume load. Therefore, RT configurations with fewer repetitions per set could be recommended for the maintenance of higher mean velocities and to induce lower level of fatigue during training.
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2. Scott et al. Sports Med, 2016.
3. Genner & Weston. J Strength Cond Res, 2014.

THE EFFECT OF TRAINING LOAD ON MUSCLE FIBER SPECIFIC HYPERTROPHY TO RESISTANCE EXERCISE: A META REGRESSION ANALYSIS OF 111 STUDIES WITH A TOTAL 2099 SUBJECTS

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INTRODUCTION:
Heavy-load strength training (>65% of 1 RM) appears to produce a superior hypertrophy of type II over type I muscle fibers (1). In the same line, we have recently shown that low-load resistance exercise may induce a greater hypertrophy in type I than in type II muscle fibers (2). There is, however, some conflicting results on the relation between training load and the fiber type specific adaptations. It is therefore pertinent systematically analyze the current data to determine whether there exists a fiber type–specific hypertrophy response to varying magnitudes of resistance during strength training.
METHODS:
The literature search was conducted in the PubMed/MEDLINE and SPORTDiscus for all periods until October 2020. We included clinical trials carried out in healthy humans, measuring type 1 and type 2 muscle fiber cross-sectional areas (CSA) by immunohistochemistry before and after strength training. Training had to be dynamic using coupled concentric and eccentric contractions, and last for a minimum of 3 weeks. A total of 3293 abstracts were evaluated based on the inclusion criteria, resulting in 111 included studies with a total 2099 subjects. A simple, random-effects meta-regression of the included studies was performed with the standardized mean difference between type I and II fiber CSA and with muscle fiber as the dependent variable, and resistance (%1RM) as independent variable. Sub-analyses were performed on studies with loads ≤45%- and ≥65% of 1RM separately. Analyses were carried out using the software, Comprehensive Meta-Analysis (version 3.3; Biostat Inc., Englewood, NJ).
RESULTS:
The main analysis revealed that the effect of resistance (%1RM) was significantly greater in type II vs. type I (β=0.0067 [95 CI: 0.002-0.0107], p=0.001). Meta-regression for the muscle fiber types revealed a significant effect of resistance for fiber type II (β=0.0074 [95 CI: 0.003-0.0118], p=0.001), but not for type I (β=0.0012 [95 CI: -0.0033-0.0058], p=0.599). Additionally, sub analyses revealed no significant difference between type I and II fiber hypertrophy in the studies with ≤45%1RM (SMD: -0.072, type I: 12.3±9.4% vs. type II: 11.7±9.8%, p=0.390), but hypertrophy was greater in type II than in. type I fibers in the ≥65%1RM studies (SMD: 0.264, type I: 10.5±9.9% vs. type II: 20.7±12.7%, p<0.001).

CONCLUSION:
The results of this meta-analysis support the claim that heavier loads induce larger growth in type II muscle fibers. Although there are some individual studies showing preferential type I muscle fiber hypertrophy with low-load training, pooling of data did not support this hypothesis, with equal type I fiber growth observed regardless of load. Notably however, only 14 included studies measured myofiber hypertrophy with loads <45% of 1RM; hence, there is currently insufficient evidence to draw strong conclusions regarding the effects of varying resistance on muscle fiber type–specific hypertrophy.
REFERENCES
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OP-AP03 Training and Testing

ASSESSING MAXIMAL STRENGTH, POWER, AND CHANGE OF DIRECTION: BEYOND THE BASICS

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INTRODUCTION:
Sport performance is predicated upon maximal strength to drive subsequent adaptations like speed and power [1]. American football (AF) demands high intensity movements such as rapid change of direction (COD). However, COD is complex and warrants further investigation into its associations with maximal strength and performance tests [2,3]. Further, AF encompasses a wide range of qualities across sport position, yet small sample sizes often limit within-team analysis. Therefore, the purposes of the current study were: 1) determine direct and indirect effects of maximal strength on vertical jump and COD ability, and 2) examine if these relationships are moderated by sport position group: skill (S) vs. non-skill (NS).
METHODS:
Subjects included collegiate AF athletes from sport position groups of S (n=60: quarterbacks, running backs, wide receivers, defensive backs) and NS (n=83: linebackers, offensive and defensive lineman). Of the 223 total measures, 98 were from skill positions and 125 from non-skill positions. Maximal strength was measured using 1RM back squat (BS) and hang clean (HC). Vertical jump (VJ) was used to assess lower body power. COD was assessed via the 5-10-5 (i.e., 20-yard shuttle) test. Path analysis was used to examine causal pathways among variables. Multigroup analysis was used to determine moderating effects of S and NS groups. Equality constraints were placed on all causal pathways and removed sequentially. Chi-squared difference tests were used to compare models ($p < 0.05$). Model fit explains how well the model fits the data and was determined using comparative fit index (CFI; >0.95), standardized root mean square residual (SRMR; <0.05), root mean square error of approximation (RMSEA; <0.06) and RMSEA CI-90% (CI90%) with upper limit <0.10.
RESULTS:
The final model displayed a good fit (Chi-squared = 0.081, p= 0.776, CFI= 1.00, SRMR= 0.003, RMSEA= 0.00, CI90% = [0.00-0.16]) and was significantly different than the constrained model (delta Chi-squared= 9.73, p= 0.047). An association found was between VJ and COD (β= -0.44, $p < 0.001$) when examined among all athletes. However, the final model revealed that vertical jump fully mediated the relationship between HC and COD (HC-VJ: β= -0.41, $p< 0.001$, VJ-COD: β= -0.38, $p< 0.001$, HC-COD: β= -0.137, p= 0.17) in S players whereas NS players showed only direct effects of HC on COD (β= -0.335, $p< 0.001$).
CONCLUSION:
These findings suggest maximal strength does not solely explain COD ability, but can serve to enhance underpinning qualities, such as relative force production observed in the vertical jump. Further, it is recommended that coaches consider sport position differences in assessing and analyzing physical qualities in a team setting. The qualities in sport position groups vary and may influence the interpretation of common field tests.
REFERENCES:
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LEVEL OF EFFORT: A RELIABLE AND PRACTICAL ALTERNATIVE TO THE VELOCITY-BASED APPROACH FOR MONITORING RESISTANCE TRAINING

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INTRODUCTION:
The level of effort is defined as the number of repetitions performed in the set (i.e., intra-set volume) in relation to the maximum number of repetitions that can be completed (i.e., relative load), and has been proposed as a practical alternative to the daily velocity monitoring [1] . For instance, programming a level of effort of 10 (15) means performing an intra-set volume of 10 repetitions using an absolute load (kg) that would allow the athlete to complete a total of 15. Therefore, the instructions used to prescribe based on the level of effort methodology would be similar to those provided when using the repetitions in reserve (RIR) system (i.e., performing 10(15) or leaving 5 repetitions in reserve), [1,2] but previously considering the maximum number of repetitions that could be completed with each absolute load (which would determine the %1RM used). Therefore, this study analyzed the potential of the level of effort methodology as an accurate indicator of the programmed relative load (%1RM) and intra-set volume of the set during resistance training in the full squat (SQ) exercise through three specific objectives: i) to examine the inter-and intra-subject variability in the number of repetitions to failure (nRM) against the actual %1RM lifted (adjusted by the individual velocity), ii) to investigate the relationship between the number of repetitions completed and velocity loss reached, and iii) to study the influence of the subject's strength level on the aforementioned parameters.
METHODS:
After determining their individual load-velocity relationships, thirty subjects with low (n=10), medium (n=10), and high (n=10) relative strength levels completed two rounds of nRM tests against their 65%, 75%, 85%, and 95% 1RM in the SQ exercise. The velocity of all repetitions was monitored using a linear transducer (T-Force System, Ergotech, Murcia, Spain). Inter- and intra-subject variability analyses in-

cluded the 95% confidence intervals (CI) and the standard error of measurement (SEM), respectively. Coefficient of determination (R2) was used as the indicator of relationship.
RESULTS:
nRM showed a limited inter- (CI ≤ 4 repetitions) and a very low intra-subject (SEM ≤ 1.9 repetitions) variability for all the strength levels, %1RM and exercises analyzed. A very close relationship (R2 ≥ 0.97) between the number of repetitions completed and the percentage of velocity loss reached (from 10% to 60%) was found.
CONCLUSION:
These findings strengthen the level of effort as a reliable, precise, and practical strategy for programming resistance training.
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ACUTE EFFECTS OF RESISTANCE TRAINING WITH DIFFERENT INTER-SET REST AND VOLUME-EQUATED

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INTRODUCTION:
Conducting resistance training (RT) is a method commonly used to improve athlete´s muscular strength. Manipulation of the one or several RT variables (e.g. exercises, relative intensity, volume, rest interval) characterizes the type and magnitude of the stimulus and, consequently, the physiological adaptations to RT [1]. In this regard, rest interval between sets is an important variable that affects both mechanical and metabolic acute effects of training [2]. Therefore, the purpose of this study was to compare acute mechanical and metabolic effects of 4 sessions of RT equated by volume and relative intensity but with different set configurations and rest time between sets.
METHODS:
In a counterbalanced randomized order, 18 healthy males completed four RT protocols in separated sessions. Training configurations were (sets × repetitions [inter-set rest (min)]): 3×8 (2); 3×8 (5); 6×4 (2); 6×4 (5). The exercise (bench press), number of total repetitions (24), and relative intensity (80% 1RM) were the same for all protocols. Mechanical fatigue was quantified by measuring the mean propulsive velocity against a 60% 1RM load (MPV60) and metabolic fatigue was assessed via the blood lactate concentration [Lac], both before and after each session.
RESULTS:
The 3×8 (2) protocol could not complete all scheduled repetitions resulting in a significant lower number of repetitions (P ≤ 0.05) than the rest of protocols. Additionally, this protocol showed a significant higher [Lac] and lower MPV60 after session compared to the 6×4 (2) and 6×4 (5) protocols (P ≤ 0 05). Moreover, the 3×8 (5) protocol showed significant higher [Lac] (P ≤ 0 05) compared to 6×4 (2) and lower MPV60 than 6×4 (5) (P ≤ 0.05).
CONCLUSION:
This study revealed that RT configuration with 2 and 5 minutes of inter-set rest determines specific responses to RT. Five minutes of rest time allowed athletes to obtain a lesser mechanical and metabolic stress, especially when the training configurations are done with a lower number of repetitions per set. Therefore, RT with longer rest intervals should be recommended to induce a lower decrease in performance after the training session.
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AGE AND SEX-RELATED DIFFERENCES IN ISOMETRIC PERFORMANCE AND FATIGABILITY DURING A QUADRICEPS INTERMITTENT FATIGUE TEST

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INTRODUCTION:
Ageing is accompanied by alterations in neuromuscular function (NMF) and fatigability, leading to increased risk of autonomy loss and incidence of frailty. These impairments could vary with sex and age. Particularly, the age-related decline seems to accelerate after 80 years old (very old adults), suggesting possible differences in NMF between various age groups. However, differences in NMF and fatigability in very old adults are poorly understood. In the present study, we aimed to investigate the age- and sex-related differences in NMF and fatigability during an isometric quadriceps intermittent fatiguing test (QIF test).
METHODS:
Thirty young (<35 yr) men (YM, n = 15) and women (YW, n = 15), 16 old (>60 yr) men (OM, n = 10) and women (OW, n = 6) and 24 very old (>80 yr) men (VOM, n = 13) and women (VOW, n = 11) performed a QIF test until exhaustion. Force-time integral and number of contractions were calculated as indices of absolute performance and performance relative to maximal force, respectively. Fatigability was quantified as maximal voluntary isometric strength (Fmax) loss at the end of the test compared to baseline. Evoked quadriceps responses were assessed via femoral nerve magnetic stimulation to investigate fatigue-induced alterations in contractile function.
RESULTS:
Fmax was lower with advancing age and were greater for men than women (YM: 690 ± 94 N; YW: 468 ± 91 N; OM: 518 ± 157 N; OW: 344 ± 49 N; VOM: 356 ± 79 N; VOW: 246 ± 40 N; age and sex comparisons: all P < 0.05), force-time integral showed to similar results. Number of contractions performed at the QIF test was similar between ages and sexes (66 ± 8 contractions, P > 0.05), indicating that all participants performed a similar relative performance. At exhaustion, Fmax decreased significantly more for YM (-30 ± 11%) compared to OM (-20 ± 6%; P = 0.009) and VOM (-20 ± 8%; P = 0.016), with no differences between groups in the evoked responses (P > 0.05). The decrease in Fmax was similar across ages in women (YW: -26 ± 11%; OW: -17 ± 6%; VOW: -26 ± 8%; P > 0.05), with no differences in the evoked responses (P > 0.05). Finally, no sex differences were found in fatigability and evoked responses, independent of age (P > 0.05).
CONCLUSION:
These results show that young men, but not women, presented greater fatigability after a QIF test compared to older adults. Older adults presented lower fatigability, but similar etiology compared to the younger adults. These findings suggest that similar factors contribute to impairments in NMF and fatigability development with age and across sexes during an incremental fatiguing test of the quadriceps muscles.

THE RELATIONSHIP BETWEEN BACK MUSCLE STRENGTH AND POSTURAL STABILITY AFTER UNEXPECTED EXTERNAL PERTURBATIONS

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INTRODUCTION:
Whilst higher rates of force development (RFD) have been shown to be related to better performance in various physical tests, the potential importance of this variable in perturbation-based balance tests has yet to be investigated. This study investigates the relationship between postural sway response to unexpected external perturbations and both peak force and peak RFD produced during a maximum voluntary isometric contraction (MVC) of the back muscles in young individuals with a prevalently sedentary lifestyle.
METHODS:
Groups of healthy young sedentary men (n=32, age 22.7±2.6 y, height 179.4±10.3 cm, body mass 88.1±12.7 kg) and women (n=23, age 22.2±2.3 y, height 169.5±7.7 cm, body mass 66.8±10.6 kg) underwent postural perturbations induced by a 2 kg load release and an isometric maximum strength test of the back muscles. While in the first case the peak anterior to peak posterior displacements of the center of pressure (CoP) and corresponding time from peak anterior to peak posterior displacements of the CoP were registered, in the second case both peak force and peak RFD during MVC of the back muscles were measured.
RESULTS:
There were significant correlations between peak RFD during MVC of the back muscles and peak anterior displacement of the CoP ($r=-0.81$, $p=0.011$), peak posterior displacement of the CoP ($r=-0.64$, $p=0.033$), peak anterior to peak posterior displacement of the CoP ($r=-0.76$, $p=0.022$) and correspoding time to peak anterior displacement of the CoP ($r=-0.77$, $p=0.019$), time to peak posterior displacement of the CoP ($r=-0.60$, $p=0.038$), and time from peak anterior to peak posterior displacement of the CoP ($r=-0.73$, $p=0.027$). However, small to moderate correlations were revealed between peak force produced during MVC of the back muscles and parameters of the perturbation-based balance test (r ranged from -0.19 to -0.38, $p>0.05$).
CONCLUSION:
A stronger relationship between postural sway response to perturbations elicited by weight unloading and peak RFD rather than peak force produced during MVC of the back muscles implies that better postural control in the anteroposterior direction after sudden external perturbations may be related to improvements in the ability to develop a high force in a short period of time after the exercise program. Therefore peak RFD, in addition to traditionally used MVC peak force produced by the back muscles, should be included in functional performance testing of healthy sedentary individuals in order to get deeper insight into their capability to respond effectively to unexpected postural perturbations.
Acknowledgment: This work was supported by the Slovak Research and Development Agency under the contract No. APVV-15-0704 and the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences (No. 1/0089/20).

PREDICTING THE 1-RM FROM INDIVIDUALIZED LOAD-VELOCITY AND STRENGTH-ENDURANCE RELATIONSHIPS

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INTRODUCTION:
The one-repetition maximum (1-RM) is considered to be both, a valuable indicator for maximum strength performance and a popular variable to standardize resistance training load. However, a direct assessment of the 1-RM by means of a progressive loading test can be time-consuming and may not be suitable for frequent application during a training intervention. This advocates the necessity for additional approaches to accurately determine the 1-RM. The objective of the present study was to investigate the validity of two alternative methods to predict the 1-RM in the concentric bench press.
METHODS:
Thirty resistance-trained subjects (19 males, 11 females, age: 27.2 ± 4.2 y, body mass: 77.3 ± 12.5 kg, relative bench press 1-RM: 1.19 ± 0.22 kg·kg-1) visited the laboratory on two days separated by 48 hours. On day 1, participants were familiarized with the test procedure and completed a 1-RM test in the free-weight concentric bench press. On day 2, they completed warm-up sets at 25%, 50% and 75% of the identified 1-RM, followed by three working sets to muscular failure at 90%, 80% and 70% with 20 min of passive and active rest in between working sets. Subjects were instructed to perform each repetition at explosive intent. Mean barbell velocity was assessed using a linear position transducer. For each participant, two individualized models were used to calculate a point-estimate of the 1-RM from test data: a) a linear 2-point load-velocity profile was based on the load and highest achieved mean velocity at 50% and 90% 1-RM and b) an exponential 3-point strength-endurance profile was based on the load and maximum number of repetitions at 70%, 80% and 90% 1-RM. A Bayesian random-intercept model with an uninformative prior was calculated to compare relative estimation errors between the two methods. The posterior distributions were interpreted according to their Maximum A Posteriori (MAP) estimates, 90% Highest Density Intervals (HDI) and their relationship to a region of practical equivalence set at ±1% of the true 1-RM.
RESULTS:
Posterior distribution analysis showed a tendency for load-velocity profiles to underestimate the 1-RM (MAP [90% HDI] = -1.87% [-3.21, -0.63]). There was an 87.4% probability of the population parameter to fall below the lower threshold of practical equivalence. Strength-endurance profiles resulted in less estimation error (MAP [90% HDI] = -0.27% [-1.68, 0.93]) with a 73.8% probability of the population parameter to fall within the region of practical equivalence.
CONCLUSION:
These results suggest that, on average, strength-endurance profiles may provide higher accuracy in the estimation of the concentric bench press 1-RM compared to load-velocity profiles. Practitioners who do not have access to velocity-measuring devices may therefore consider applying individualized strength-endurance profiles as a worthwhile and potentially more accurate approach to estimating the 1-RM.

OP-AP04 Team Sports - Soccer

VALIDITY AND RELIABILITY OF PHYSIOLOGICAL AND PERCEPTUAL RESPONSES DURING A TREADMILL-BASED SOCCER REFEREE SIMULATION (SRS)

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INTRODUCTION:
Simulation protocols that mimic match play are often utilised to circumvent the challenges of conducting research in the actual performance setting (1). In addition to negating the contextual variables and large levels of variability that confound match play data (2), simulation protocols enable physiological responses to be monitored in a more controlled environment. A number of match simulations have therefore been developed for soccer players (1,3,4). In comparison, a valid and reliable simulation protocol is yet to be established for soccer referees. The current study therefore sought to explore the validity and reliability of the physiological and perceptual responses elicited during a novel treadmill-based Soccer Referee Simulation (SRS).
METHODS:
Following the collection of baseline measures and habituation procedures, eight sub-elite soccer referees completed a single trial of the SRS whereby measures of heart rate (HR), oxygen uptake ($\dot{V}O2$), blood lactate concentrations, and differential ratings of perceived exertion (RPE) were obtained. Referees' HR responses were also monitored during a series of competitive matches (5 match observations per referee). For the reliability aspect of the investigation, eight well-trained males were initially habituated, and thereafter completed three separate trials of the SRS during which the reliability of the selected outcome variables were ascertained. Trials were separated by 3-7 days and performed under standardised conditions.
RESULTS:
No differences were evidenced between the SRS and match play in relation to measures of mean HR (SRS: 79.6 ± 6.6%; Match Play: 80.6 ± 6.0%; P=0.444; ES=0.29), peak HR (SRS: 90.0 ± 7.1%; Match Play: 93.8 ± 3.5%; P=0.074; ES=0.74), or HR-based training impulse (SRS: 58.3 ± 20.2 au; Match Play: 61.6 ± 14.1 au; P=0.498; ES=0.25). Additionally, no systematic differences were detected between reliability trials for any of the measured outcome variables (P≥0.293), whilst good levels of reliability were observed for measures of mean HR (ICC=0.94; CV=3.1%), peak HR (ICC=0.93; CV=2.2%), HR-based training impulse (ICC=0.95; CV=10.0%), mean $\dot{V}O2$ (ICC=0.95; CV=2.6%); blood lactate concentrations (ICC≥0.89; CV≤11.5%), and differential RPE (ICC≥0.94; CV≤15.1%).
CONCLUSION:
The present findings have demonstrated the SRS to be a valid and reliable protocol that closely replicates the physiological and perceptual responses elicited by soccer referees during competitive match play.
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RELATIONSHIP BETWEEN GENERIC EXTERNAL TRAINING LOAD MEASURES AND INJURY IN TWO PROFESSIONAL SOCCER PRE-SEASONS.

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INTRODUCTION:
Numerous investigations have identified association between high-speed running (HSR) and sprint distances (SD) with injuries in elite soccer [1]. Exposing players to acute increases in HSR and SD reportedly increases the risk of injury [1]. Furthermore, spikes in weekly total distance, accelerations and decelerations (AD) have also been shown to be related to higher injury risks [2]. Previous research suggests that there is a high incidence of injury during training and match play during pre-season [3]. The aim of the current study was to investigate the association between GPS metrics and injuries in professional soccer
METHODS:
Thirty-five professional soccer players from a single squad (Mean± SD, age: 25.4±4.5 years; height: 173.9±14.1cm; mass: 77±6kg; body fat %: 9.0±3.1) participated in the study. Data was collected across the 2020 and 2021 soccer pre-season. All outfield players were included in the study which accounted for four positional groups (Central defenders (n=9), full backs (n=7), central midfielders (n=11) and forwards (n=8). All injuries that prevented a player from full team training and match play was recorded. During two pre-seasons (2020 = 5 weeks; 2021 = 6 weeks), nine pre-season games and sixty training sessions were included. Measures of physical performance included TD covered (m), HSR (19.8-25.2km.h-1), sprint distances (>25.2km.h-1), AD and high metabolic load (HML). These metrics were collected via GPS (Statsports, Northern Ireland). Statistical significance was set at P<0.05
RESULTS:
The findings from the current study show a significant difference between SD and injury (P=0.02). Meaningful significance was found with HML and injury (P=0.06). No significant differences were found between TD, HSR and AD with injury. A non significant difference was found with week-to-week changes in metrics to injury.
CONCLUSION:
The main finding of the study are that high volumes and acute increases in SD are related to an increase in risk of injury. The findings of the current research reflects previous research which suggest that acute spikes in maximal or sub maximal velocity running can be related to injury [4].
References
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HIGH-LEVEL SOCCER PLAYERS CONDITION AFTER OFF-SEASON PERIOD - THE RELEVANCE OF INDIVIDUALIZATION, EVALUATION AND CONTROL OF TRAINING

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INTRODUCTION:
Soccer performance is a complex concept, with multiple factors interacting, including physiological, psychological, tactical, and technical aspects [1]. However, nowadays the reality of soccer is associated with great competitive density, a factor that leads to pre-seasons with reduced adaptive periods and time for moments of evaluation and control of training throughout the season. The aim of this study was to analyze the physiological and physical condition of high-level soccer players after the off-season period and return to daily practice.
METHODS:
Sixteen high-level soccer players (24.1±4.7 years of age; 1.78±0.06 m height; 74.5±4.5 kg weight and 9.4±2.6 kg of body fat), all outfield players and the majority with trajectory in youth national teams and at senior level of different countries, underwent the following evaluations after 1-month off-season period: 1) An incremental running test in treadmill with Metamax 3B (Cortex, Leipzig, Germany) for maximal oxygen uptake (VO2max), respiratory compensation point (RCP) and gas exchange threshold (GET), as well as the respective exercise intensities and heart rate (HR) throughout the tests and each minute at end-exercise until 3-min (HR1min, HR2min and HR3min); 2) Segmental body composition assessment with Tanita MC-780 MA (Tanita, Tokyo, Japan); 3) Countermovement jump and squat jump determination (CMJ and SJ, respectively) with ergojump system (Byomedic, Barcelona, Spain); 4) Handgrip (HG) maximum isometric strength analysis of the dominant hand with Camry 90 kg dynamometer and; 5) Flexibility of the lower limbs with sit and reach test, specifically with each limb (Flex_R and Flex_L).
RESULTS:
VO2max (59.4.0±3.9 ml·kg·min-1) was higher compared to RCP (54.7±3.7 ml·kg·min-1) and GET (30.0±5.0 ml·kg·min-1). VO2max intensity (17.7±5.4 km·h-1) was associated to extreme values of 19 and 15 km·h-1. HRmax (181.1±5.4 beats·min-1) was correlated to CMJ (45.3±4.1 cm; r=0.57, p<0.05) and SJ (38.3±5.5 cm; r=0.56, p<0.05). HR2min (130.1±8.9 beats·min-1) and HR3min (119.9±8.2 beats·min-1) were correlated to muscular mass of both lower limbs, contrarily to HR1min (151.7±9.2 beats·min-1). HR3min was also correlated to basal metabolic rate (1971.3±125.5 kcal; r=0.52, p<0.05) but not visceral fat (1.4±0.6). SJ was correlated to Flex_R (7.5±5.6 cm; r=0.59, p<0.05), Flex_L (6.5±6.3 cm; r=0.68, p<0.01) and HG (48.8±5.6 kg; r=0.57, p<0.05), this last also correlated to muscular mass of both upper limbs. Body fat of both upper and lower limbs were statistically different (9.0±1.6% vs. 8.8±2.1% right and left upper limbs, and 9.2±1.9% vs. 9.4±1.8% right and left lower limbs), the same was observed only in muscle mass of upper limbs (3.0±9.4% for both right and left upper limbs).
CONCLUSION:
After off-season period, a careful evaluation of the athletes when returning to regular training is of relevant interest in order to determine the effects of detraining, the ideal loads for training prescription and to assess the need for individualized training to improve a certain capacity or even promote balance between body segments aiming injury prevention.

PHYSICAL DEMANDS OF U10 PLAYERS IN A 7-A-SIDE SOCCER TOURNAMENT DEPENDING ON THE PLAYING POSITION AND LEVEL OF OPPONENTS IN CONSECUTIVE MATCHES USING GLOBAL POSITIONING SYSTEMS (GPS)

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INTRODUCTION:
Modern elite football currently involves a large number of tournaments and matches throughout the season, and it is not unusual for a team to play two or more matches in a very short period of time (1). Similarly, in grassroots football, there are many tournaments where usually 6 or more 7-a-side matches are played in the same day. There are reasons to believe that too many games may lead to a lack of motivation, concentration and more incremental fatigue, which can effect coordination, leading to worse performance and an increased risk of injury (2). Therefore, the aim of this study was to analyse the physical demands of U10 players in a 7-a-side-soccer tournament based on the playing positions in 6 consecutive matches by global positioning systems (GPS).
METHODS:
Six games of a 7-a-side soccer tournament in the central region of Spain played by a U10 amateur soccer team (age= 10.2 years) were analysed using a GPS with sampling rates of 15 Hz (GPSport, Canberra, Australia). Variables of total distance, relative distance in different speed zones, maximum speed, time interval between accelerations, maximum speed acceleration, maximum acceleration, acceleration distance and the number of high-intensity accelerations were analysed.
RESULTS:
Differences between playing positions were found in the total distance covered by the midfielders. They covered higher total distances than the defenders (+1167 m; 95% CI: 411 to 1922 m; effect size (ES) = 1.41; $p < 0.05$) and forwards (+1388 m; CI 95%: 712 a 2063 m; TE = 0.85; $p < 0.05$). The total covered distance increased in the final rounds with respect to the group stage ($p < 0.05$; ES: 0.44 to 1.62), and high-intensity actions, such as the number of accelerations, were greater in the final rounds compared to the group stage ($p < 0.05$; ES: 0.44 to 1.62).
CONCLUSION:
The present study indicates that physical performance is influenced by playing position and depends on the level difference between opponents. Midfielders covered more distance in high-intensity zones (Zone 5 and Zone 6) and performed more high-intensity actions (VMaxACC, MaxACC, TDACC and HI accelerations) than defenders and forwards. Regarding the difference in level between the opponents, the distances covered at high intensity decreased as the tournament progressed; however, the total distance and accelerations at high intensity are higher in the final rounds, probably due to the level of the opponent. In addition, it allows training and load distribution to be designed according to the demands of a congested schedule, taking into account the possibility of having no limit on substitutions.
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DIFFERENTIAL RATINGS OF PERCEIVED EXERTION IN ELITE FOOTBALL: DO PLAYERS DIFFERENTIATE?

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INTRODUCTION:
In football, training load data are used to plan loading and recovery during a training week, which is often structured based on the number of days between the session and the next of previous match day. The training response and outcomes are determined primarily by the internal load. However, it remains difficult to quantify the internal load precisely. An indicator that is often applied is to rate the perceived exertion (sRPE). To improve this method, recent studies suggest differentiating between perceived breathlessness (sRPE-B) and leg-muscle exertion (sRPE-L) can be a useful surrogate to separate two key but contrasting body systems (i.e., central and peripheral). Although data suggest players can differentiate between the two RPE types in sessions such as resistance training, contrasting evidence exists regarding players' ability to differentiate after football-specific sessions. Therefore, this study examines the extent to which players differentiate between sRPE-B and sRPE-L in different types of training sessions throughout a typical training week.
METHODS:
Data from 28 elite male football players were included. External load data were collected using a 10 Hz global navigation satellite system (Johan Sports V4, Noordwijk, Netherlands). After each session, players provided their sRPE-B and sRPE-L. First, descriptive statistics were calculated to quantify how often players differentiated between sRPE-B and sRPE-L. Second, the relation between differential RPE and four session types was analysed. Using a k-means cluster analysis, three session types with a characteristic external load were identified: recovery (MD+1 and MD+2), loading (MD-4 and MD-3), and tapering (MD-1). A match session was added as an additional session type. Subsequent to a Chi-square test, post-hoc tests with Bonferroni adjustment were executed for between session type comparisons to identify which session types are different from one another, with respect to the number of sessions with a higher sRPE-B, higher sRPE-L and equal ratings.
RESULTS:
Overall, players differentiated in 25% of all sessions. Sessions with clear differentiation often identified a higher sRPE-L (67%). Post-hoc comparisons showed that higher rates of differentiation (i.e., difference between sRPE-B and sRPE-L) were seen after matches, recovery, and loading sessions compared to taper sessions. Rates of differentiation were statistically similar among the other session types.
CONCLUSION:
Players did not often differentiate between sRPE-B and sRPE-L for football-specific sessions in our study. The equivalence between sRPE-B and sRPE-L was most evident for taper sessions. When differentiation was evident, players tended to report higher sRPE-L although the mechanisms behind these observations remain unclear. Further research into the face and content validity of differential RPE, as well as a revision of its conceptual framework specific to training load, may help identify how these measures can best be adopted in practice.

INFLUENCE OF THE AREA PER PLAYER IN NON-PROFESSIONAL SOCCER PLAYERS: FOCUS ON POSITIONAL ROLES

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INTRODUCTION:
Effective small sided games (SSG) in soccer rely not only on the choice of single determinants (format, pitch dimension, etc) but also on derived parameters, such as area per player (Ap). This study analyses the influence of different Ap (75, 98 and 131m2) on the average metabolic power and other soccer-related performance variables in relation with the positional roles.
METHODS:
19 non-professional soccer players (attackers, midfielders and defenders) were recruited to play 3 different small-sided games (SSGs): SSG1 (5vs5; 30x30m; 5min), SSG2 (5vs5; 35x45m; 5min) and SSG3 (7vs7; 35x45m; 8min). Specific playing rules were applied. GPS-assessed soccer-related variables were: average metabolic power (AMP), distance covered in 1 min (DIS); %time spent at high speed (v>16km/h) (%hst); %time spent at high metabolic power (>20W/kg) (%hmpt); %distance covered at high/negative positive speed (accelerations: 2 RESULTS:
All recorded variables differed when each SSG was compared to the others ($p<0,05$), but for hmpa for attackers. Most performance variables were positively associated to increasing Ap ($p<0,05$), but for %ACC and %DEC, and differed among positional roles within the same SSG ($p<0,05$)
CONCLUSION:
Here we provide qualitative and quantitative Ap-related determinants, able to significantly improve soccer-specific performance variables, demonstrating that different arrays of SSGs are needed to fulfil the demands characterising each positional role, irrespective of the physical/technical level of players.

TYPICAL WEEKLY PERIODIZATION IN FRENCH ACADEMY SOCCER PLAYERS: A SURVEY

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INTRODUCTION:
In elite level youth soccer players, weekly periodization is of paramount importance to plan for short- and long-term development. Although few studies provided insights into the management of week periodization amongst academy soccer players (1–3), much information is still missing. Currently, the literature is still scarce about how academies' coaching staff daily implement speed, strength and aerobic work during the microcycle. Moreover, the general type of exercises used remained unknown. The present study aimed to precisely determine the typical weekly periodization before a competitive game in French soccer training academies.
METHODS:

A survey was completed online to determine the typical weekly periodization with a special reference to daily training and work before match-day (MD). The survey attempted to characterise each training according to the duration, physical focus, and global type of exercises. The frequency rates of the responses were compared using two-tailed Chi-square tests with the significance level set at $p < 0.05$.
RESULTS:
Forty-five questionnaires were analysed. Most respondents indicated they performed active recovery the day after the match on MD+1 (77.8%) alongside prophylactic work (33.3%). Furthermore, comparable results were found for the second day after the match, on MD+2, with active recovery (20.1%) and prophylactic work (22.4%). Integrated technical exercises were primarily used (30.0% for MD+1 and 25.9% for MD+2). Moreover, development sessions were mostly used during training sessions in the middle of the week (37.3% for MD-4 and 35.6% for MD-3). Strength was the main aim (52.2% for MD-4 and 28.8% for MD-3), then aerobic (28.4% for MD-4 and 27.1% for MD-3), and speed (10.4% for MD-4 and 18.6% for MD-3). Speed was mostly practiced close to match-day (46.5% for MD-2 and 26.8% for MD-1). A consensus for training session at MD-1 was observed with a massive use of small sided games (92.3%) and reactivity exercises (100.0%).
CONCLUSION:
The present survey revealed that French soccer academies practiced low-load sessions at the beginning of the week mostly with technical exercises. Greater-load training were achieved during the middle of the week, before lowering the training load towards competition with more intensive exercises such as speed and reactivity.
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CROSS-VALIDATION OF THE EQUATIONS TO PREDICT AEROBIC CAPACITY AND THEIR RELATIONSHIP WITH INTERMITTENT AEROBIC POWER IN FEMALE SOCCER PLAYERS. THE BASQUE FEMALE FOOTBALLERS COHORT [BFFC] STUDY

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INTRODUCTION:
This study aimed to 1) test the predictive capacity and accuracy of the female operational regression equations to determine the Fixed Blood Lactate Concentration (FBLC) thresholds previously developed, and 2) examine the relationships between the FBLC thresholds and the performance on the popularized and validated 30-15 Intermittent Fitness Test (VIFT).
METHODS:
This study is part of a larger project underway on Basque female footballers (BFFC study). Within the BFFC study, a cross-validation and predictive cross-sectional study was conducted in a semi-professional female soccer team (n = 15). FBLC thresholds were determined. A week apart, the VIFT was determined. Cross-validation of the practical equations to estimate the FBLC thresholds was performed. Furthermore, the extent of degree of commonality between the constant aerobic capacity (i.e., FBLC thresholds) and the intermittent aerobic power capacity (i.e. VIFT) was determined.
RESULTS:
Concerning the cross-validation analyses, mean differences between estimated and measured FBLC thresholds were <6% (range: 0.1 to 5.9%) and SEMs <4% (range: 2.7 to 3.6%). Pearson's correlation magnitudes ranged from 0.79 to 0.97 ($P<0.01$), ICCs from 0.85 to 0.98 ($P<0.01$), and CVs <7%. Moreover, cross-sectional analyses indicated FBLC thresholds to be robustly related to VIFT [$r = 0.697$ to 0.704; $P<0.005$], with low standard errors of the estimate (5.7%).
CONCLUSION:
This is the first study validating operational equations to estimate the FBLC thresholds in female footballers. Using these equations reduces the burden associated with cardiorespiratory testing and facilitates the monitoring of the aerobic capacity. To the best of our knowledge, this is the first study reporting the relationships between the FBLC thresholds and VIFT in female soccer players. These equations might be helpful to design both constant aerobic capacity and intermittent aerobic power capacity training zones using only one fitness assessment. Results of this study would be of particular interest to the supporting staff of female soccer teams.

SMALL-SIDED GAMES VS. MATCH PLAY: COMPARISON OF EXTERNAL AND INTERNAL WORKLOAD IN ÉLITE YOUNG SOCCER PLAYERS.

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INTRODUCTION:
Small-Sided Games (SSGs) represent a widely used training modality to develop concurrently physical performance and technical-tactical skills in soccer players (1) as well as in other team sports (2). This study aimed to compare external and internal training loads in élite junior soccer players between two different SSGs (only ball possession, SSG-POS; ball possession play, and shuttle run after the pass, SSG-SHU) and those of official matches (OM).
METHODS:
Ten élite young male soccer players (age 18.6±1.9 years; weight 73.1±5 kg; height 175± 1.5 cm) were recruited from Under 19 Italian professional team and monitored during 10 official championship matches of the corresponding age category. Players performed two different 5vs5 SSGs (SSG-POS and SSG-SHU) of the same duration (4x4 min–1min rest), 2 times each, in a randomized order, one per week for 4 weeks. SSGs sessions and OM data of locomotor activity were recorded using 10-Hz Global Positioning System. Total distance (TD), Distance at high speed (DHS; 14.4–19.8 km·h-1) (m), distance at very high speed (DVHS; 19.8–25.2 km·h-1) (m); average metabolic power (AMP;W·kg-1); high and very high intensity accelerations (HA; ≥2/3 m·s–2), high and very high intensity decelerations (HD; ≤–2/-3 m·s–2) and the relative distance (Drel; m·min-1) were monitored. Heart rate (HR) was continuously recorded, whereas blood lactate [La]+ was measured at the end of each SSGs session. The internal training load was assessed through the rate of perceived exertion (RPE). ANOVA was applied to statistically evaluate normally-distributed parameters, whilst non parametric statistical analysis were applied to not-normally distributed data.
RESULTS:

The comparison of locomotor activity parameters between the two SSGs formats showed that TD was higher ($p<0.001$) in SSG-SHU than in SSG-POS, whilst no significant differences were found in AMP, DHS, DVHS, Drel, HA, HD. HRpeak and RPE values did not differ between SSGs, while [La]+ values in SSG-SHU were significantly higher than in SSG-POS ($p<0.001$). The comparison between SSGs and OM showed higher values of AMP ($p<0.05$), HA ($p<0.01$) and HD (0.001) in SSGs compared to OM. DHS and DHVS values were higher in OM than in both SSGs ($p<0.001$), while Drel and HRpeak values did not differ between SSGs conditions and OM. Finally, internal workload measured through RPE was found to be higher ($p<0.05$) after OM, than after either SSG-SHU or SSG-POS.
CONCLUSION:
This study shows that SSG-SHU induces higher total distance covered with a higher solicitation of anaerobic energy contribution compared to SSG-POS. Furthermore, our results show that in young élite soccer players both SSGs, when compared to OM, might be an effective training regime in terms of average mean power and speed-based conditioning, with greater enjoyment and lower subjective perception of effort.
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OP-AP05 Team Sports

EVALUATION OF A NOVEL REACTIVE AGILITY TEST AND 20-M SPRINT TEST TO DISTINGUISH PLAYING LEVELS OF MALE TOUCH RUGBY PLAYERS

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INTRODUCTION:
Touch rugby is a variety of conventional rugby and stresses players' agility due to the heavy reliance on rapid acceleration and deceleration during match-play (Chow et al., 2020). The qualities of linear and multidirectional speed are deemed to differentiate players' abilities. Previous research has shown that a battery of speed and agility assessments could predict physical qualities in different playing levels in many intermittent sports, but yet to be investigated in touch rugby. The purpose of the study was to determine the reactive agility and 20-m sprint ability among elite and amateur male touch rugby players, and healthy males from other sports, and the reliability of the tests.
METHODS:
Twenty male touch rugby players from the elite divisions (M ± SD: Age 23.40 ± 2.60 years; BMI: 22.65 ± 2.28; Body fat 18.01 ± 3.02%), 20 from the club divisions (Age 25.50 ± 2.57 years; BMI: 23.65 ± 1.97; Body fat 17.89 ± SD: 4.36%) and 20 males from other sports (Control; Age: 24.25 ± 1.37 years; BMI: 23.18 ± 2.15; Body fat 14.52 ± 4.44%) were invited to participate in the study. A ten-minute standardized warm-up and familiarization of the tests were provided prior to the anthropometric and fitness assessments. Reactive agility was evaluated by Sector Reactive Agility Test (SRAT), a novel touch-rugby-specific assessment, using Blazepod reactive agility device. A 20-m sprint test was assessed by Brower timing system. Outcome variables were compared among the three groups by two separate one-way analyses of covariance. The effect size was calculated by Cohen's d. The test-retest reliability and accuracy of both tests were verified by 2-way mixed intraclass correlation coefficient (ICC3,1) and coefficient of variation.
RESULTS:
Excellent reliability and high precision were found in SRAT (ICC3,1 = 0.98, 95% CI: 0.97 to 0.99, CV = 0.33%) and 20-m sprint test (ICC3,1 = 0.93, 95%CI: 0.89 to 0.96, CV = 1.03%). Time of completion in SRAT in the elite players was 23.93 ± 1.65 s, which is shorter than the amateur players with a mean of 2.95 s (95% CI: 1.67 to 4.23, $p < .001$, $d = 1.93$) and the control with 3.89 s (95% CI: 2.61 to 5.17, $p < .001$, $d = 1.63$). No significant difference was found in the 20-m sprint test among elite players (2.69 ± 0.16 s), amateur players (2.80 ± 0.16 s), and control group (2.68 ± 0.19 s).
CONCLUSION:
Elite touch rugby players demonstrated superior performance in SRAT, a touch-rugby-specific reactive agility test, compared to the amateur and the control. SRAT demonstrated evidence of reliability and accuracy to measure reactive agility performance in touch rugby. It also suggested the importance of reactive components and sport-specific agility tests in discriminating players of different levels and experience.
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Chow, G.C.C. (2020). Global positioning system activity profile in touch rugby: does training meet the match-play intensity in a two-day international test match series? Journal of Sports Science and Medicine, 19, 613–619.

RETENTION TRENDS OF TEENAGERS IN RUGBY UNION: A LONGITUDINAL PLAYER DATABASE ANALYSIS

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INTRODUCTION:
Data on youth rugby players in Ireland suggest dropout is particularly severe between the ages of 16 and 20 years (Lunn & Kelly 2019). While there is some literature on context-specific reasons for drop-out in the United Kingdom (Cobley & Till, 2017; Sellars et al., 2018), there is little research in the Irish context. The purpose of this study was to examine a database that tracks player participation in an Irish provincial region, to identify factors associated with player retention.
METHODS:
The database provided demographic information on players from U-13 to U-18.5 including team type, competition(s) and the total appearances for players participating in the region. In total, 33,733 records were evaluated from 2015-2019. Player ID numbers were matched across seasons to determine whether players continued participating or dropped out of rugby. Mann Whitney U tests compared appearances between players who were retained and who dropped out for each age group and year. Chi-squared or Fisher's Exact Tests were used to evaluate the association between player retention and participation characteristics (e.g., playing for multiple teams, relative age quartile).
RESULTS:

The median number of appearances for those that were retained were significantly higher than those that were not (p's < 0.05). Playing for multiple rugby teams or age-grades was associated with higher retention rates than playing for one team only (p's <0.05). There was no association found between quartile of birth and number of appearances (p's > 0.05).
CONCLUSION:
Findings suggest that the more appearances a player records, the greater likelihood of retention. This can inform policy making at organizational level (e.g., implementation of half game rule for adolescents to enhance meaningful game-time). Relative age (birth quartile) had no influence on opportunity to participate. Given the established influence of relative age on general participation in rugby league in the United Kingdom (Cobley & Till 2017), the absence of relative age effect in this province is a positive finding. Further exploration into the possible benefits of playing for multiple teams is warranted. Collection of additional relevant data (e.g. actual game-time, female data) and exploring ways by which the analysis framework can be updated annually is recommended. These actions could help in drawing up a convention for best practice in tracking and monitoring player progression.
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RELATIONSHIPS BETWEEN TRAINING LOAD, SUBJECTIVE MARKERS OF RECOVERY, SALIVARY CORTISOL AND PHYSICAL CAPACITY IN PROFESSIONAL OFFSHORE SAILORS.

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INTRODUCTION:
Inadequate training load (TL) analysis can lead to insufficient recovery and, thus, provoke a decrease in performance and increased risks of overtraining injuries. TL has been widely used as a monitoring marker to optimize training in many sports. However, for predominantly strategy-based sports, such as sailing, TL analysis data is still lacking. Therefore, the purpose of this study was to examine the effects of 6 months of training on neuromuscular adaptations, subjective markers of recovery, mood state and salivary biomarker cortisol in an elite offshore sailing environment.
METHODS:
Ten professional offshore sailors (8 male and 2 female) participated in this study. Daily internal TL (ITL), strain (TS), monotony (TM), intensity (INT) and acute:chronic TL ratio (AC) as well as a weekly total score of fatigue (TSF) were quantified respectively by session-rating of perceived exertion (sRPE) and a 4-item wellness questionnaire (delayed onset muscle soreness, stress, fatigue and sleep quality). Salivary cortisol (C), countermovement jump height (CMJ), maximal strength on bench press (BP) and total mood disturbance (TMD) were evaluated at the start of each meso-cycle.
RESULTS:
Preliminary results: Significant correlations were found between testing parameters and the TL variables. Salivary cortisol was significantly correlated to CMJ performance ($r=-.86$, $p<0.05$), ITL ($r=-.87$, $p<0.05$), AC ($r=.66$, $p<0.05$) and block INT ($r=-.58$, $p<0.05$). CMJ performance was associated with ITL ($r=-.72$, $p<0.05$), AC ($r=-.55$, $p<0.05$) and weekly INT ($r=.55$, $p<0.05$). Subjective markers of recovery were significantly correlated to ITL ($r=.54$, $p<0.05$) and AC ($r=.61$, $p<0.05$). BP performance was strongly correlated to AC ($r=-0.98$, $p<0.01$). TMD did not provide significant relations with training parameters.
CONCLUSION:
The collected data suggests that subjective instruments, such as sRPE and a 4-item questionnaire, seem to be good means for assessing TL in offshore sailors. In terms of planning and programming, the use of AC analysis provides interesting insights for managing physical and physiological readiness.

PHYSICAL WORKLOAD INTENSITIES OF NCAA D-I AMERICAN FOOTBALL PLAYERS ON OFFENSE VS. DEFENSE DURING PRACTICAL DRILLS

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INTRODUCTION:
American football coaches prescribe so-called Team play (team) and Special Team (ST) practice drills to develop coordinated team play focused on offensive, defensive, or special team gameplay. Positions in football with similar physical demands have been grouped together previously to analyze their training load [1]. Monitoring training loads with microtechnology informs coaching staff on volume and intensity of training [2] and positional variations [1,3,4]. Positions on both sides of the line of scrimmage that oppose each other during practice drills (e.g., offensive linemen (OL) vs. defensive linemen (DL) in blocking drills; or wide receivers (WR) vs. defensive backs (DB) in passing drills) [1,4] may exert different physical workloads. The current study aimed to determine physical workloads of positions in American Football that oppose each other within practices.
METHODS:
From 12 weeks of the in-season period, a total of 36 practice sessions were captured during team and ST drills. Linemen and nonlinemen were classified by players' positions. Linemen included OL (n = 9) and DL (n = 12). Nonlinemen included WR (n = 11) and DB (n = 17). Positional demands from 49 collegiate (NCAA D-I) American Football players were recorded during in-season practice sessions (Vector; Catapult Innovations, Melbourne, Australia). High-intensity accelerations (High-IMA/min; efforts > 3.5m/s2) were used to assess non-running efforts of linemen players during drills. High-speed running (HSR/min; >12 mph) was used to assess running efforts of nonlinemen positions. The data were analyzed using linear mixed-effects models.
RESULTS:
DL had significantly more high-IMA/min than OL during ST drills (0.42 ± 0.51 vs. 0.15 ± 0.21; $p < 0.001$), and team drills (0.48 ± 0.56 vs. 0.22 ± 0.22; $p < 0.01$). WR HSR/min was significantly greater than DB during team drills (1.45 ± 2.33m vs. 2.84 ± 3.69m; $p < 0.01$), but not for ST drills.
CONCLUSION:

Results of the current study showed higher workloads for DL and WR than their direct opponents, OL and DB, respectively. Those findings were present especially in team drills, where the positions directly face each other. Results are in contrast to previous findings that state no difference in acceleration demands between OL and DL [3,4]. Further, results are consistent with previous findings that WR have higher running intensity demands compared to other nonlinemen positions (i.e., DB) [3]. Findings in this study illustrate the aggressive role of DL in ball pursuit efforts vs. the static defensive positioning of OL during team and ST drills. Further, during offensive play, WRs run towards DBs and then attempt to create space for ball movement downfield. The findings may be informative for team coaches to individualize physical workloads of practice drills for positional roles in preparation for game and practice demands.
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TEAMS RUNNING WITH BALL POSSESSION AND MAXIMUM SPRINTING SPEEDS HAVE GREATER SUCCESS AT THE END OF THE SEASON

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INTRODUCTION:
Over the last few years, load monitoring in team sports has evolved through the increasing use of electronic performance and tracking systems (Linke et al. 2018). Although the total running distance covered by professional soccer players has decreased, the distance covered at high intensity has increased (Pons et al. 2021). Thus, many researchers highlight that in modern soccer, players have become faster and perform more frequent sprints too, which is a crucial determinant of success (Andrzejewski et al. 2018). The aims of this study were (1) to determine the match running performance required by different teams based on their final ranking position and (2) to analyze the association between match running performance variables and teams' success at the end of the season.
METHODS:
A total of 1,224 match observations from professional soccer teams competing during two consecutive seasons in the German Bundesliga were analyzed. Match running performance parameters of all field players, excluding the goalkeepers, were analyzed. Match running performance parameters were collected using electronic performance tracking systems. In addition, the final ranking position and the total of points obtained by each team at the end of the season were registered for the analysis of the association between team success and match running performance.
RESULTS:
The main findings were that high ranked teams ran the greatest total distance (TD), sprinting distance (SPD), sprinting actions (SPA) with possession of the ball and maximal velocity (VMAX). Moreover, TD covered with possession of the ball and VMAX were the most important variables to predict the total of points obtained at the end of the season ($R2 = 0.7$).
CONCLUSION:
These findings may provide insights into the establishment of team performance profiles with the development of specific training drills, which may optimize playing style. Training programs for professional soccer players should be focused on improving the sprint capacity and running with possession of ball (e.g., transitional tasks and small-sided games). Moreover, this has implications for talent identification since today's soccer requires players who engage in repeated high-intensity actions, reach maximum speeds above 30 km/h, and develop technical coordination when running with the ball.
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INTERNAL AND EXTERNAL LOAD DEMANDS OF SMALL-SIDED RECREATIONAL TEAM HANDBALL GAMES IN POSTMENOPAUSAL WOMEN

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1:CIAFEL,FADEUP,PORTO,PT;2:SHSC-SDU,ODENSE,DK;3:SSHS-UE,EXETER,UK;4:SUS,SHANGHAI,CN;5:ST-FIGC,FLORENCE,UTV,ROME,IT;6:CIDESD,ISMAI,MAIA,PT;7:CIFI2D,FADEUP,PORTO,PT;8:PORTOSMEDCENTER,PORTO,PT

INTRODUCTION:
Recreational team handball is a high-attendance and low-risk exercise mode, that has shown positive effects in cardiovascular, metabolic and musculoskeletal health as well as in physical fitness of postmenopausal women (1,2). However, the specific demands of this type of exercise in postmenopausal women organized as small-sided games are not clearly described. Therefore, this study aimed to analyze the internal and external load demands of 4v4 recreational team handball matches in postmenopausal women without previous experience with the sport.
METHODS:
Internal load parameters, such as heart rate (HR), blood lactate and rating of perceived exertion (RPE) as well as external load parameters, namely distance covered and time spent at different locomotor categories (standing, walking, jogging, fast running and sprinting) were analyzed in ten postmenopausal women (61.6±7.4 years, stature 161.3±5.2 cm; body mass 67.0±10.5 kg; fat percentage 36.6±5.7%; VO2peak 25.6±3.9 mL/min/kg) during small-sided (4v4) recreational team handball matches performed in outdoor team handball courts (40x20 m, adjusted to give 35 m2 area/player). The matches were preceded by a standardized warm-up and were organized in 3x15-min periods interspersed by 2-min breaks. The goalkeeper changed every 3 min. External load parameters and HR were recorded during the matches. Individual speed for each locomotor category were determined by telemetric photoelectric cells. Maximal HR (HRmax) was determined as the highest HR value obtained either in a treadmill test until exhaustion, in the Yo-Yo Intermittent Endurance level 1 test or

in the matches (3). Blood lactate was randomly measured at the end of each period. RPE (AU, 0-10 scale) was assessed at the end of the matches.
RESULTS:
Total distance covered during a 1-hour recreational team handball session was 1778±363 m, with 1352±277 m being covered by walking (76±7%), 302±145 m by jogging (17±6%), 123±101 m by fast running (7±7%). Participants spent 39±11% of total match time standing, 54±10% walking, 5±2% jogging and 2±2% running fast. Mean HR was 143±12 b.min-1 (82±7% HRmax) with peak values of 162±12 b.min-1 (92±6% HRmax). HR was above 80% and 90% HRmax for 64±30% (29±13 min) and 27±24% (12±11 min) of total match time, respectively. Mean blood lactate was 2.6±0.7 mM (2.1-3.1) and RPE was 4.6±1.9 AU (3.1-6.0).
CONCLUSION:
Recreational team handball played as small-sided games (4v4) is an intermittent high-intensity exercise mode, with physical and physiological demands within the range of those found to have a positive effect on aerobic, anaerobic, and musculoskeletal fitness.
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This work is supported by national funding through the Portuguese Foundation for Science and Technology, I.P., under project UIDB/00617/2020-base and PhD grants (SFRH/BD/136789/2018; SFRH/BD/144132/2019).

OP-AP06 Fatigue

ACUTE EFFECT OF CONCURRENT RESISTANCE AND ENDURANCE TRAINING SESSION ON NEUROMUSCULAR FATIGUE AND HEART RATE RECOVERY

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INTRODUCTION:
Concurrent training (CT) consists of resistance training (RT) and endurance training (ET) in a unique session. The training content done first affects performance in the second content and likely the chronic adaptation to CT could be different. The countermovement squat jump (CMJ) height loss is used for monitoring the levels of fatigue during a training session (1). In addition, heart rate (HR) recovery is suggested to be a marker of physical fitness and used as a measure of training-induced disturbances in autonomic control, and it can be used to quantify the autonomic nervous system recovery after a high-intensity exercise (2). Therefore, the present study aimed to determine the acute effects of RT and ET contents of CT on CMJ height loss and HR recovery.
METHODS:
Eighteen active men participated in this study (age: 22.00 ± 2.03 yr; mass: 79.40 ± 10.01 kg; training hours/week: 6.61 ± 3.60 h/week). Each participant performed an endurance high-intensity session (six 30-s “all-out” interspersed by 15-s of passive recovery) before the resistance session (3 sets of 15 repetitions near failure of back squat with rest intervals of 45-s [1 repetition in reserve]) separated by a period of 5min of rest. In order to examine the acute effects of each exercise on neuromuscular and heart rate recovery, the CMJ height and HR were recorded before each exercise and 10s, 1min and 6min after. Prior each exercise, a 10min warm-up period was conducted.
RESULTS:
There was a significant increase of HR post-exercise (10s [179.32 ± 2.03 bpm], 1min [152.47 ± 3.00 bpm] and 6min [129.47 ± 2.72 bpm]) compared to pre-exercise (69.68 ± 2.91 bpm) in the endurance exercise ($p<0.05$), while in the resistance exercise it increased at 10s (178.95 ± 2.41) and 1min (146.10 ± 2.83) ($p<0.05$), but at 6min (125.68 ± 2.20) it was already similar to pre-exercise values (121.74 ± 5.41 bpm). Regarding the CMJ heigh loss, there was a significant decrease ($p<0.001$) in all post-exercise measurements (26.76 ± 1.36, 28.39 ± 1.55 and 32.86 ± 1.39 cm, for 10s, 1min and 6min) after the endurance exercise compared to pre-exercise (37.11 ± 1.28 cm). However, after the resistance exercise there was a decrease only after 10s (31.40 ± 1.23 cm) and 1min (33.26 ± 1.33 cm) post-exercise ($p<0.001$), but not at 6min (35.97 ± 1.25 cm) compared to pre-exercise (36.16 ± 1.32 cm).
CONCLUSION:
Neuromuscular fatigue is recovered at 6min after a resistance exercise but not after an endurance exercise during a concurrent training (endurance-resistance sequence). Heart rate seems to recover later after resistance exercise possibly due to residual cardiovascular effect of the previous endurance exercise.
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VOLUME VERSUS INTENSITY PROGRAMME TRAINING FOR A HALF-MARATHON: HAEMATOLOGICAL AND BIOCHEMICAL PARAMETERS IN MIDDLE-AGED WOMEN

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INTRODUCTION:
Half-marathon race is very popular among recreational runners with the most important increases in participation in the last years among the middle-aged population group and in women [1]. Over the last decade, researchers have evaluated different plasma markers and hematological parameters after a half-marathon run, by most were focused on young males. The aim of our study was to determine the effects on haematological and biochemical plasmatic markers in middle-aged recreational females who prepared a half-marathon with two different training programmes
METHODS:
Twenty women (40±7 yr) followed two different training schedules: moderate intensity continuous training (MICT), based on running volume at intensities below 80% VO2max, and high intensity interval training (HIIT), with less volume ran at 80%-100% VO2max combined

with uphill running and resistance training. Haematological parameters, plasma osmolality and several plasmatic markers of metabolic status, muscle damage, inflammatory and oxidative stress were measured at the beginning (S1) and end (S2) of the training and 24h after finishing a half-marathon (S3)
RESULTS:
With few exceptions such as for some haematological parameters and plasma osmolality, both training programmes had similar moderate effects at S2. However, the acute response after the half-marathon (S3) induced different alterations depending on the training programme. We found significant decreases in plasma total protein and albumin concentration ranging from 24% to 30% in MICT and from 11% to 17% decreases in HIIT. Total cholesterol was reduced by 30% (MICT) and 16% (HIIT), while LDL decreased by 36% in MICT and 24% in HIIT. More consistent differences were found in HDL and TAG levels, with statistically significant decreases of 10% in HDL and 40% in TAG in MICT that contrasted with a lack of significant changes in HIIT. Creatine kinase (CK) and C-reactive protein (CRP) levels in S3 were significantly elevated compared to S1 and S2. Moreover, the levels of both markers were significantly higher in MICT than in the HIIT in S3. MICT also showed greater variability in S3 values with higher interquartile ranges than HIIT for all markers of muscle damage and inflammation
CONCLUSION:
The acute response to the half-marathon, measured after 24 hours (S3), induced a temporary state of fatigue-related alterations in recovery and stress reflected in blood markers of metabolic status and muscle damage. It was notable that differences existed depending on the training adopted. HIIT, that incorporated strength exercises based on body weight, led to better adaptation to competition probably due to repeated exposure to higher oxygen consumption and the activation of anaerobic metabolism during the intense bouts of eccentric exercise. Finally, a greater variability in MICT in S3 for some plasma markers suggests a different inter-individual variability in the response to training

IS THE AMPLITUDE OF SURFACE EMGS EQUALLY DISTRIBUTED ON DISTINCT PECTORALIS MAJOR REGIONS DURING DIFFERENT INCLINATIONS OF THE BENCH PRESS EXERCISE?

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INTRODUCTION:
Contradictory findings have been reported regarding the effect of the bench press inclination on the pectoralis major (PM) excitation pattern [1,2]. This lack of consensus could arise from non-physiological sources, such as the innervation zone location and its shift [3], often disregarded when the conventional bipolar configuration is applied. To control these issues, here we used high-density surface EMG to investigate whether different PM regions are excited during the flat and 45° inclined bench press exercises.
METHODS:
Eight healthy males were asked to perform four exercises at random order and with 5 min rest in-between: (i) flat bench press at 50% of 1 repetition maximum (RM); (ii) flat bench press at 70% of 1 RM; (iii) inclined bench press at 50% of 1 RM; (iv) inclined bench press at 70% of 1 RM. A linear array of electrodes positioned parallel to the sternum and ~2 cm medially from the IZ location was used to collect single-differential EMGs from 15 regions along the PM cranio-caudal axis. The barbell vertical position was quantified, and individual eccentric and concentric phases were respectively identified from local maxima to local minima and vice versa. The range of motion and the cycle duration were calculated from the barbell vertical position to assess the within-subject consistency across cycles. The number of channels detecting the largest EMGs amplitude (i.e., active channels), their interquartile range and their barycentre coordinate were assessed, separately for each exercise phase, to characterise the EMG amplitude distribution within PM.
RESULTS:
No significant differences in the range of motion ($P>0.11$) and cycle duration ($P>0.28$) were observed between the two bench press inclinations. Considering all participants performed consistently similarly the bench press exercises, group results of active channels and barycentre were averaged across cycles, separately for each load intensity and exercise phase. There were no significant differences in the number of active channels ($P>0.05$) and interquartile range of active channels ($P>0.39$) when comparing the two bench press exercises. Conversely, the barycentre shifted from the PM sternocostal region towards to the clavicular region ($P<0.001$) when the bench press changed from flat to 45°.
CONCLUSION:
Our key findings revealed that: i) EMG amplitude values distributed differently along the PM cranio-caudal direction between the two exercise variants; ii) greatest EMG amplitude values were concentrated at the PM sternocostal and clavicular heads when exercising in the flat bench press and 45° inclined bench press, respectively. These results suggest the same exercise, performed with different postures, demand the excitation of different PM regions.
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MUSCLE FATIGUE AND FATIGABILITY FOLLOWING CONTINUOUS AND INTERMITTENT PLANTAR FLEXORS CONTRACTIONS

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INTRODUCTION:
Muscle fatigue is defined as any exercise-induced reduction in the ability to generate muscle force or power (1) and is generally quantified as the decrease in maximal voluntary contraction (MVC). Muscle fatigue is known to be task-dependant. Hence, many studies investigated muscle fatigue induced by various types of exercises. For instance, voluntary isometric contractions performed continuously (CON) at different submaximal intensities and until task failure (TF) lead to similar muscle fatigue (2). Similarly, intermittent contractions (INT) performed at 30, 45 and 60% MVC until TF induce the same muscle fatigue (3). Therefore, it might be hypothesized that these two exercise modalities, executed until TF, lead to similar muscle fatigue. To test this hypothesis the present study aims to compare the impact of CON and INT contractions, performed until TF, on muscle fatigue and fatigability (ability to maintain a high level of torque).
METHODS:
Sixteen healthy volunteers participated in two experimental sessions. Subjects sustained a 1-min MVC of the ankle plantar flexors (PF) before (pre) and after (post) fatiguing exercises performed at 40% MVC, until TF. These exercises consisted of CON or INT (15s on/5s off)

isometric contractions. Muscle fatigue was quantified by the MVC loss while muscle fatigability was assessed by the torque loss during the sustained 1-min MVC. Percutaneous electrical nerve stimulations (doublet at 100 Hz) were delivered at rest and superimposed to the 1-min MVC, in order to discriminate the nervous (voluntary activation, VA) and muscular (potentiated doublet) alterations induced by the fatiguing exercises.
RESULTS:
A similar MVC loss was obtained after both fatiguing exercises (CON = 27.4% MVC pre vs. INT = 24.8% MVC pre; p>.05), despite a greater muscle workload for INT compared to CON (58737 Nm·s vs. 17966 Nm·s, p<.001, respectively). Also, VA and potentiated doublet were reduced to a similar extent after both fatiguing exercises (10.1% and 13.8 % respectively). On the contrary, solely for the CON, the torque loss during the 1-min MVC was significantly greater post exercise (pre = 38.2 % MVC, post = 53.9% MVC, p<.001). In the same way, also the VA loss during the 1-min MVC was greater only after the CON exercise (pre = 3.4% vs. post = 13.1%, p<.01), whereas the potentiated doublet loss during 1-min MVC was unchanged.
CONCLUSION:
In accordance with our hypothesis, INT and CON PF contractions performed at moderate intensity and until TF induce a similar amount of muscle fatigue, with akin nervous and muscular contributions. On the other hand, the more pronounced muscle fatigability observed after CON exercise could be mainly attributed to nervous factors. The different evolution of these two parameters proves that fatigability is a paramount aspect to provide a more detailed description of neuromuscular alterations generated by a fatiguing exercise.
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THE EFFECT OF EXERCISE-INDUCED FATIGUE ON THE GABAERGIC INPUT IN STRIATUM

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INTRODUCTION:
Exercise-induced fatigue (EF) is a reduction in maximal voluntary muscle force that results from intense and prolonged exercise (1). It is common in sports competition and training, and long-term EF is harmful to physical and mental health. In our previous study, we had found that the corticostriatal long-term potentiation (LTP) and long-term depression (LTD) were both impaired, the concentration of Glu in the striatum was increased and the frequency of spontaneous excitatory postsynaptic current (sEPSC) was increased after EF, which means that the glutamatergic input activity in the striatum was increased after EF (2). However, the effect of EF on the GABAergic input in the striatum is not well known. The aim of this study is to explore the changes of GABAergic input in the striatum afer EF.
METHODS:
Adult male C57BL/6 mice were randomly divided into two groups: control mice (Control) and exercise-induced fatigue mice (EF). EF mice were forced to run on an electric treadmill until fatigue daily for seven consecutive days, while control mice did not perform the treadmill exercise. High performance liquid chromatography (HPLC) was used to examine the concentration of GABA in the striatum. Whole-cell patch clamp was used to record the spontaneous inhibitory postsynaptic current (sIPSC) and miniature inhibitory postsynaptic current (mIPSC) of MSNs in two groups.
RESULTS:
Compared with control mice, the concentration of GABA was increased significantly ($P < 0.05$) in EF mice. The frequency of sIPSC was increased ($P < 0.05$), and the amplitude of sIPSC was also increased in EF mice ($P < 0.01$). Similarly, both the frequency ($P < 0.01$) and amplitude ($P < 0.001$) of mIPSC were increased in EF mice. The results suggest that the concentration of GABA in the striatum is increased, the probability of presynaptic GABA release and the function of postsynaptic GABA receptors are both increased in EF mice.
CONCLUSION:
After EF, the GABA concentration in the striatum was increased, the probability of presynaptic GABA release was increased and the function of postsynaptic GABA receptors was improved, resulting in the increased GABAergic input in the striatum. The enhancement of GABAergic inhibitory input activity in the striatum may be a central protective mechanism after EF.

ACUTE METABOLIC AND MECHANICAL RESPONSES TO DIFFERENT VELOCITY LOSS THRESHOLDS IN RESISTANCE TRAINING WITH BLOOD FLOW RESTRICTION

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INTRODUCTION:
The use of blood flow restriction resistance training (BFR-RT) has experienced a noteworthy increase due to the great exercise-induced adaptations related to muscle hypertrophy and strength (Lixandrao et al, 2018). Besides, BFR-RT has been commonly used with light loads until muscular failure (Patterson et al, 2019). However, the acute effects of BFR-RT using moderate loads and inducing different degrees of fatigue within the set have not been studied yet. For that, the aim of this study was to analyze the mechanical and metabolic responses of two BFR-RT in the full-squat (SQ) exercise with different velocity loss (VL) thresholds (20% vs. 40%).
METHODS:
Twenty strength-trained men (n=20) took part in this randomized cross-over research design. After a standardized warm-up without occlusion, subjects performed 3 SQ sets at 60% 1RM with 2 min rest between sets with a 50% of individual arterial occlusion pressure. Both protocols differed in the VL threshold allowed within each set (VL20 vs. VL40). In order to analyze the acute mechanical and metabolic responses to both protocols, the following battery of test was performed: 1) blood lactate concentration; 2) countermovement jump (CMJ); 3) maximal isometric force (MIF) in SQ at a 90º knee angle and 4) velocity against the 60% 1RM load (V60) in SQ.
RESULTS:
Significant “protocol x time” interactions ($p<0.001$) were observed for lactate concentration, CMJ height, and V60. Moreover, significant “time” and “protocol” effects were found for all variables analyzed ($p<0.001$-0.05). In addition, VL40 induced a significant higher fatigue (i.e. higher lactate concentration and performance impairments) in all variables ($p<0.001$) compared to VL20. Both protocols resulted in significant changes ($p<0.001$) a in blood lactate concentration, CMJ, MIF and V60.

CONCLUSION:
Despite both levels of fatigue induced responses in all variables, a 40% VL threshold provoked higher acute metabolic and mechanical stress than a 20% VL magnitude in the SQ exercise with BFR implementation.
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OP-AP07 Statistics and Analyses of Sports

MISLEADING CONCLUSIONS BASED ON STATISTICAL SIGNIFICANCE AND NON-SIGNIFICANCE AT THE 2020 ECSS CONFERENCE

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INTRODUCTION:
Conclusions about effect magnitudes based on statistical significance and non-significance may sometimes be misleading, since rejection or failure to reject the nil hypothesis does not necessarily imply that an effect is respectively substantial or trivial relative to a smallest important effect magnitude. I have therefore assessed such conclusions in a sample of 33 presentations relevant to athletes at the 2020 annual meeting of ECSS.
METHODS:
I used rejection of non-substantial and substantial hypotheses as decisive evidence for substantial and trivial effects respectively, assuming sampling variation was the only source of uncertainty. I chose smallest important magnitudes and alphas (p-value thresholds) for the hypothesis tests that are appropriate for effects on athletes. I also used magnitude-based decisions (MBD), in which hypothesis-test p values are interpreted as reference-Bayesian probabilities of magnitudes (e.g., likely substantial). I assessed all significant and non-significant effects that had sufficient data to calculate p values.
RESULTS:
Significance was presented as substantial and non-significance as trivial in at least 90% and 74% of presentations respectively. Of 32 assessable significant effects, only 18 (56%) were decisively substantial (rejection of a non-substantial hypothesis, pN+<0.05 or pN-<0.05), while three were actually decisively trivial (rejection of both substantial hypotheses, p+<0.05 and p-<0.05). Of 19 assessable non-significant effects, none (0%) was decisively trivial. MBD provided usefully nuanced probabilistic assessments of magnitude, especially for those clinically relevant effects where the hypothesis of harm but not of benefit was rejected (pH<0.005, pB>0.25; most unlikely harmful, possibly beneficial).
CONCLUSION:
There was an unacceptably high prevalence of misleading assessments of magnitude based on statistical significance and non-significance at this conference. Researchers should account for sampling variation by replacing the nil-hypothesis test with tests of substantial and non-substantial magnitudes or preferably magnitude-based decisions.

THE USE OF WEARABLE DEVICES FOR RUNNING GAIT ANALYSIS: A SYSTEMATIC REVIEW

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INTRODUCTION:
Running gait assessment has traditionally been performed using subjective observation or expensive laboratory-based objective technologies, such as 3D motion capture or force plates. However, recent developments in wearable technology allow for continuous monitoring and analysis of running mechanics in any environment. Objective measurement of running gait is an important clinical tool for injury assessment and provides metrics that can be used to enhance performance. Therefore, the aim of this systematic review was to identify how wearable devices are being used for running gait analysis in adults.
METHODS:
A systematic search of literature was conducted in the following scientific databases: PubMed, Scopus, WebofScience, and SportDiscus. Information was extracted from each included article regarding the type of study, participants, protocol, wearable sensor(s), main outcome measures, analysis, and key findings.
RESULTS:
A total of 132 articles were reviewed: 17 focused solely on validity and/or reliability of the sensors and 66 focused on applied use. Most studies used inertial measurement units (IMU) (53) or accelerometers (64), with 26 using pressure insoles. Sensor locations were distributed among the shank, foot, and the waist/lower back/pelvis. The mean number of participants was 27 (± 33), with an average age of 27.7 (± 7.4) years, with only 4 studies examining solely female participants. Most studies took place indoors, using a treadmill; performed retrospective group-based analyses, with the main aims seeking to identify running gait characteristics, determine injury status, investigate experience level on running gait or characterise the effects of fatigue. Generally, wearable devices were found to be valid and reliable tools for assessing running gait compared to reference standards.
CONCLUSION:
Despite the advancements in wearable-specific metrics for running gait analysis, there is a need for prospective, subject and sub-group specific investigations that analyse running gait over prolonged periods, among larger numbers of participants, and in natural running environments. The development of multi-modal wearable technology to give a more comprehensive analysis of running gait would further aid analysis outside of the laboratory. Furthermore, consensus regarding terminology, testing validity and reliability of devices and suitability of performance metrics needs to be established. Recommendations for future studies examining wearables for running gait assessment are provided and discussed.

ILLUSTRATING CHANGES IN LANDSCAPES OF PASSING OPPORTUNITIES ALONG A SET OF COMPETITIVE FOOTBALL MATCHES

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INTRODUCTION:
Within a football match, passing opportunities emerge, persist, and dissolve within a limited space-time window, and greatly depend on the players' interactive behavior. This rich set of individual and environmental constraints that can arise in a football match influences the availability of a diverse set of potential actions, which can be conceptualized as a landscape of potential actions. Therefore, this study aims to illustrate the landscape of passing opportunities of a football team across a set of competitive matches.
METHODS:
To create these landscapes player's positional data of 5 competitive football matches was used. Ball carrier, potential receiver and closest defenders relative positions defined the polygons that identified passing opportunities. These opportunities were divided into three types depending on the hypothetical threat they may pose to the opposing defense (penetrative, support, and backward passes). These categories were used to create three heatmaps per match. However, characterizing a football match in terms of passing opportunities with a single heatmap dismisses the dynamics that occur throughout a match. Therefore, three temporal heatmaps over windows of 10 minutes were presented highlighting on-going dynamical changes in pass availability. Moreover, the mean time of passing opportunities was calculated and compared across matches and for the three categories of passes.
RESULTS:
Due to the specificity of player's interactive behavior, results showed heatmaps with a variety of patterns. The fifth match was the most dissimilar compared with the other four. Results also displayed that penetrative passes were available over shorter periods of time than backward passes, which in turn were available over shorter time than support passes. The temporal heatmaps displayed how differences evolve over the first half of one of the matches, where passing opportunities decreases as the time of the first half evolves.
CONCLUSION:
This landscape model showed sensitivity to different task constraints that emerge within football matches. Specifically, the model is sensitive to variables that express the threat generated by the offensive team, as penetrative passing opportunities were available for shorter periods than the other passes. Although this model still needs to improve in its accuracy, at the current state it can provide suitable insights regarding the dynamics of passing that opportunities that are created during football matches.

CHARACTERIZING THE PLAYING STYLES OF THE STRIKERS IN CHINESE FOOTBALL SUPER LEAGUE BASED ON PLAYER-VECTOR

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INTRODUCTION:
Characterizing playing style is primarily important for football clubs on scouting, monitoring and match preparation. Although there have been attempts to analyze the playing style of teams, few studies have focused on that of players. Previous studies considered a player's style as a combination of technical performances, failing to consider the spatial information of individual action. Therefore, the study was aimed to characterizing the playing styles of strikers in Chinese Football Super League matches, integrating a recently player-vector framework.
METHODS:
Data of all 960 matches from 2016-2019 CSL where 22 teams competed were provided by OPTA Sports. Match ratings, and five types of match events (shooting, crossing, dribbling, passing and heading) with the corresponding x/y coordinates for all the players whose on-pitch time exceeded 60 minutes were extracted from the raw data. To analyze the playing style, the Player-vector was constructed for each player in each match based on an unsupervised learning framework using Nonnegative Matrix Factorization (NMF). Another NMF process was acted on the Player-vectors of the strikers to extract different types of playing styles and the similarity between a striker's playing style and these representative styles. The most similar style was considered as the playing style of an individual striker in a specific match. Appear numbers (N), win/loss ratio (W/L) and average match ratings (R) of each style were calculated to compare their contributions. Each playing style was defined referring to a well-known sport video game—Football Manager.
RESULTS:
The NMF processes generated a Player-vector of 23 dimensions and a Style-vector of 4 dimensions. The CSL strikers were classified into 3 playing styles: Poacher (preference for close shot and front header), Second Striker (preference for long Shot, center Dribble and center Pass) and Mobile Striker (high preference for L/R shot, L/R backline cross, L/R flank dribble and L/R flank pass). Among a total of 1979 observations, the best rated style was Poacher (N=465, W/L=0.95) with an average rating of 7.32±0.97, followed by Mobile Striker (R=7.26±0.97, N=614, W/L=1.01) and Second Striker (R=7.22±0.89, N=900, W/L=0.94).
CONCLUSION:
This study revealed that almost half of the Strikers (Second Striker) in CSL tended to move deep into the midfield to help teams' organizing, which was further evidenced by the lower W/L ratio: the teams were facing unfavorable match situation. However, unlike the Second Strikers, Poachers were required to focus on the most important task in football: putting the ball in the back of the net, which explained their highest average rating. Moreover, Mobile Strikers with the highest W/L were inclined to play on the flanks and to cut into the middle, implying that assigning best strikers to play on the flank may be a potential key to goal-scoring. Knowledge gained from the study would be helpful for player recruitment and the construction of the CSL teams' attacking line.

DIFFERENCE OF REFEREES' PHYSICAL PERFORMANCE WITHIN DIFFERENT MATCH LEVELS IN CHINESE FOOTBALL SUPER LEAGUE

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INTRODUCTION:
Refereeing football match is a challenging task that necessitates correct decision-making based on the rules of game and fast recognition of ongoing behaviors. In order to guarantee fair gameplay and actual performance of players, referees are expected to keep up with the

match pace and to achieve appropriate physical performance. The purpose of this study was to explore how referees' physical performance and distance to the ball were influenced by different Chinese Football Super League (CSL) match levels.
METHODS:
Data of 108 matches completed by top-4 ranked and bottom-4 ranked teams from 2018 and 2019 CSL seasons were collected and provided by Amisco tracking system. All teams ranking were determined using their end-of-season rankings. Levels of matches were classified into three groups: a. upper-ranked (top-4) teams against top-4 oppositions, b. top-4 against lower-ranked teams (bottom-4), and c. bottom-4 against bottom-4. Twenty-five variables related to the main referee's physical and spatial performance were extracted from the original data: distance of fast running (17-21km/h), high speed running (21-24km/h), and sprinting (+24km/h); numbers of sprint, high speed and fast running; average recovery time of sprint and high speed; and Euclidean distance to the ball during different game events. A Kruskal-Wallis H-test and one-way ANOVA were used to examine the statistical difference of referees in these variables among different match levels ($p < 0.05$), with the significance level of ANOVA adjusted following a pos-hoc Scheffe test.
RESULTS:
Distance run when the ball is in play was the only physical-related variable that was statistically different among three match levels ($p=0.04$, Effect Size (ES)=0.07). The Euclidean distance to the ball at the following three events were statistically different among three match levels: clearance ($p=0.03$, ES=0.0009), running with ball ($p=0.01$, ES=0.0002) and shot not on target ($p=0.04$, ES=0.003). Results of post-hoc test showed that they covered more distance when ball is in play ($p=0.04$, $d=0.65$) while referring top-4 against bottom-4 matches (7.2±0.7 km) than that of bottom-4 against bottom-4 (6.8±0.7 km). And they kept a closer distance while meditating top-4 against bottom-4 matches than that of bottom-4 against bottom-4 when there were shot not on target (median difference=-0.7m, $p=0.04$, $r=0.06$) and running with ball (median difference=-0.1m, $p=0.01$, $r=0.01$).
CONCLUSION:
The current findings indicated that although CSL referees showed no obvious difference in physical performance when officiating matches of three competitive levels, distinct rhythms of competitions determined that they needed to adjust running strategies so as to maintain proper distance to the ball. Such phenomenon was further evidenced by the fact that they stayed closely synchronized with the ball during critical events. Future study is suggested to evaluate their spatial-temporal relationships with decision-making outcomes intervened by video assistant referee.

SPECIFIC ON-COURT PERFORMANCE IN ELITE MALE ADOLESCENT TEAM HANDBALL PLAYERS

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INTRODUCTION:
In team handball the selection of the best young players is a fundamental process in several national federations, clubs and academies; however, literature-addressing knowledge about the specific on-court performance in team handball is almost nonexistent. Consequently, the aim of the study was to assess and compare the team handball specific on-court performance in elite male team handball players of different age.
METHODS:
Twelve under-23, ten under-19, ten under-17 and ten under-15 elite male players were recruited from a leading club of the German Bundesliga including a professional team handball academy. All subjects performed a game based performance test during the second part of their preparation phase. In the game based performance test oxygen uptake, heart rate, sprinting time in defense, offense, fast break and fast retreat as well as ball velocity and jump height in the jump shot were measured.
RESULTS:
Significant differences between under-23, under-19, under-17 and under-15 players were found for body height ($P<.001$) and weight ($P<.001$), absolute peak oxygen uptake ($P<.001$), offense ($P<.05$) and defense time ($P<.001$), fast break acceleration ($P<.05$) and throw time ($P<.05$) as well as jump height ($P<.001$) and ball velocity ($P<.001$) during the jump shot in the game based performance test.
CONCLUSION:
In conclusion, our results indicated that with increasing age male elite team handball players are heavier and taller (body weight and height), faster (team handball offense, defense and fast break), jump higher and throw faster (in the team handball jump shot), and have a better aerobic performance (absolute peak oxygen uptake). We suggest that specific tests like the game based performance test are important in the selection process of young team handball players. The better performance in the under-23 and under-19 players, compared to elite male adult players in a previous study demonstrated the necessity of a high specific on-court physical performance to become a top-elite player in team handball.

MULTIVARIATE ANALYSIS OF FEMALE HANDBALL OFFENSIVE PERFORMANCE DURING EXCLUSIONS AT THE EURO 2018

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INTRODUCTION:
The handball regulations changed in 2016 allowing teams to play with empty net any time (goalkeeper as an outfield player). Playing under numerical inferiority in attack, as a consequence of exclusions, could then be turned back to equality in the number of field players when substituting the goalkeeper out for a field player. Team's performance during exclusions has an effect on the match outcome (Saavedra, Borgeirsson, Kristjánsdóttir, Chang, and Halldórsson, 2017), and under this context of match-play, multivariate models can be applied to investigate in depth the offensive performance during this specific scenario (Gómez, Moral, and Lago-Peñas, 2015). Then, the aim of the present study was to analyse the impact of offensive performance during exclusions on match outcome at the female handball Euro 2018.
METHODS:
The sample was composed of 1,173 attacks during exclusion situations from the Female Euro 2018 (n=47 matches). Observational methodology procedures were followed for collecting data. The binary logistic regression and classification tree (Exhaustive CHAID) multivariate models were used to identify the best predictor variables for the match outcome.
RESULTS:
Results showed that 1,173 ending actions as a consequence of exclusions took place during the tournament (652 in conditions of superiority and 521 in conditions of inferiority). Results from binomial logistic regression emphasized that ranked among the best 4 teams is directly linked with the match outcome. The CHAID results identified winning teams as those who finished in goal their attacks during exclusions

when playing in the last stage of the tournament. Losers tend to play with empty net during inferiority situations of the main round stage matches (similarly than Gümüs and Gencçoglu, 2020). Additionally, losers who did not go through the group stage were associated to play with 1 pivot or no-pivot when the difference in the score was of 4 or less goals. The identified trends allow coaches to improve strategic plans involving a specific context when training exclusions scenarios.
CONCLUSION:
Winning teams who reached the games for the 1st to 4th final positions have a better attack efficacy ending in goal their attacks during exclusions in semifinal and final matches. Losers, while being in inferiority, tends to play with empty net during groups and main round phases, but did not make it to the semifinals.
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ANALYZING THE BMX SUPER CROSS WORLD CUP

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INTRODUCTION:
BMX Super Cross races take place on race track with a starting hill, an overall length between 300 and 400 meters and it needs to contain at least three (full) turns. Given the fairly lose regulations regarding the details of the track, the racing times of different locations differ significantly. However, races are finished in less than 50 seconds and given the low racing times, there is a need for measuring the time with an accuracy of a millisecond using transponder technology that is attached to the bicycles.
There are at least four locations of a track where the times are measured during a world cup race:
- at the bottom of the starting hill,
- at the second turn,
- at the finish line.
Unfortunately, the exact positions of the time measuring devices are neither uniform across locations nor specified exactly for each location. Thus, it might even happen that the positions change between two events of the same location. For the analysis described in this submission it has been assumed that the positions of the time measuring devices did not change.
METHODS:
The question in focus was whether there are groups of similar athletes and whether the characteristics of the athletes can be described as simple rules. The grouping question has been tackled with simple k-means clustering first, before proceeding to an artificial neural network approach with so-called Self Organizing Maps (SOM) as introduced by Teuvo Kohonen. The segmentation was computed for each location and the search was initiated with a maximum of 50 segments.
To identify the "significant" properties of a segment, a tree classifier was used to "predict" the cluster label. In a subsequent step, the rules were extracted from
the tree model. Since the rule contain redundant conditions, the rules are reduced after the extraction to be more readable for human beings.
RESULTS:
The data that has been used as the basis for this analysis is publicly available at www.bmx-results.com. For the described analysis results we used the data from
2017, 2018, 2019, and 2020 and RapidMiner Studio on top of a PostgreSQL database to apply the data mining methods. The data had to be extracted and transformed in a uniform schema first because the different locations used different data schemas in the past. As a result we were able to use the data of 143 athletes and 13,329 race participations of 7 locations.
Due to limited space, we cannot present the detailed results in this abstract. As an example we might look at rule for the top segment in Zolder:
Athletes who need less than 16.096 seconds from the bottom of the starting hill to turn 2 are in the top segment.
The second segment needs between 16.096 seconds and 16.295 seconds but has additional conditions regarding the starting hill and the final part.
CONCLUSION:
The results of this data science project are used to identify "types" of athletes as well as "target times". They can also be used to verify assumptions regarding the importance of certain training efforts.

TENNIS SHOT CLASSIFICATION USING A WEARABLE AND NEURAL NETWORKS

HOLLAUS, B.

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INTRODUCTION:
Sports has become increasingly data driven. Decision making, training, scouting and more rely heavily on data and its analysis. Tennis is no exception, but currently only elite athletes have access to technology that enable data driven approaches. Nevertheless, non-elite athletes like to have feedback on their performance (Gallardo, 2020; Aroganam, 2019). Therefore, the goal of this project was to provide a system that allows all tennis athletes to gather highly accurate data on their shot types in tennis so they can use data driven approaches.
METHODS:
Classification tasks in tennis have been approached with neural networks in recent years (Edelmann-Nusser, 2019). The main shot types are the serve, backhand and forehand (classes S, B, F). Top spin and slice are common variants of the main shots, which would lead to five shot types (classes S, BS, BT, FS, FT). The experiment was designed, so data could be recorded for each shot. This was done with a wearable device (preconfigured STEVAL-STLKT01V1, as Hollaus, 2020) on the wrist of the racket arm leading to 3D accelerations and spin rates with 1kHz, 3D magnetic flux densities with 100Hz and audio data with 8kHz. Each sample of the dataset contained 1 seconds of data. After the

data was gathered, it was labeled as one of the aforementioned classes. A total of 5682 tennis shots served as dataset in the training of the neural network. The dataset was split into four folds with a stratified K-Fold cross validator approach. Ranger was used as the optimizer together with a categorical crossentropy loss function. Two network architectures have been tested (a residual network (ResNet) approach and a fully connected network (FCN) approach). Both used convolutional layers. The architectures have been configured with the three main shot types as output classes, but also for the aforementioned five output classes.
RESULTS:
The F1 score for FCN and ResNet configured for the three main shot types is in the range of 93 to 98%. Using the configuration with five shot types both networks have high F1 scores in the range of 92 to 97% for the shot types S, Bt and FT. The F1 score is 80% for the BS and 72% for FS. Both architectures are well suited for the classification task with the ResNet having a slightly better performance.
CONCLUSION:
Using a neural network approach to classify tennis shots lead to highly accurate classifications. Therefore, a data driven approach can be used to further optimize the sport. The system enables logging of successful and unsuccessful shot sequences, strength and weaknesses, fatigue monitoring and many more things.
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DISTRIBUTION OF EFFORT IN THE WOMENS 800 METERS AT THE EUROPEAN ATHLETICS CHAMPIONSHIPS TORUN 2021

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INTRODUCTION:
The 800 meters event is a middle-distance event. Despite this, it is a competition where speeds are high and in which aerobic and anaerobic metabolism are combined, being the first the predominant, but where the second one has a great relevance. In an indoor championship, the competition takes place on an indoor track with 200 meters of length, and the athletes compete on their own lane until they pass the first curve, where they must take all the same lane. It is an event where the regulation of effort and intensity is essential. herefore, the objective of this study is to describe the importance of the position during the competition and the split times to get the best final result.
METHODS:
The womens 800 meters competition of the 2021 Torun Indoor Athletics World Championships was analysed. Have been included all the athletes participating in the championship (n = 58) and is divided into 3 groups: heats, semi-finals and final, that are distributed in 6 heats (n = 34), 3 semi-finals (n = 18) and a final (n = 6). Official data has been obtained from the European Athletics Federation. The variables analysed are final time (s), time of each 100 m partial (s), partial time of every 100 metres split (s), position every 100 meters (n), qualified for next round (YES / NO) and number of changes in position during the race. Anova, linear regression and Chi-square and test of contingency tables were performed. Post-hoc test of Bonferroni and Tukey were also applied. All data was analysed with the statistic software JASP 0.14.1.
RESULTS:
Mean final time (s) was 2'05''76 ±2,40, 2'04''40± 1,40, 2'04'',75± 1,274, for heats, semi-finals and final respectively. Significant differences were found between a better split time in every 100 m (s) and the final time in heats (s) 100(R 0,564, p<0,001), 200 (R 0,564, p<0,001), 300 (R 0,541, p<001), 400 (R 0,536, p<0,01), 500 (R 0,612, p<0,001) y 600 (R 0,672, p<0,001). For semi-finals only one split was significant 700 (R 0,787, p<0,001) and for the final 3 different splits were found 500 (R 0,857, p<0,05), 600 (R 0,918, p<0,001) and 700 (R 918, p<0,01).
No significance was found between changes in position or between the number of times the athlete was in first position and be qualified for next round in none of the groups.
CONCLUSION:
There is no single effort distribution strategy and the temporal distribution are unique for each athlete. Otherwise, in the heats it becomes more important to being in the first places during the competition, but not during the semi-final and final. Moreover, changes in position during the race are not decisive but faster splits between 400-500 metres and a better position seems to be a good strategy to achieve a better result.
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AERODYNAMICS SIMULATION OF SKI-JUMPING CONSIDERING DYNAMIC POSTURE CHANGE IN ALL PHASES OF THE JUMP

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INTRODUCTION:
The ski jump is a type of dynamic winter sports game and consists of four phases: run-in, take-off, flight, and landing. The overall flight distance of a jump is strongly influenced by the aerodynamic forces on the jumper in all four phases of the jump. Therefore, optimizing the drag and lift forces on the jumper in all four phases of the jump is key to success.
In recent years, computational Fluid Dynamics (CFD) has been used to analyze the aerodynamics of ski-jumping. However, to the best of our knowledge, there is no study in the literature that considers all four phases of the jump in a unified analysis. The main purpose of this study is to investigate aerodynamic characteristics and detailed flow-field from take-off to landing by using CFD methods. In particular, we focus on the influence of the ground effect on the aerodynamics just before landing.
METHODS:
In order to reproduce the real-world jumper kinematics in our simulation, experiments were carried out with professional athletes to capture their motion kinematics. This measurement was performed using a suit fitted with inertial sensors and a global navigation satellite system (GNSS). The inertial sensors enable detailed tracking of the jumper's body motion, and the GNSS sensor was used to obtain the velocity of the jumper's translation. The motion data captured with the inertial sensors was coupled with the jumper's 3 D model and used as input for CFD simulation.

Furthermore, the velocity of the jumper's translation obtained from GNSS was used as inlet flow velocity in the numerical analysis. For the CFD simulations, an in-house solver, CUBE, was used which solves continuity and Navier-Stokes equations using a finite volume method. the solver is based on a hierarchical Cartesian meshing technique called the building cube method (BCM) which enables efficient large-scale parallel simulations. In order to model the complex motion of the jumper an immersed boundary method was used.
RESULTS:
The CFD simulations were used to obtain the aerodynamic characteristics in each phase of the jump. An interesting finding is the fact that the lift force increases before landing due to the ground effect. A careful observation of the flow field reveals separation zones around the jumper's back is related to the increase in lift force before landing. Further details of the aerodynamic characteristics of the jump will be presented.
CONCLUSION:
In this study , CFD analysis was performed to investigate the aerodynamic behavior of a ski jumper from take-off to landing. The results of the simulation showed that aerodynamic characteristics were different in each phase. In addition it was found that lift force had a specific trend before landing ,whose cause was understood by observing the flow-field around the jumper .

IMPACT OF DYNAMIC FRICTION ON RACE TIMES IN CROSS-COUNTRY SKATE SKIING - A NUMERICAL SIMULATION STUDY

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INTRODUCTION:
Dynamic friction is an important parameter in cross-country skate skiing. A reduction of the dynamic frictional coefficient (μ) with 47% can increase the time to exhaustion with 50% when roller-ski skating [1]. With normal ski preparation μ may vary up to 15% due to the ski base texture [2]. To isolate the impact of μ on race time, numerical simulations with a power-balance model could be used as previously demonstrated [3],[4]. Field measurements have provided more detailed relationships for propulsive power and drag area with the skating sub-techniques, allowing more reliable simulations [5]. Thus, the aim of this study was to examine the impact of different dynamic frictional coefficients on the required time to complete a cross-country skate skiing.
METHODS:
A power balance model for cross-country skate skiing was implemented and solved in Matlab for skiers with body masses of 70, 80 and 90 kg respectively. Propulsive power was modelled as a function of speed, acceleration and body mass [5]. Additionally, five values of μ and three wind conditions were examined, giving a total of 45 combinations. These were all simulated on two different courses. Total race times were taken from a 15.6 km race (5 laps of the 3 km biathlon race course in Östersund) imported from GPS-data. Speeds at specific inclination angles were taken from a fictional course with sections of constant inclination angle (mean speed downhill, steady state speed on the uphill and flat). In the 15.6 km race the ambient winds were aligned to give either 4 m/s tailwind in the majority of downhill sections and headwind uphill (4SW), the opposite (4NE) or zero wind. In the fictional course wind was either 4 m/s tailwind, 4 m/s headwind or zero through the entire race.
RESULTS:
The mean total race time in the 15.6 km race was 2240.7±141.1 s, with shorter race times for the heavier skier (90 kg 19.2±1.3 s < 80 kg 22.2±1.3 s < 70 kg) and for tailwind uphill (4NE 5.0±2.0 s < zero wind 5.9±2.0 < 4SW). Changing μ from 0.013 to 0.015 increased the total race time for the 70, 80 and 90 kg skiers with 33.6 s (1.53%), 34.0 s (1.57%) and 34.0 s (1.58%) respectively. Changing μ from 0.025 to 0.027 gave 34.6s (1.44%), 34.2s (1.44%) and 35.1s (1.49%) increased race time for the 70, 80 and 90kg skiers respectively. The changes in speed from the 70 to 80 to 90 kg skiers were all below 0.43% on the uphill and between 0.70 and 1.53% on the flat and downhill. Changing μ gave largest change in speed for moderate downhill (e.g. 2.15%, μ 0.015 to 0.013) followed by flat (1.29%) and moderate uphill (1.22%).
CONCLUSION:
An absolute change in μ of 0.002, e.g. a different preparation of the skis, have slightly larger impact on faster (μ~0.014) than slower snow (μ~0.026) but in both cases could turn the tide in a close race. This change in race time is generated mostly in sections with moderate or no inclination angle.
1. Ainegren et al. (2009) 2. Budde & Himes (2017) 3. Sundström et al. 2013 4. Moxnes et al. 2014 5. Gloersen et al. (2018)

RELIABILITY OF CHANGE OF DIRECTION TESTING USING ROBOTIC RESISTANCE TECHNOLOGY

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INTRODUCTION:
Current change of direction (CoD) tests (multiple phases with one or more turns) have been criticized as they do not quantify phase specific information of the initial acceleration to deceleration and re-acceleration phases (1). Reliable and accurate phase specific outcome measurements can provide important information to athletes as acceleration and deceleration represent different physical qualities, which subsequently can be used in the individualized training prescription. The purpose of this study was to determine test-retest reliability of overall and phase specific performance measurements of the modified 505 test (m505) using a robotic resistance device.
METHODS:
Seven male (age 24±5 years; height 181±3 cm; body weight 81±5 kg) and three female (age 21±1 years; height 176±9 cm; body weight 71±4 kg) ball game/team sport athletes completed two familiarization and two test sessions (8±2 days between sessions). After a standardized warm-up each athlete performed two m505 turning off the left (L) and right (R) foot with a 3 kg external load using a robotic resistance device (333 Hz) (1080 Sprint, 1080 Motion AB, Lidingø, Sweden). Specifically, the athlete performed the initial acceleration to deceleration (phase 1a) running toward and the re-acceleration (phase 1b) running away from the robotic resistance device. The CoD is defined as the time when velocity change direction in the robotic resistance device. The outcome measurements provided by the system and analyzed in the current study are overall time and phase specific (1a and 1b) time and average velocity. Test-retest reliability was calculated from test session one and two using correlational analysis (r), intraclass correlation coefficient (ICC), typical error (TE), coefficient of variation (CV) and interpreted based on established guidelines (2).
RESULTS:
Overall time (L: 3.05±.14; R: 3.06±.23) had good to excellent correlations (L: .77; R: .93), good ICC (L: 0.82; R: 0.80), good CV (L: 2.3 ; R: 3.8) and TE values (L: .07 sec; R: .08 sec). Phase 1a time (L: 1.70±.09 sec; R: 1.69±.12 sec) and average velocity (L: 2.83±.17 m/s; R: 2.87±.19 m/s) had good to excellent correlations (range: .71 to .88), good ICC (range: 0.76 to 0.90), good CV (range: 2.5 to 3.1) and TE values (L and R time

.05 sec; L and R average velocity: .07 m/s). Phase 1b time (L: 1.34±.07 sec; R: 1.35±.09 sec) and average velocity (L: 3.60±.20 m/s; R: 3.57±.19 m/s) had good to excellent correlations (range: .79 to .96), good ICC (range: 0.76 to 0.97), good CV (range: 1.1 to 3.1) and TE values (L time .03 sec; R time: .04 sec; L average velocity: .07 m/s; R average velocity: .04 m/s).
CONCLUSION:
Overall and phase specific outcome variables obtained by a robotic resistance device from the m505 test have good to excellent test-retest reliability.
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1) Nimphius et al., J Strength.Cond.Res, 2017
2) Hopkins., Sportscience, 2015

INTEGRATING OFF-TRAINING AND TRAINING ACTIVITY SUBSTANTIALLY ALTERS TRAINING VOLUME AND LOAD ANALYSIS IN ELITE ROWERS

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INTRODUCTION:
Training studies in elite athletes traditionally focus on the relationship between scheduled training (TRAIN) and performance outcome. In this prospective study, activities outside of scheduled training i.e., off-training (OFF) contributing to total training (TOTAL) were integrated into the analysis of one season (i.e., from preparation period to main competition, approximately 30–45 weeks), aiming to evaluate the contribution of OFF on performance changes. To the best of our knowledge, this has never been studied before.
METHODS:
The TRAIN and OFF activities of eight national and international elite rowers were monitored with multisensory smartwatches. Changes in performance were assessed with four ergometer tests via power at 2 and 4 mmol•L-1 blood lactate and maximal oxygen uptake (V̇O2max). Based on 1-Hz-sampling of heart rate data during TRAIN and OFF (> 60% peak heart rate), the volume, session count, intensity, training impulse (TRIMP), and training intensity distribution based on a 3-zone model were calculated. A valid day was very rigidly defined as a minimum of 480 min of OFF recorded per day and a valid week consisted of at least 6 days.
RESULTS:
The entire dataset of eight rowers comprised 100,738,768 s, resulting in a total of 1,425 valid days and 194 valid weeks. OFF altered volume, TRIMP, and session count by 19%, 11%, and 41% ($p < 0.001$). When including OFF, training intensity distribution did not change on a group level, but individual analysis revealed meaningful changes in 3% of all valid weeks. The athletes exercised 31% of their weekly volume below 60% of their maximal heart rate. Low to moderate intensities dominated during OFF with 87% (95% CI [79, 95]); however, in some weeks high intensity training ≥ 88% of maximal heart rate amounted to 21 min • wk-1 (95% CI [4, 45]). No effect of OFF on changes in power output at 2 or 4 mmol • L-1 blood lactate or V̇O2max ($p \geq 0.072 \leq 0.604$) was found.
CONCLUSION:
The integration of OFF substantially altered volume, TRIMP, and session count. The differences between TOTAL and TRAIN due to OFF were in a range that is often regarded to be sufficient to discriminate between groups in intervention studies. OFF should therefore be considered for future analyses of comprehensive training to illuminate the probably relevant blind spot of OFF and to better understand adaptation.

OP-AP08 Body Composition

SEX DIFFERENCES IN CHANGES IN BODY COMPOSITION, PHYSICAL PERFORMANCE, AND MUSCLE FIBERS AFTER A STRENUOUS MILITARY FIELD EXERCISE

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INTRODUCTION:
Strenuous military field exercises (MFE) have been shown to cause loss of muscle mass and long-lasting impairments in physical performance in men, but little is known about such responses in women. The purpose of the current study was to investigate possible sex differences in the effect of a demanding MFE on physical performance, body composition, muscle fiber type, muscle fiber specific cross-sectional area (CSA), and muscle glycogen content.
METHODS:
Body composition and physical performance were tested in 10 men and 8 women before (T0), and 1 (T1), 7 (T7), and 14 (T14) days after a 10-days MFE consisting of rigorous physical activity with food and sleep restriction. Muscle biopsies from m. vastus lateralis were taken at T0, T1, and T7.
RESULTS:
During the MFE, body mass was reduced by 5.3±1.5% and 4.9±1.9% and fat mass by 33.5±17.4% and 26.9±14.3% in men and women respectively ($p<0.01$). At T14, body mass was still reduced in men (-2.6±2.0%, $p<0.01$) and tended to be reduced in women (-2.3±2.6%, $p=0.07$) while fat mass was still reduced in both men (-15.2±7.4%, $p<0.01$) and women (-9.1±6.8%, $p<0.05$). Only the men decreased muscle mass during the MFE (-1.8±1.4%, $p<0.05$). There were no sex differences in the percentage change from pre to any timepoint in body composition.
Countermovement jump (CMJ) height was decreased in men (8.4±7.4%, $p<0.01$) at T1 and was still decreased at T7 (-7.9±4.5, $p<0.01$). The women did not significantly decrease their CMJ height at T1 (-4.6±3.5%, $p=0.357$) but it was decreased at T7 (-7.7±6.0%, $p<0.05$). Isometric knee extension torque did not change during the study in either sex. In men, the peak torque in isokinetic knee extension at 240°/s tended to be reduced at T1 (-4.1±4.7%, $p=0.05$) and T14 (-3.2 ± 2.6%, $p=0.06$) and was reduced at T7 (-4.7 ± 5.1%, $p<0.05$). The women had similar reductions in peak torque, but this did not reach statistical significance at T1 (-5.3±5.2%, $p=0.22$) or T7 (5.4±6.0%, $p=0.27$) but was significantly reduced at T14 (-5.8±5.5%, $p<0.05$).
There were no changes in fiber type distribution or fiber CSA during the study period. At T1, glycogen content in the muscle fibers was reduced in both men and women with 8.4±9.7% ($p<0.05$) and 8.0±7.6% ($p<0.05$) respectively. At T7 men had increase glycogen content

compared to T0 with 10.3±5.6 (p<0.05) while the women were back to T0 values. At T7 the percentage change from T0 was different between sexes (p<0.05). The changes in glycogen content were similar in Type I and type II fibers.
CONCLUSION:
A demanding MFE resulted in reduced body mass and physical performance in both sexes. The ability to produce force at high contraction velocities was more affected than isometric force, but this was not related to any changes in fiber type, area of the different fiber types or muscle glycogen stores.

ANTHROPOMETRIC MODELS TO PREDICT APPENDICULAR SKELETAL MUSCLE MASS IN PEOPLE LIVING WITH HIV/AIDS WITH AND WITHOUT LIPODYSTROPHY

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INTRODUCTION:
Even in young ages, people living with HIV/AIDS (PLWHA) present with an accelerated aging process, especially in terms of reduction in the skeletal muscle mass (SMM). Low SMM is associated with physical disability, poor quality of life, and mortality. Early detection of low SMM along with participation in exercise and sports programs may increase physical activity levels and preserve SMM and strength in PLWHA. An index calculated based on appendicular skeletal muscle mass measured using Dual energy X-ray absorptiometry (DXA; ASMMDXA) can be used to express SMM. Currently, there is no anthropometric predictive model for ASMMDXA in PLWHA considering sex and lipodystrophy diagnosis. This study aimed to develop and validate anthropometric models to estimate ASMMDXA in PLWHA with and without a diagnosis of lipodystrophy taking into consideration sex.
METHODS:
One hundred and twenty five (n =125) PLWHA (59.2% male), aged equal/higher 18 years old and under combined antiretroviral therapy participated in this study. Available Cutoff points (male=1.24% and female=0.95%), were adopted for lipodystrophy diagnosis using Fat Mass Ratio by DXA. Pearson or Spearman analysis were used to examine the association between ASMMDXA and potential predictive variables, such as age, sex (male or female), lipodystrophy diagnosis (yes or no), height, body weight, body mass index, and four body circumferences (dominant extended arm, forearm, thigh - proximal, medial calf - larger diameter). Variables with significant association were included in the multiple stepwise linear regression to predict ASMMDXA. The Predicted Residual Sum of Squares (PRESS) method of cross validation tested the validity of each proposed model. Bland-Altman plots were used to explore distributions of errors and agreement.
RESULTS:
Average age of PLWHA was 46.3 ± 9.3 years (range = 19 to 60 years). Results support the use of anthropometry for predicting ASMMDXA in male and female PLWHA. A high coeficient of determination with a small degree of error was observed for ASMMDXA in four generated models (adjusted r^2 = 0.84 to 0.87, SEE = 1.7 to 1.6 kg). The validation of anthropometric models to predict ASMMDXA were confirmed observing high coeficients (Q^2PRESS = 0.84 to 0.86) and reliability of reduced errors (SEEPRESS = 1.7 to 1.6 kg). The simplified variables included in our models were height, body weight, body circumferences of forearm and medial calf, lipodystrophy diagnosis, and sex.
CONCLUSION:
Our findings demonstrated that the proposed models to predict ASMMDXA in PLWHA – using simplified anthropometric measurements - are valid and reliable based on the high coeficients observed throughout the analysis. We believe this information will advance the public health field by assisting health professionals in diagnosing early loss of SMM at a low cost.

IS ADHERENCE TO THE MEDITERRANEAN DIET AND WEIGHT STATUS IN THE ACTIVE YOUNG POPULATION RELEVANT? RELATIONSHIP WITH PHYSICAL FITNESS

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INTRODUCTION:
The prevalence of overweightness and obesity in children and adolescents is a global public health problem. However, childhood and adolescence are key stages in the acquisition and establishment of lifestyle habits. For this, it is important to establish a healthy lifestyle, which allows us to acquire healthy eating habits and an adequate level of physical fitness that will be the determinants of present and future health. Different studies have demonstrated the importance of a healthy and balanced diet, together with an adequate level of physical fitness to prevent obesity and improve the health-related quality of life in this population. Therefore, the aim of this study was to analyze the differences in body composition and physical fitness according to the weight status and the level of adherence to the Mediterranean Diet in physically active children and adolescents.
METHODS:
1676 active children and adolescents (aged 6-17) from different municipal sports schools participated in this study. Athletes were divided into four subsamples as a function of sex and pubertal status. In addition, the four subsamples were divided into three groups based on their weight status (normoweight, overweight and obese) and the level of adherence to the Mediterranean Diet (low, medium and high). Data on anthropometric measurements, cardiorespiratory fitness (the 20-m shuttle run test), muscular fitness (handgrip strength and CMJ tests) and nutritional habits (Kidmed questionnaire) were collected. Differences between the three groups of each classification were evaluated through one-way ANOVA. The test was replicated individually in the four subsamples. The level of significance was set at p<0.05.
RESULTS:
The results show that normoweight young and adolescent active people showed better values of body composition and physical fitness. The normoweight group performed significantly better in the 20 mSRT than the overweight group ($p < 0.05$; ES: 0.50 to 0.67) and the obese group ($p < 0.001$; ES: 1.42 to 1.75). On the contrary, the overweight group showed significantly higher results than the normoweight group in handgrip in prepubertal and pubertal boys ($p < 0.01$; ES: 0.31 to 0.53). In pubertal girls, significant differences were found only in CMJ in the normoweight group with respect to the obese group ($p < 0.001$; ES: 0.95). On the other hand, fat mass was negatively associated with physical fitness. In the same way, high or optimal adherence to the MD revealed better performance in the different physical fitness parameters, especially in the population of
CONCLUSION:

This study suggests that weight status is a fundamental factor for health, which is significant in body composition variables as well as in the effect on physical fitness. For this reason, it is important to establish specific initiatives and strategies that increase public awareness about this health problem in children and adolescents, leading to changes in nutritional and active-healthy habits.

EFFECTS OF SCHOOL-BASED HIGH-INTENSITY INTERVAL TRAINING ON BODY COMPOSITION, CARDIORESPIRATORY FITNESS AND CARDIOMETABOLIC MARKERS IN ADOLESCENT BOYS WITH OBESITY: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION:
Childhood obesity is one of the most serious health challenges of the 21st century. Since adolescents with obesity have higher morbidity and mortality risks compared to normal weight counterparts and are of higher risk of becoming adults with obesity, pediatric obesity is of foremost public health concern. Growing evidence under laboratory conditions showed that HIIT is more time-efficient than MICT in improving body composition or other health parameters and have more enjoyment. However, lack of HIIT research in real-world environment without expensive equipment (i.e., cycle ergometers and treadmills). We hypothesized that school-based HIIT is feasible and has a certain improvement on the body composition, cardiorespiratory fitness and glycolipid metabolism in obese children.
METHODS:
Forty-five adolescent boys with obesity (age = 11.2 ± 0.7 years, BMI = 24.2 ± 1.0 kg/m2), were randomized to high-intensity interval training group (HIIT, n = 15), moderate-intensity continuous training group (MICT, n = 15), or a control group (CON, n = 15). The intervention groups were performed three weekly exercise sessions over 12 weeks. HIIT group performed two sets of eight bouts of 15 s run at high-intensity [90~100% maximal aerobic speed (MAS)] separated by eight bouts of 15 s recovery run at low-intensity (50% MAS), MICT group performed 30 min run at moderate intensity (60~70% MAS) and CON group were instructed to continue their normal behaviors. All participants had indices of body composition, cardiorespiratory fitness (CRF) and cardiometabolic markers measured at baseline and post-intervention.
RESULTS:
Following the school-based training program, in both training groups, BMI and body fat mass decreased, while 〖"V" "O" 〗_"2peak" increased. Visceral adipose tissue was significant decrease in HIIT group whilst the MICT group experienced a significant decrease in body fat percentage. Low-density lipoprotein cholesterol decreased only in HIIT group (-17.2 %, $P < 0.05$). Significant decrease in the usual index of insulin resistance (HOMA-IR) occurred in HIIT and MICT groups (-27.3 and -28.6 %, respectively; $P < 0.05$).
CONCLUSION:
Our results demonstrated that high-intensity interval training based on running can be used to improve the physical health of obese adolescents in school. Further investigations involving a larger cohort of participants, taken from different schools, is recommended.

CHANGES IN BODY COMPOSITION OVER A COMPETITIVE SEASON PREDICT IMPROVEMENTS IN RUNNING AND CYCLING PERFORMANCE IN TRIATHLETES.

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INTRODUCTION:
Previous studies have examined physiological adaptation processes of triathlon training and identified triathlon experience, body composition (BC), and aerobic fitness as important predictors of performance [1,2]. However, interrelated effects between training, BC, and performance remain controversial. Therefore, this retrospective descriptive study aimed to analyze seasonal alterations in BC over a competitive season in mid-to-long distance amateur triathletes. We further investigated associations between changes in BC with improvements in cycling and running performance.
METHODS:
Twenty-nine (90 % male) experienced triathletes were included (age: 44 ± 8 yrs, height: 181 ± 6 cm, body weight (BW): 75.9 ± 8.2 kg, fat mass (FM): 13.7 ± 2.8 %). Assessments were conducted over the course of a season ranging from off-season (Off), preparation- (Prep) and competition- (Comp) to a second off-season (Off 2). Data was gathered for BW, FM, and fat-free mass (FFM) via a 10-point skinfold method. Cycling performance data (Power, VO2, VLamax) were assessed via spirometry and blood lactate measurement during a 15-sec all-out-test and a ramp test. Running performance data (Velocity, VO2, VLamax) were gathered on a treadmill. Differences between timepoints, were analyzed using one-sided paired t-tests. Regression modeling was based on Pearson correlation (r).
RESULTS:
BW (-2.6 ± 3.8 %), FM (-11.2 ± 14.9 %), and FFM (-1.2 ± 2.5 %) decreased significantly (mean ± SD, $p < 0.05$) from Off to Comp. Cycling performance power at anaerobic threshold (Pat): 236 ± 38 to 261 ± 38 w, VO2max: 4,038 ± 615 to 4,236 ± 586 ml/min, VLamax: 0.52 ± 0.15 to 0.45 ± 0.14 mmol/l/s improved significantly, as did running speed at anaerobic threshold (Sat): 3.8 ± 0.5 to 4.0 ± 0.4 m/s ($p < 0.05$). For cycling, changes in maximal power output ($r = -0.44$, $p = 0.043$), Pat ($r = -0.47$, $p = 0.023$), and VO2max ($r = -0.51$, $p = 0.014$) were correlated with alterations in FM. Further, changes in Pat ($r = -0.43$, $p = 0.046$) and VO2max ($r = -0.48$, $p = 0.023$) but not in VLamax were significantly correlated with alterations in BW. Increased Sat was correlated with a loss in BW ($r = -0.50$, $p = 0.042$) and FFM ($r = -0.52$, $p = 0.034$).
CONCLUSION:
The findings suggest that our athletes achieved their optimal performance and BC for Comp. We further subsume that a loss in FM or BW is expected to improve cycling power and VO2max. Sat increases through a reduced BW or FFM. Hence, a loss in BW induced by a lowered FM predicts a progress in triathlon performance but always requires an individual approach.
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CHANGES IN BODY COMPOSITION AND RESTING METABOLIC RATE OVER THE COURSE OF A COMPETITIVE SEASON IN ELITE ALPINE SKIERS

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INTRODUCTION:
The complex, multifactorial nature of alpine skiing makes it challenging to isolate single factors that guarantee success in the sport. However, winning margins are decreasing due to improvements in equipment and individualized training programs that focus on technical and tactical adjustments to course and snow conditions. Therefore, utilizing optimized nutritional strategies to promote subtle changes in physical and physiological characteristics may play a role in the fight for podium positions over the course of a season.
METHODS:
In a prospective observational study, changes in body composition were determined over the course of a competitive season in active international male (n= 9, 27±2.9 yrs) and female (n=10, 25±3.0 yrs) alpine skiers. Body composition (displacement plethysmography and bioelectrical impedance) and resting metabolic rate (RMR, indirect calorimetry) were assessed at the start of the on-snow training phase (PRE) and at the end of the competitive season (POST). Throughout the season, body mass data was collected remotely using smart scales.
RESULTS:
Overall, fat free mass (FFM) (-0.7±1.0 kg, p=0.007) and skeletal muscle mass (SMM) (-0.5±0.6 kg, p=0.05) decreased significantly from PRE to POST. The loss in muscle mass tended to be greater in female when compared to male athletes (p=0.09), whereas the reduction in body mass (BM) tended to be greater in men when compared to women (p=0.07). RMR significantly decreased (-71±124 kcal/d, p=0.033) over the course of the season in all athletes.
CONCLUSION:
Our findings indicate that elite alpine skiers are at risk of failing to meet the energy demands of training and competition in extreme environments over the course of a competitive season, and the loss of FFM and SMM may be exacerbated by reductions in resistance training during the competition phase. Therefore, body composition should be strictly monitored throughout the season to identify athletes at risk and – when necessary - nutritional support should focus on improving energy balance to avoid negative effects on performance and injury risk.

ACSAUTO - REDUCING THE COMPLEXITY OF ULTRASOUND-DERIVED MUSCLE CROSS-SECTIONAL AREA ANALYSIS

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INTRODUCTION:
Ultrasound images require a lot of effort as well as time for interpretation and are complex to evaluate. Various automated and semi-automated programs were developed over the past few years to accelerate the evaluation process of ultrasound images. However, open-access scripts to perform muscle anatomical cross-sectional area (ACSA) measurement in ultrasound images are currently unavailable. This study presents a novel, semi-automatic and open-source ImageJ script (named “ACSAuto”) for quantifying the ACSA of lower limb muscles.
METHODS:
We collected ultrasound images in 60 individuals between the age of 14 to 25 (n = 46 male and 14 female). Three images per participant were taken at 33%, 50% and 66% of femur length using B-mode panoramic ultrasound. We compared manual ACSA measurements from 180 ultrasound scans of vastus lateralis (VL) and rectus femoris (RF) muscles to measurements assessed by the ACSAuto script. The script identifies muscle outlines by applying masking, tubeness filtering, smoothing, convolution filtering and edge detection. Subsequently to image processing, the muscle outline is suggested and the user has the possibility to correct the suggestion before final ACSA measurement. We investigated inter- and intra-investigator reliability of the script. Consecutive-pairwise intra-class correlations (ICC) and standard error of measurement (SEM) with 95% compatibility interval were calculated. Bland-Altman analyses were employed to test the agreement between measurements.
RESULTS:
Comparing manual and ACSAuto measurements, ICCs and SEMs for both muscles ranged from 0.96-0.999 and 0.12-0.96 cm^2 and mean bias was smaller than one cm^2. Inter-investigator comparison revealed ICCs, SEMs and mean bias ranging from 0.85-0.999, 0.07-1.16 cm^2 and -0.16-0.66 cm^2. Intra-investigator comparison revealed ICCSs, SEMs and mean bias between 0.883-0.998, 0.07-0.93 cm^2 and -0.80-0.15 cm^2.
CONCLUSION:
Taken together, the ACSAuto script represents a valid and reliable tool to measure RF and VL ACSA and can reduce duration and complexity of ultrasound image evaluation. Although semiautomatic, the ACSAuto script is openly accessible and thus can reduce the variability introduced by manual ultrasound image analysis. However, the ultrasound image quality needs to be high for the ACSAuto analyses to be efficient and accurate.

REPEATABILITY AND REPRODUCIBILITY OF PANORAMIC ULTRASONOGRAPHY ARE HIGHLY DEPENDENT ON THE MUSCLE REGION: A STEP-BY-STEP ANALYSIS OF THE MEASUREMENT ERRORS.

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INTRODUCTION:
Clinicians and researchers have benefited from the development of panoramic ultrasonography (PANUS) to measure muscle cross-sectional area (CSA). Nevertheless, information on the repeatability (errors from the image acquisition and analysis) and reproducibility (errors when compared with a gold standard) of this technique is limited. Between other factors, it has been suggested that measurement errors generated in the different steps included in the PANUS technique could be influenced by the specific muscle region being evaluated (e.g., proximal or distal) (1,2). Therefore, this study aimed to examine the influence of the muscle region on the repeatability and reproducibility of the PANUS to measure CSA.
METHODS:
Both legs of sixteen healthy men (body mass index = 24.0 ± 2.1 kg/m2) were included (n = 32). Images of rectus femoris (RF), vastus lateralis (VL), and vastus medialis + intermedius (VMVI) muscles were taken by an experienced operator at six regions of the quadriceps

femoris (20, 30, 40, 50, 60, and 70%; mid patella = 0%, greater trochanter = 100%). The study of acquisition errors included the comparison of two CSA images of each individual muscle (VL, RF, VMVI) at each region (20-70%), whereas the first of these images was analyzed twice to examine the analysis errors. Finally, reproducibility was examined by comparing the CSA value obtained by PANUS against that measured by magnetic resonance imaging (gold standard). Statistics included the standard error of the measurement in relative terms as a coefficient of variation (CV = 100 SEM/mean).
RESULTS:
The lowest acquisition errors were identified at 40% (VL: CV = 1.17%; VMVI: CV = 0.73%) and 50% (RF: CV = 1.78%), whereas the highest errors were found at 20% (VL: CV = 4.16%), 30% (RF: CV = 2.84%), and 70% (VMVI: CV = 2.13%). Similarly, analysis errors were found to be lower at 40% (VL: CV = 0.32%; VMVI: CV = 0.26%) and 50% (RF: CV = 0.56%), but higher at 20% (VL: CV = 1.49%; VMVI: CV = 0.83%) and 30% (RF: CV = 1.70%). Finally, when comparing with magnetic resonance imaging, the lowest errors were identified at 30% (VMVI: CV = 1.79%) and 50% (RF: CV = 2.76%; VL: CV = 2.03%), whereas the highest errors were found at 20% (VL: CV = 8.40%), 30% (RF: CV = 10.09%), and 70% (VMVI: CV = 5.68%).
CONCLUSION:
Repeatability and reproducibility of PANUS to measure quadriceps femoris CSA are highly dependent on the muscle region being evaluated. Specifically, the lowest measurement errors are generated at the middle regions (40 - 50%) of this muscle.
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SKELETAL MUSCLE MASS INDEX AMONG COLLEGE STUDENTS

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INTRODUCTION:
Sarcopenia is a condition commonly associated with the loss of muscle in the elderly. The appendicular skeletal mass (ASM) which is defined as the muscle masses of the four limbs was progressively increased from 10's to 40's and drop afterwards [1]. Apart from age, muscle mass is highly related to the activity level. Due to the urbanized lifestyle, well development of transportation and technological advances, physical inactivity becomes the global public health problem. Low muscle mass is not a unique problem for elderly, which may originate from childhood. Children may already have the problem of low skeletal muscle mass [2]. The current study aims to examine the skeletal muscle mass index (SMI) of a cohort of college students in Hong Kong.
METHODS:
Data were collected from Chinese students who studied in PolyU Hong Kong Community College (HKCC) between 2013 and 2017. Subject were recruited from a nutrition subject and during a series of healthy lifestyle promotion activities. Body weight, percentage body fat (PBF), appendicular lean mass and height were measured with the subject barefoot and wearing light clothing. Appendicular lean mass was measured by bioelectrical impedance analysis (BIA) (InBody 230, Biospace Co., Ltd, Seul, Korea) as a poxy for appendicular muscle mass (AMM). The skeletal muscle mass index (SMI) was calculated by dividing the appendicular muscle mass by square of height (AMM/ ht2, kg/m2) [3].
RESULTS:
There were 1111 students who completed the assessments, 403 of them were male and 708 were female. The mean age, BMI and PBF of the students were 19.4±0.9 years, 20.5±2.9 kg/m2, and 24.3±8.5% respectively. (BMI, M:21.1±3.0 kg/m2 vs F:20.2±2.8 kg/m2; PBF, M:16.5±6.2% vs F: 28.8±6.0%). The mean SMI of female participants was 5.7 kg/m2 and male participants was 7.5 kg/m2 respectively. Based on the cutoff of SMI from the Asin Working Group for Sarcopenia (AWGs) [4], low SMI (presarcopenia) is defined as SMI <5.7 kg/m2 for female and <7.0 kg/m2 for male. Nearly one- fourth (22.6%) of male and half (49.9%) of female were classified as low SMI. Seventy percentage of female with PBF ≥ 30% and low SMI.
CONCLUSION:
Our finding showed that the mean SMI of this group of students is similar to two Korean studies ie 5.64 kg/m2 for female [1] and 5.4 kg/m2 for female, 7.3 kg/m2 for male [2]. Low skeletal muscle mass was significantly associated with metabolic syndrome [5] and type 2 diabetes [6]. Fat-free mass peak at early adulthood which is determined by physical activity. It is paramount to promote physical activity particularly resistance training among youngsters [7]. The high prevalence of low SMI among this group of female students should be of concern and further research should confirm whether it is a common problem among young sedentary people. Future public health education should focus on retaining skeletal muscle mass.

OP-AP09 Sport Technology Apps and Monitoring

VALIDATION OF THE AZURE KINECT SENSOR IN OBSTACLE CROSSING DURING WALKING

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INTRODUCTION:
Obstacle crossing is one of the typical adaptive locomotion. The performance of an obstacle crossing task is assessed by using the foot clearance which is the minimum distance from the foot to an obstacle. Previous study has shown that the foot clearance is related to the risk of falls. Conventionally, expensive and exaggerated optical motion capture systems have been used, requiring a large budget, and participants must visit a laboratory, which made it difficult to perform large-scale quantitative analyses of obstacle crossing behavior. In this study, we aimed to develop an easy and cheap solution for measuring obstacle crossing behavior by using Microsoft Azure Kinect, one of the most promising marker-less motion capture systems.
METHODS:
Sixteen healthy young male participants crossed over an obstacle set at the middle of a 7-m walkway. Three obstacle heights were tested: 50, 150, 250 mm. Whole-body kinematics was measured by an Azure Kinect sensor (Microsoft) and eight-camera optical motion capture

system (Qualisys). The Azure Kinect sensor was placed on the trail leg side diagonally in front of the obstacle. A Foot clearances were calculated for lead and trail legs based on the Kinect and Qualisys as the vertical distance from the foot to the obstacle when the foot was just above the obstacle. To validate the Azure Kinect sensor, Pearson's correlation coefficient was calculated between the Kinect and Qualisys. We also performed Wilcoxon's signed rank tests to compare the foot clearance between Kinect and Qualisys for each condition.
RESULTS:
The correlation coefficients were 0.976 and 0.984 for the lead and trail clearances when the obstacle height was 50 mm, 0.915 and 0.989 for the lead and trail clearances when the obstacle height was 150 mm, and 0.922 and 0.890 for the lead and trail clearances when the obstacle height was 250 mm. No differences in median value of the trail leg' clearance were observed between Kinect and Qualisys, whereas the Kinect underestimated the foot clearance by 10-20 mm for the lead leg (50 mm: $W(15) = 0.000$, $p < .001$, $r = -1.000$; 150 mm: $W(15) = 0.000$, $p < .001$, $r = -1.000$; 250 mm: $W(15) = 1.000$, $p < .001$, $r = -0.985$).
CONCLUSION:
The observed high correlation coefficients between the Kinect and Qualisys measurements suggest that Azure Kinect would be an alternative tool measuring the foot clearance in large-scale studies in the fields of rehabilitation and sports sciences. However, it should be careful to compare the foot clearance between the lead and trail legs given the significant differences observed.

EXAMINING THE IMPACT OF AN MHEALTH APP ON FUNCTIONAL MOVEMENT AND PHYSICAL FITNESS

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INTRODUCTION:
There are thousands of mobile apps available for download that are geared towards health and fitness, yet limited research has evaluated the real-world effectiveness of such apps. The movr app is a mobile health (mHealth) app designed to enhance physical functioning by prescribing functional movement training based on individualized movement assessments. movr's influence on functional movement and physical fitness (flexibility, strength, and cardiovascular fitness) has not yet been established empirically. Thus, the purpose of this study was to examine the real-world impact of movr on functional movement, flexibility, strength, and cardiovascular fitness ($\dot{V}O_2max$).
METHODS:
Forty-eight healthy adults (24 women, 24 men; 24 ± 5 years) completed an 8-week pragmatic randomized controlled trial whereby they were randomly assigned to either 8 weeks of use of the movr app (n = 24) or 8 weeks waitlist control (n = 24). Measures of functional movement, strength, flexibility, and $\dot{V}O_2max$ were collected at baseline and 8-week follow-up.
RESULTS:
Mixed repeated-measures ANOVAs revealed significant group by time interactions for the 100-point Functional Movement Screen (FMS), shoulder flexibility, active straight-leg raise, half-kneeling dorsiflexion, and push-up tests (Ps < .05), such that pre- to post-intervention improvements were found in the movr group (Ps < .05), but not in the control group (Ps > .05). There were no changes in the sit and reach or handgrip strength test scores for either group (Ps > .05). A significant main effect of time was found for countermovement jump ($P = .02$), such that scores decreased pre- to post-intervention in the control group ($P = .02$), but not in the movr group ($P = .38$). Finally, a significant group by time interaction was found for $\dot{V}O_2max$ ($P = .001$), revealing that scores decreased pre- to post-intervention in the control group ($P < .001$), but not in the movr group ($P = .54$).
CONCLUSION:
The findings revealed that movr improved indices of functional movement, flexibility, and muscular endurance over an 8-week period compared to a control group, while maintaining handgrip strength, lower body power, and cardiovascular fitness. As such, this study provides initial evidence of the effectiveness of the movr app for enhancing functional movement and physical fitness among healthy adults.

EVALUATION TOOL OF INFORMATION SOURCES FOR OPTIMAL INERTIAL MEASUREMENT UNIT PLACEMENT FOR MOTION CLASSIFICATION

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INTRODUCTION:
External training load monitoring is of great interest to optimize athlete performance. Smart clothing featuring motion recognition is growing interest [1]. The placement of inertial measurement units (IMU) on the human body is essential for a good motion characterization. The data from these sensors are mostly used by learning algorithm for movement recognition [2]. However, there is a lack of tools to evaluate the information sources for optimal placement of these sensors. It currently depends on biomechanical parameters such as spacer surfaces and/or sport-related constraints [1]. Therefore, the aim of this study is to develop a tool to evaluate the optimal IMUs positions for movement recognition based on a biomechanical model.
METHODS:
One participant performed motion capture acquisition with the Xsens MVN Link capture suit [3] and Delsys Trigno Avanti (IMUs). The Xsens technology builds a biomechanical model that is processed by Custom Matlab Library [4] (synthesized IMU data: SID). And the Delsys technology serves as reference (real IMU data: RID). The first step is to evaluate the relevance of the biomechanical model through statistical analysis based on features from raw data [5] (40 trials, 3 movements). SID and RID are compared. The second step is to implement and test a classification algorithm (SVM) on SID for 154 possible sensor locations. Cross validation scores are used to evaluate best sensor placement.
RESULTS:
The points of SID are mapped to the placement of the RID. Normalized RMSE is computed for the various points and features. Each data acquisition is segmented with a window of 0.5 seconds. Sampling frequencies are 240Hz for SID (6 Dof) and 370Hz for RID (6 Dof). Maximum error is 81% for sensor located on the right thigh and minimum error is 34.4.% for sensor located on the right hand. Frequency study shows that RID contains a wider spectrum. Classification algorithm SVM is applied on all SID points of the biomechanical model (154 points) individually, the acceleration standard is used as input signal. A 5-fold cross-validation is used to evaluate the score of each point, the best movement recognition point is the right forearm with 96.6% accuracy.
CONCLUSION:
The use of a biomechanical model for the evaluation of sources of information is viable despite the non-homogeneity of the results. A set of parameters and features have been validated while others are identified as less consistent. A simple case of motion classification has

been studied to highlight this preliminary study. Considering multiple sensing locations and adding constraints are the next step toward the design of smart clothing with optimal sensor placement.
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WEARABLE SENSOR DETECTION OF BREATHING PATTERN DURING RUNNING

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INTRODUCTION:
Breathing pattern (BP) is a comprehensive concept with biomechanical, biochemical, and psychophysiological factors relevant to sports performance (1). New wearable technology enables researchers and practitioners to monitor various aspects of BP during sports and in diverse environments (2). As the true potential of these sensors becomes realized, it is important to establish the construct of BP as a multi-dimensional quality to be measured (3). Therefore, this study utilized data from a sensor-equipped wearable garment during indoor incremental running tests to characterize changes in key BP parameters across intensities and individuals.
METHODS:
Twelve healthy runners (6M/6F) with diverse training history completed an incremental running protocol to exhaustion on an indoor treadmill. BP was gathered using Hexoskin (HX) shirts (Carre Technologies, CAN) equipped with thoracic and abdominal stretch sensors (2 channel respiratory inductance plethysmography, 16-bit, 128 Hz). Synchronized spiroergometry data was gathered using the Cosmed Quark (CM) (Cosmed, L.L.C., Rome, Italy). Time-domain features were extracted from HX raw data via a custom algorithm in MATLAB 2020a. A linear mixed-effect model was used to calibrate HX volume to the spirometer tidal volume.
RESULTS:
Most, but not all, components of BP changed significantly as running intensity increased. Breathing rate (BR) increased from 29.0 [24.7, 33.3] breaths per minute (bpm) below the first ventilatory threshold (VT1) to 47.6 [41.9, 53.23] bpm above VT2. Depth changed as tidal volume increased 18.7±8.2% and lung operating volume had sharp increases near VT2 in all participants. Ventilatory drive increased 38.5±4.5% and duty cycle was unchanged from 46.6 [42.5, 50.80] to 47.8 [45.2, 50.3]% over the same interval. Coordination changed as thoracic and abdominal signal amplitudes and peak lag varied disproportionately between participants over the trials. Extended periods of Locomotor-Respiratory coupling (LRC) were detected for n=4 at whole-integer ratios of 7:1, 6:1, 5:1, 4:1, and 3:1.
CONCLUSION:
This study demonstrates the ability of a sensor-equipped garment to characterize inter- and intra-individual changes in BP during running. Taken together, these results support previously-defined BP concepts and provide a new framework for BP detection and classification in the categories of: BR, depth, timing, drive, and coupling. Future work should seek to utilize these concepts across other sports, larger groups, and perhaps use them as a basis for intervention studies.

TRAINING/MATCH EXTERNAL LOAD RATIOS, ASSESSED VIA WEARABLE TECHNOLOGY, IN PROFESSIONAL FEMALE HAND-BALL PLAYERS: A FULL SEASON STUDY

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INTRODUCTION:
Monitoring of workload (WL) during handball (HB) training sessions and matches is important for adjusting the training sessions weekly WL (WWL) of each player to the physical requirements of the match (1). Training/Match external Ratio (TMR) (2) could be used in HB to manage WWL. To our knowledge, no study on HB has focused on this ratio. Moreover, the expression in absolute values (e.g., number of accelerations) of the different variables used (2) does not seem relevant, given the important difference, on a weekly basis, between training time and competition time. The use of relative values (e.g., number of accelerations per minute of effective playing time) seems more appropriate. Therefore, the purpose of this study was (i) to investigate TMR, using different external WWL variables, during a full HB season and (ii) to compare results expressed in absolute values (AbV) to those expressed in relative values (ReV)
METHODS:
14 female HB players, belonging to the professional League 1 (France) were recruited for the study. The players had a training experience of the highest level of expertise in France. Mean values (± SEM) of age, stature, body mass and fat were 26.2 ± 4.5 years, 176.0 ± 5.7 cm, 73.6 ± 6.5 kg and 22.2 ± 4.2 % respectively. During the 35 weeks of the season, data were monitored, via an inertial microsensor technology (Clearsky T6, Catapult Sports®, Australia), during each training and match. The variables selected for analysis were the following: Player-load (PL), high acceleration (HA>3 m/s2) and high deceleration (HD>3 m/s2). In total, out of the 35 weeks studied, only the weeks with one match per week were analyzed, i.e.,17 weeks. The average value of the number of training sessions per week during these 17 weeks was 3 ± 0.24. The variables were expressed in absolute (arbitrary unit for PL and number of HA and HD) and relative values. In the latter case, the variables were related to the effective playing time corresponding to the time during which the players were active on the field (excluding rest or recovery periods)
RESULTS:
Preliminary results show that the average values of the variables measured during training sessions (PL: 1694.6 ± 50.9; HA: 74.25 ± 3.6; HD: 29.1 ± 1.3) are significantly higher ($P < 0.01$) than those measured during matches (PL: 354.2 ± 12.4; HA: 18.15 ± 0.94; HD: 8.5 ± 0.5), when expressed in absolute values. On the contrary, when expressed in relative values, the average values measured during training sessions (PL: 7.75 ± 0.08; HA: 0.36 ± 0.01; HD: 0.15 ± 0.006) are significantly lower ($P<0.01$) than those measured during matches (PL: 9.3 ± 0.13; HA: 0.48 ± 0.02; HD: 0.22 ± 0.012). Mean TMR values are also significantly higher when expressed as absolute values (PL: 6.5 ± 0.75; HA: 5.12 ± 0.37; 5.13 ± 0.45) compared to relative values (PL: 0.84 ± 0.009; HA: 0.84 ± 0.03; 0.81 ± 0.05)
CONCLUSION:
This study gives information to optimize training weeks with ReV and AbV of external load, and is the first study focused on TMR in handball

BODYENERGYEXPENDITURE: AUTOMATIC MEASUREMENT OF ENERGY EXPENDITURE ASSOCIATED WITH PHYSICAL EXERCISE

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INTRODUCTION:
The measurement of energy expenditure during physical exercise is a fundamental tool in evaluating and managing sports training programs. The management of training load and physical effort during competition and physical fatigue measurement require real-time energy expenditure measurement to continuously monitor effort, allowing to achieve better performances [1]. The energy expenditure measurement associated with physical exercise can be accomplished indirectly using wearable devices that acquire in real-time multiple metrics, known to be correlated with the variable of interest. Based on the different methods, this study aimed to develop a prototype for a wearable device for that purpose, based on the use of different sensors and complemented by the implementation of the necessary data fusion methods. Both the device and fusion algorithms were validated experimentally.
METHODS:
Experiments were carried out in a controlled environment where twenty participants ran on a treadmill at different speeds. The subjects were instrumented with a prototype made up of various sensors distributed all over the body for real-time data recording. The acquired signals were later processed and integrated into mathematical models developed for the estimation of energy expenditure. In total, three cross-validated multiple linear regression models were trained: one model containing only physiological signals (heart rate (HR), muscle oxygenation (SmO2) and electrodermal activity (EDA)) as features; one model containing only accelerometry signals as features; and one model based on both physiological and accelerometry features. Pearson's correlation was computed to assess the correlation between energy expenditure and the various acquired signals.
RESULTS:
The combination of signals led to slightly better performance on energy expenditure estimation, when compared to the separated models. The model combining physiological and accelerometry data had the lowest RMSE (0.6422 ± 0.0144 kcal/min). On the other hand, the model containing only accelerometry data had the highest RMSE (1.4474 ± 0.0228 kcal/min). As for the physiological data model, the RMSE was 1.0718 ± 0.0142 kcal/min. Heart rate had the greatest Pearson correlation coefficient value (0.9108) and the magnitude acceleration from the right upper leg the lowest (0.6117).
CONCLUSION:
The most reliable methods for measuring energy expenditure are expensive and require a laboratory environment to be used and specialists to interpret the results, which are not provided in real-time. For these reasons, they become hard and impractical to use in real-life situations. The proposed prototype presents an alternative, more practical, solution for energy expenditure measurement, allowing its use inside and outside the laboratory environment.
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ANTA AWARD: THE "DEVELOPMENT OF ALGORITHMS TO OBTAIN RELIABLE STRIDE-BY-STRIDE RUNNING KINEMATIC DATA IN REAL LIFE CONDITIONS (DARDAR)" PROJECT

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INTRODUCTION
When running in the outdoors, kinematic variables such as stride frequency (SF), duty factor (DF) and stride length (SL), are currently estimated with inertial measurement units (IMU) fixed at the foot, tibia or belt levels [1]. On the other hand, heart rate is an important physiological variable to assess while running, implying the need of at least two different sensors. Hence, we created and tested a deep learning algorithm able to estimate SF, DF and SL from a single IMU sensor embedded in a heart rate chest strap. As a first step, validation of the methodology has been conducted in laboratory settings against a gold-standard technology for running kinematic assessment.
Methods
After having determined their self-selected preferred running speed (PRS), 20 recreational runners (11 M, 9 F; mean (SD); age 25 (6); BMI 20.76 (1.75); running experience in years 5.9 (5.5); maximum aerobic speed in kph 17.3 (1.8)) were asked to run several 10-min treadmill bouts without slope for 10 min at 80%, 90%, 100%, 110% and 120%, in a random order. Then, the same participants were asked to run at 90% of PRS at different slopes (%): ±2, ±5, and ±8, in a random order. This allowed us to cover a broad range of speed/slopes
despite running on a treadmill. Gold-standard footstep frequency was assessed with an optical system (Optogait, 1 kHz). An IMU (Movesense HR+, 208 Hz) was placed at the thorax level and provided acceleration data. The data of 15 runners were used to train and test a convolutional neural network [2] designed to estimate SF and DF from a 2 sec sliding window of IMU data only. SL and TC were computed in post process from the locomotion speed and the SF and DF. The algorithm was tested on the remaining 5 runners, and the accuracy of the estimations (mean squared error) averaged on the two feet were evaluated.
Results
The algorithm was able to estimate: the SF with an error of 0.027(0.017) Hz and the DF with an error of 4.8(4.2) % (average of the two feet). Therefore, the resulting precisions were equal to the 1.2 % for SL (equal to 0.028 m on a SL of 2.38 m) and 12% for TC (equal to 0.03 s on a TC of 0.25 s). Additionally, we noticed that: 1) SF was slightly under-estimated in steeper (both uphill and downhill) conditions and in faster conditions, 2) DF might be slightly
over-estimated in uphill-steeper conditions and in faster conditions.
Discussion & Conclusion
The algorithm presented here can be used to reliably assess SF and DF from a single IMU fixed at the chest level in post process. Therefore, this research work, can trigger a number of other research studies interested in the assessment of running kinematic variables in ecological

conditions. Given the big amount of energy required to transmit the large amount of data required the next natural step of this research will consist in deploying this algorithm directly on the microprocessor embedded in the thorax sensor.
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OP-BM01 Cycling

COMPETITIVE CYCLISTS' FREELY CHOSEN CADENCE IS DEPENDENT ON PEDALLING HISTORY

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INTRODUCTION:
History dependence can refer to the phenomenon that a recent prior activity affects a subsequent motor output. An example of history dependence is that steady-state isometric force at a preset muscle length is lower and higher after active shortening and active lengthening of the muscle, respectively [1]. Another example is that freely chosen tapping rate in an index finger tapping bout is enhanced after a preceding tapping bout and a rest period. The latter has been termed repeated bout rate enhancement [2]. We investigated whether initial pedalling at relatively low and high preset target cadences affected the subsequent freely chosen cadence at the end of the same bout of submaximal ergometer cycling. The cadence that occurs during cycling has practical significance. The reason is, for example, that the cadence can affect physiological, and related, variables [3] - and thereby the result of a submaximal ergometer cycling test performed to evaluate training status [4].
METHODS:
Male (n=19) competitive cyclists performed a single test session that consisted of three separate bouts of submaximal ergometer cycling. In one bout, cycling at 60 rpm was followed by cycling at freely chosen cadence. In another bout, cycling at 110 rpm was followed by cycling at freely chosen cadence. In yet another bout (considered a reference-bout), the cadence was freely chosen throughout. Behavioural (cadence), biomechanical (internal power and tangential pedal force), and physiological (heart rate) responses were measured.
RESULTS:
Increased cadence resulted in increased internal power and decreased maximal tangential pedal force, and vice versa, in line with existing knowledge [5]. Initial cycling at 60 and 110 rpm affected freely chosen cadence at the end of the submaximal bout (where the cadence was freely chosen) to be, on average, around 7% lower and higher ($p<0.05$), respectively, than the reference freely chosen cadence (91±10 rpm). These differences in cadence were accompanied by differences in heart rate and tangential pedal force profile characteristics ($p<0.05$).
CONCLUSION:
The tested competitive cyclists' freely chosen cadence at the end of an ergometer cycling bout depended on the preset target cadence applied at the beginning of the same bout. The finding can be denoted a phenomenon of history dependence of the motor output of freely chosen cadence.
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TORQUE EFFECTIVENESS AND TRANSFER FROM A CIRCULAR TO A NON-CIRCULAR CHAINRING IN CYCLING

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INTRODUCTION:
Athletes must transfer their performance when equipment changed because of sports technical innovative developments. This can be accompanied by a temporary decrease in performance. Hence, an experiment was conducted in which participants must switch from a circular (C) to a non-circular (NC) chainring. Reported advantage of NC chainring is a more efficient force production and therefore a better pedaling technique. Torque effectiveness (TE) is the ratio of the tangential force to total force applied to the crank and represents in this study the pedaling technique. Since TE is dependent on both cadence and load, the participant´s task was to learn a cadence of 70 rounds per minute at 50 % individual watt maximum on a cycling ergometer.
METHODS:
Participants (N = 24) were randomly assigned to one experimental group (EG: n = 12 using both chainrings) and one control group (CG-NC: n = 12 using NC chainring only). It was examined if there is any transfer in the EG when chainring changes from C to NC. Participants were blindfolded to avoid visual information about the chainrings. Forces applied to the right pedal were recorded. During task acquisition and transfer, each condition was practiced for three blocks of multiple trials and lasted a total of 30 minutes. Participants in the EG practiced on two consecutive days (Day 1: acquisition condition C; Day 2: transfer condition NC) and CG-NC used the NC chainring on Day 2. Dependent variables were TE of the right pedal and total variability (E) of the cadence. TE and E were calculated for the last 20 crank rotations of each trial.
RESULTS:
All groups significantly reduced their E during the task, while TE remained constant over the blocks. We found an initial positive performance transfer for E (20.04 %), but not for TE. There was a significant difference for E between the EG and the CG-NC on Day 2 in block 1, with lower E for the EG, $t(22) = -3.09$, $p < .01$, $d = -1.26$. However, this difference leveled off until the end of practice (i.e., block 3).
CONCLUSION:
The results indicated that practice with C induce a positive transfer effect of NC regarding E. However, TE did not change within or between groups (EG, CG-NC), which support the aforementioned result. Contrary to the theoretical assumption, a change from C to NC chainring is not accompanied by a decrease in performance. The parameter TE was not affected when the chainrings were altered. Our findings showed no disadvantage when chainring changed from C to NC. One question that arises is if this positive transfer exists permanently.

UNIQUE NEUROMUSCULAR ACTIVATION OF THE RECTUS FEMORIS DURING CONCENTRIC AND ECCENTRIC CYCLING

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INTRODUCTION:
Cycling is a popular exercise for promoting health and improving athletic performance. The rectus femoris (RF) is a key muscle for athletic performance such as sprinting (Ema et al. 2018); therefore, neuromuscular information of RF during cycling would be important for the effective adoption of cycling exercise in individuals. The present study investigated the neuromuscular activation of the proximal and distal regions of RF, vastus lataralis (VL), and biceps femoris (BF) during concentric cycling and eccentric cycling at low to high power outputs.
METHODS:
Eleven untrained men completed 30 s of concentric cycling and eccentric cycling each at 5 power outputs of 100–300 W (every 50-W interval), with cadence at 60 rpm. During cycling, surface electromyographic (EMG) signals were obtained from the proximal and distal regions of RF (RFp and RFd), VL, and BF, and normalized to those obtained during maximal voluntary contraction. The rating of perceived exertion (RPE) was evaluated using the Borg Scale.
RESULTS:
The EMG amplitudes of VL and BF were 21.6%–67.6% higher ($P < 0.05$) during concentric cycling than during eccentric cycling at all power outputs, while those of RFp and RFd at 100–200 W were 29.6%–40.4% lower during concentric cycling as compared to those during eccentric cycling. The RPE was most similar between concentric cycling at 150 W and eccentric cycling at 250 W. There were no significant differences in the EMG for VL or BF between concentric cycling at 150W and eccentric cycling at 250 W; however, the RF EMG activity was greater during eccentric cycling as compared to that during concentric cycling. The VL had the highest amplitude, and the amplitudes of RFp (150–250 W) and RFd (100–300 W) during eccentric cycling were significantly higher than those of BF. There were no regional differences in RF activations.
CONCLUSION:
The VL and BF activations were smaller during eccentric cycling than during concentric cycling at all power outputs. However, the findings were not similar for the RF. RF activation was greater during eccentric cycling than during concentric cycling or similar for concentric cycling and eccentric cycling. There was the higher RF activation during eccentric cycling than during concentric cycling between the cycling types at a similar RPE. These suggest the greater RF activation during eccentric cycling than during concentric cycling at a given metabolic demand and a given power output. The magnitudes of RF activation during concentric cycling and eccentric cycling were smaller than those of VL, and those during eccentric cycling were higher than those of the BF. Intramuscular differences in RF activation were not found. These results showed the unique neuromuscular activation of the RF than other thigh muscles during concentric cycling and eccentric cycling.
1. Ema et al. Med Sci Sports Exerc. 2018;50:2085–2091

CROSS SECTIONAL DIFFERENCES IN RACE DEMANDS BETWEEN JUNIOR, UNDER 23 AND PROFESSIONAL ROAD CYCLISTS

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INTRODUCTION:
International road cycling categories, ruled by the Union Cycliste Internationale (UCI), provide three age-related categories which follow an international race calendar culminating with world championships: junior (JUN; 17–18 years), under 23 (U23; 19–23 years), and professional (PRO, > 23 years). Due to technological innovations, during the last decade a growing number of studies has been published describing professional road races' external and internal demands 1,2, comparing men and women races, 3 professional men races with different competitive levels4 and altimetric profiles5. However, to the best of our knowledge, no studies have yet cross-sectional examined both external and internal race demands in JUN, U23 and PRO. Therefore, the aim of this study was to compare the physical external and internal race demands of the three UCI age-limited road cycling categories: JUN, U23 and PRO
METHODS:
30 male cyclists divided into the three age-related categories ruled by the Union Cycliste Internationale (JUN, n=10; U23, n=10; PRO, n=10) were enrolled in this study. Data collected during the 2019 competitive season races were retrospectively analyzed. Race general characteristics, external and internal race demands were measured. Effect size is reported as partial eta squared $\eta 2$ or epsilon squared $\varepsilon 2$.
RESULTS:
Largely higher annual duration, duration per race, annual distance, distance per race, annual elevation gain, elevation gain per race, annual eTRIMP, annual total work, work per race and work per hour, were observed in PRO compared to U23, in PRO compared to JUN and in U23 compared to JUN ($p < 0.01$). PRO and U23 recorded large higher mean maximal power between 5 and 180 min compared to JUN ($p < 0.01$). eTRIMP per hour was largely higher in JUN compared to both PRO and U23 ($p < 0.01$). Accordingly, JUN spent much percentage time at high internal intensity zones (80-89% and 90-100% HRpeak), respect to U23 and PRO, while these two latter categories spent more time at low internal intensity zones (50-59%, 60-69% and 70-79% HRpeak) ($p < 0.01$).
CONCLUSION:
JUN races are shorter, more internal intense and include less elevation gain for distance unit compared to U23 and PRO races. JUN produce less power output in the moderate, heavy and severe intensity exercise domains respect to U23 and PRO (RPOs 5-180 min). U23 and PRO races presents similar work per hour and RPOs, however PRO races are longer than U23, Coaches and practitioners should consider these differences in talent identification and when planning training strategies.

ON THE ROAD TO CAMARÓN: THE SLEEP OF AN ULTRA-ENDURANCE ATHLETE CYCLING 10 000 KM IN 23 DAYS

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INSEP

INTRODUCTION:
The interaction between sleep and recovery is a fundamental issue for ultra-endurance athletes. Some investigations in extreme sports have showed that humans can maintain performance with a minimum of sleep (Netzer et al., 2020) but literature on this issue remains very scarce. The present case study allowed an examination of the link between sleep and performance in an ultra-endurance cyclist engaged in a simulated 10 000-km tour on a stationary bicycle from Paris (France) to Camarón de Tejeda (Mexico).
METHODS:
Actigraphy data (CamNtech, MotionWare 8) was collected for 16 days before the start of the study and during the study to assess the sleep-wake patterns of the 57-year-old ultra-endurance athlete (height, 1.85 m; mass, 81 kg). A night with a complete polysomnography portable device (Nox A1; Resmed) and a night of familiarization with a reduced-montage dry-electroencephalographic (EEG) device (Dreem headband; Arnal et al., 2020) were performed before the race. The athlete's sleep behaviour during the race (i.e. 23 nights) was monitored using the headband and the wrist activity monitor. Food intake as well as performance achieved on a daily basis (i.e. number of kms) were recorded for the duration of the race. Actigraphy and EEG data was collected during two nights after the race to follow the recovery.
RESULTS:
Baseline EEG values before the race revealed that the athlete slept a nightly average of 6.8 ± 1.3 h consisting of 42.4 ± 3.9% in light sleep (i.e. sleep stages 1 and 2), 29.7 ± 1.9% in deep sleep (i.e. stage 3), and 27.9 ± 2.1% in Rapid Eye Movement (REM) sleep stage. The athlete completed 10 477.8 km in 23 days with a mean±SD daily distance of 436.6 ± 57.9 km. During the race (23 nights), the athlete slept a nightly average of 5.2 ± 0.5 h consisting of 38.8 ± 11.3% in light sleep, 45.4 ± 7.3% in deep sleep, and 15.8 ± 5.6% in REM sleep. During the two recovery nights, the sleep duration increased to 7.4 ± 0.5 h consisting of 48.6 ± 7.5% in light sleep, 31.7 ± 3.2% in deep sleep, and 19.7 ± 4.4% in REM sleep.
CONCLUSION:
The present ultra-endurance event had a marked influence on sleep quantity reduction, alongside a profound modification in sleep architecture. The predominance of deep sleep during the race may be explained by the role of deep sleep into physiological restitution.
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INFLUENCE OF LONGITUDINAL SHOE-CLEAT POSITION ON JOINT COORDINATION IN PROFESSIONAL CYCLISTS

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INTRODUCTION:
Bike Fitting is a methodology that aims to optimize the configuration of the bicycle to the cyclist. Longitudinal shoe-cleat position is an important parameter in bike fitting methodology (1). Its effect on oxygen consumption and muscular activity have been addressed in the literature (1). Its effect on joint coordination during the pedal cycle has not received the same interest. Therefore, the purpose of this study was to examine the effect of three shoe-cleat longitudinal positions on joint coordination in experienced cyclists.
METHODS:
Lower extremity kinematic data were collected for twelve experienced cyclists (25 ± 6 years, 69 ± 7 kg and 1.78 ± 0.05 m) while pedaling with three different longitudinal shoe-cleat positions: under the first metatarsal head, 15 mm forward and 15 mm backward. A five-minute test was performed with a constant intensity corresponding to the power of 65% of VO2max. Three full pedaling cycles were recorded at second and fourth minute of the test. A dynamical systems approach, using vector coding technique was used to quantify coordination for Hip-Knee, Hip-Ankle, and Knee-Ankle joint couplings in the sagittal plane. Differences between the coordination patterns in the three shoe-cleat positions were assessed using one-way repeated measures (ANOVA). A post-hoc tests were calculated with Bonferroni correction for multiple comparisons. Significance level was set at $P < .05$. The magnitude of differences between the shoe-cleat positions were calculated as standardized differences.
RESULTS:
No effect of longitudinal shoe-cleat position was observed on the coordination pattern of Hip vs Knee joint couple. In the rest of the joint pairs analyzed, moderate to large differences were found between the backward and intermediate positions. The largest effects changes of shoe-cleat position on Hip vs. Ankle joint coordination were observed in the first half of the downstroke phase. A more backward position increased the time when hip and ankle extended at the same time. The largest effects changes of shoe-cleat position on Knee vs. Ankle joint pair coordination were observed in the second half of the downstroke phase. A more backward position increased the time when knee and ankle extended at the same time.
CONCLUSION:
A backward longitudinal shoe-cleat position increases the in-phase pedaling pattern (Hip vs. Ankle and Knee vs. Ankle), which is contrary to the pattern observed in experienced cyclist when comparing to novice ones (2). For this reason, from a coordination point of view, these results agree with two classical references in bike fitting (3, 4), recommending using the shoe-cleat position under the first metatarsal head in relation to a backward position.

COMPARATIVE STUDY ON PHYSIOLOGICAL INDEXES AND EXERCISE INTENSITY OF BIKE TRAINER AND TREADMILL

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INTRODUCTION:
Bike trainer training is an important way in cycling training, but bike trainers cannot simulate many real riding environments.With the development of high-speed treadmill, treadmill has become a new training method for cyclists. Treadmill riding is closer to real riding than

bike trainer, because cyclists need to maintain balance and relative position on treadmill riding. However, there is currently no comparison of physiological indexes between bike trainers and treadmill riding. This study compared the power output, blood lactate, heart rate and RPE when riding on bike trainer and treadmill.
METHODS:
Male cyclists (n=12, 20 ± 1.5yrs, BMI 22.0 ± 1.2, VO2max 70.9 ± 1.8 ml/min/kg, Wingat average power 10.3 ± 0.4 W/kg) try their best to ride for 5-min and 15-min on bike trainer and treadmill respectively. The heart rate, blood lactate, power output and RPE of cyclists were measured in the bike trainer and high-speed treadmill riding. The heart rate and blood lactate of cyclists were measured in the recovery. The results were compared by paired samples t-tests. A statistical level of $p< 0.05$ was accepted. Effect Size using Cohen's d Measure (d = 0.2, 0.5 and 0.8 correspond to small, medium and large effects).
RESULTS:
In 5-min test, the average power of bike trainer (413 ± 56 w) was significantly higher than treadmill (393 ± 56 w) ($p < 0.001$; d = 0.35）. In 15-min test, the average power of bike trainer (356 ± 39 w) was significantly higher than treadmill (340 ± 41 w) ($p < 0.001$; d = 0.40). At the end of the 5-min test, the blood lactate of bike trainer (9. 58 ± 2.32 mmol/l) was significantly higher than treadmill (6.76 ± 1.60 mmol/l) ($p < 0.001$; d = 1.42). At 10 minutes after the 5-min test, the blood lactate of bike trainer was significantly higher than treadmill ($p = 0.043$; d = 0.79). At 5 minutes after the 15-min test, the blood lactate of bike trainer (12.11 ± 3.19 mmol/l) was significantly higher than treadmill (9.98 ± 2.32 mmol/l) ($p = 0.034$; d=0.76). 10 minutes after the 15-min test, the blood lactate of bike trainer (9.99 ± 2.35 mmol/l) was significantly higher than treadmill (8.05 ± 2.41 mmol/l) ($p = 0.012$; d = 0.82). In 5-min test, the average heart rate of bike trainer was significantly lower than treadmill ($p < 0.001$; d = 0.14). In 15-min test, the average heart rate of bike trainer was significantly lower than treadmill ($p < 0.001$; d = 0.19) . There was no difference in RPE between bike trainer and treadmill during 5-min test. In 15-min test, the RPE of bike trainers (17.70 ± 73) was significantly lower than treadmill (19. 1 0 ± 0.82) ($p < 0.001$; d = 1.80).
CONCLUSION:
In the 5-min and 15-min test, the average power of the high-speed treadmill is significantly lower than the bike trainer, and the blood lactate of the treadmill is lower than the bike trainer. The average heart rate of treadmill riding was significantly higher than bike trainer riding, and the RPE of 15-min test was significantly higher than bike trainer. The high-speed treadmill is a new training mode for high-level cycling training, which is more simulating the real riding.

FEMALE PROFESSIONAL CYCLING: TRAINING CHARACTERISTICS AND THE RELATIONSHIP WITH PERFORMANCE

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INTRODUCTION:
Women's road cycling is developing rapidly together with technological developments (i.e. the introduction of the power meter), despite these developments, a limited amount of studies have studied the load and performance of female professional cyclists. Training volume and load have shown to be important components in the training programs of male cyclists, with higher training volume and load resulting in better performances[1]. As it is not known if these same principles apply to female cycling, this study aimed to describe the total duration and load (i.e. duration and sRPE [Rating of perceived exertion*duration]) of female cyclists in a season and investigated if mean maximal power outputs (MMPs) differed between successful (CAT.1) and less successful (CAT.2) female cyclists. Furthermore, this study aim was to determine if and how strong the relationships are between training load and performance in female professional cyclists.
METHODS:
Field data of 14 professional female cyclists of one team over 7 years and contained in total 43 seasons. Seasons were classified as either CAT.1 or CAT.2 based on the amount of procyclingstats points relative to the number of races (CAT.1 ≥ 5 points per race, CAT.2 < 5 points per race). Duration and load (sRPE) were determined based on the online logbooks of these professional female cyclists and the performances were based on MMPs for multiple durations (i.e. 5, 10, 30, 60sec, 3, 5, 10, 20, 60min) relative to their body weight. Differences between CAT.1 and CAT.2 were determined with a multilevel random intercept model using pairwise comparison. Pearson correlation (r) was used to determine the relationship between the total volume or load and the MMPs.
RESULTS:
No differences were found between the number of training sessions between CAT.1 and CAT.2 cyclists (264 vs 250 hours), in contrast, CAT.1 cyclists had a higher total duration (753 vs 634 hours) and total sRPE (5.8 vs 4.8 *105 AU) compared to CAT.2 cyclists. In addition, CAT.1 cyclists had higher MMPs for 60sec (9.0 vs 8.3 W·kg-1), 3min (6.4 vs 6.0 W·kg-1), 5min (5.8 vs 5.4 W·kg-1), 10min (5.3 vs 4.8 W·kg-1), 20min (5.0 vs 4.6 W·kg-1) and 60min (4.3 vs 4.0 W·kg-1) compared to CAT.2 cyclists while no differences were found for 5sec, 10sec, 30sec. Furthermore, longer durations MMPs (60sec-60min) had moderate to large correlations with the total duration and sRPE of the season.
CONCLUSION:
These results suggest that CAT.1 cyclists have a higher volume and load in the season and have a higher MMP for the longer durations (≥60sec) compared to CAT.2 cyclists. It seems that shorter duration MMPs are not related to training volume and load while longer duration MMPs improve with a higher volume and load. These results suggest that the limiting factor in some of the CAT.2 cyclists is the total volume and load in a season which could be caused by multiple factors.
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van Erp, T., D. Sanders, and R.P. Lamberts. MSSE. 2021: EPub Ahead of Print.

EIGHT WEEKS OF STRENGTH TRAINING IMPROVE EXERCISE ECONOMY AND RACE PERFORMANCE IN TRIATHLETES

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INTRODUCTION:
Triathlon is a multidisciplinary endurance sport that includes swimming (S), cycling (C) and running (R) in a single race [1]. The main physiological determinants of triathletes' performance are: maximal oxygen consumption (VO2max), Anaerobic Threshold (AT), and steady-state oxygen consumption ($\dot{V}O_2$) at given running velocity (RE) [2] or cycling power (CE) [3, 4]. These variables may be positively influenced by strength training (ST) [5] [6], although it is also known that ST can represent a detrimental stimulus for endurance performance if not adequately combined to endurance training (ET) [7]. The aim of this study was to investigate the effects of 8 weeks of ST, in combination to ET, on physiological response to exercise, muscle force and race performance in a Olympic triathlon (RACE).

METHODS:
Fifteen triathletes (age: 31±4) were recruited in the study. Each subject performed 8 weeks of ST (2 session per week) combined with endurance training for S (5±2 km·wk-1), C (102±30 km·wk-1) and R (26±7 km·wk-1). Before (PRE) and after (POST) the intervention, pulmonary O2 uptake (V̇O2) and other respiratory and cardiovascular variables were determined during an incremental maximal test followed by a verification trial for both R and C. RE and CE were determined during a constant speed/work-rate exercise at moderate intensity. RACE (1.5 km S, 40 km C, and 10 km R) was organized on a flat course (38m of positive elevation). Rate of perceived exertion (RPE) was monitored by Borg scale and a chest band monitored heart rate (HR). Data regarding speed and pace were obtained by a GPS system positioned on the athletes' wrist. Maximal voluntary strength (MVS) was assessed in knee extensors muscles: i) before the race (T0); ii) after S (T1); iii) after C (T2) iv) and after R (T3).
RESULTS:
In POST, VO2max and AT did not change from PRE in both C and R. RE (195±10 vs 211±15 mlO2/kg/km, POST vs PRE; P<0.001) and CE (13±2 vs 14±1 mlO2/min/w, POST vs PRE; P=0.006) significantly improved after ST. MVS was significantly higher in POST (620±151N) compared to PRE (565±120N, P=0.02), showing a similar reduction during RACE (18±9 %). RACE performance significantly improved in POST (156±15min) compared to PRE (159±16min P=0.004).
CONCLUSION:
This study confirms that the addition of ST sessions to traditional ET can improve performance in an Olympic triathlon race by reducing exercise economy and improving maximal isometric strength, without detrimental effects on other physiological parameters related to performance. Coach and triathletes should take into consideration exercises aimed to improve strength of lower limb during definite periods of training in order to improve race performance.
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OP-BM02 Neuro Central / Spinal drive

EFFECTS OF ELECTRICALLY-EVOKED OR VOLUNTARY LOW-LEVEL CONDITIONING CONTRACTIONS ON EXPLOSIVE, ISOMETRIC KNEE EXTENSIONS

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INTRODUCTION:
Conditioning muscle contractions can be used to positively effect contractile properties and increase twitch rate of torque development of a subsequent explosive muscle contractions (1). The conditioning stimuli can be generated electrically or voluntary (1). However, depending on the type and intensity of the performed contraction, potentiation may vary due to different involvement of corticospinal structures (2,3).
Here, we aimed at comparing the effect of electrically-evoked (by neuromuscular electrical stimulation, NMES) vs voluntary conditioning contractions performed immediately prior to explosive isometric contractions of the knee extensors.
METHODS:
Twenty participants performed 9 repetitions of a conditioning contraction (CC) immediately followed by an isometric explosive contraction of the knee extensors. CC consisted in 10 sec NMES train (100Hz, 1000μs) (STIM) at an intensity selected to initially evoke the 10% of the Maximal Voluntary Contraction (MVC), or in a voluntary contraction (VOL) mimicking the STIM CC. These two conditional approaches were tested in two different days.
The explosive contraction was performed by asking the participant to reach the target (70% MVC) as quickly as possible. Mean Torque, Peak Torque, Torque Time Integral (TTI), Rate of Torque Development in the 0-50ms ad 0-200ms time window (RTD50; RTD200), Time to reach the Target and Time to Peak Torque were evaluated.
RESULTS:
Mean Torque, Peak Torque and TTI of the explosive contractions were similar between protocols with a difference of 0.23% (p=0.920), 0.24% (p=0.870) and 0.68% (p=0.530) respectively. Similarly, Mean Torque and TTI of the conditioning-contractions were equivalent in the two protocols with a difference of 0.79% (p=0.553) and 1.79% (p=0.197) respectively.
Time to Peak Torque of the explosive contractions was lower when preceded by STIM CC (-12.7%, p=0.019) while the Time to Target was similar (STIM=0.98±0.38; VOL=1.04±0.48 sec; p=0.632). Also, the RTD50 was 37.3% higher after the STIM CC (STIM=215.15±193.5; VOL=135.1±159.8 Nm*s-1, p=0.027). On the other hand, the RTD200 was not significantly different between protocols with a difference of 13.3% (STIM=324.2±159.7, VOL=281.0±177.8 Nm*s-1; p=0.287).
CONCLUSION:
Voluntary CC impaired the explosive characteristics (lower RTD and time to peak) of the 70%MVC muscle contractions generated by knee extensors as compared to STIM CC. This may be due to central fatigue (i.e. reduction in descending drive) that has been shown to occur even with low-level voluntary efforts (4). If the improvement of explosive force generation is the goal of a training protocol that also includes conditioning muscle contractions, these last should be elicited by NMES rather than generated voluntarily.
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ACUTE EFFECTS OF ELECTRICAL STIMULATION PULSE WIDTH AND FREQUENCY ON NEUROMUSCULAR FUNCTION

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INTRODUCTION:
Contrary to conventional neuromuscular electrical stimulation (NMES) that mainly activates motor axons, wide-pulse (WP) NMES is thought to also favour the recruitment of sensory axons, potentially resulting in greater neural adjustments. While WP NMES has mainly

been used at low stimulation intensities to maximize extra torque, its application at the maximal tolerable intensity – which is known to be more effective for conventional NMES – is rare. Therefore, the aim of the present study was to compare acute neuromuscular changes induced by 20 min of maximal intensity WP and conventional NMES of the knee extensors. We hypothesised that the use of WP NMES would change excitability within the neuromuscular pathway.
METHODS:
After a familiarization visit, 17 men (27±6 years) performed three sessions, each consisting of neuromuscular testing before (PRE) and after (POST) a 20-min NMES protocol. The three NMES protocols (randomly presented) consisted in the following pulse width-frequency configurations: 0.2 ms-50 Hz (CONV), 1 ms-50 Hz (WP50), and 1 ms-100 Hz (WP100). Thirty 10-s contractions at maximal tolerable intensity were evoked during each protocol, with 30-s periods of rest in-between. NMES-evoked torque and the associated discomfort were assessed for each protocol. The neuromuscular outcomes were knee extensors maximal voluntary contractions (MVC) torque, voluntary activation (VA), doublets (Db) torque, and vastus lateralis electromyography signals [i.e. M-wave (Mmax), spinal reflex (SR), thoracic motor evoked potential (TMEP) and motor evoked potential (MEP)] evoked using electrical and magnetic stimulations during submaximal knee extensors contractions at the electromyographic level associated with 20% MVC. Intensities were set to evoke SR, TMEP and MEP responses of ~20% Mmax amplitude at PRE.
RESULTS:
No significant differences were found in NMES-evoked torque (range: 10-74% MVC; p=0.24) and associated discomfort (p=0.17) between the three NMES protocols. Decreases in MVC torque at the end of the protocols (-14.1%; p<0.001) were not significantly different (p=0.39) between NMES protocols. Peripheral alterations were shown by decreased in Db (-6.1%; p<0.05) and Mmax (-13.4%; p<0.01) amplitudes, though these alterations were not different between protocols (p=0.33 and 0.16, respectively). VA was not affected for all protocols (p>0.32), suggesting no NMES-induced failure in central drive. Similarly, SR/Mmax, TMEP/Mmax and MEP/Mmax ratios were unaltered for all protocols (p>0.11), suggesting unchanged spinal, motoneuronal and cortical excitability, respectively.
CONCLUSION:
This study demonstrated that 20 min of NMES applied on the knee extensors at maximal tolerable intensity induced peripheral but not central alterations regardless of pulse width and stimulation frequency. These results contrast with recent findings suggesting neural adjustments when WP NMES is applied on plantar flexors at low stimulation intensity.

CAN PROLONGED LOCAL VIBRATION ALTER PERSISTENT INWARD CURRENTS STRENGTH?

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INTRODUCTION:
Local vibration (LV) to a relaxed muscle or its tendon is a powerful stimulus to activate muscle spindles and induce excitatory drive from Ia afferents onto alpha motoneurons. Paradoxically, this excitatory input may also depress motoneuron excitability after prolonged LV [1]. Persistent inward currents (PICs) are activated in motoneurons through voltage-dependent channels, amplifying and prolonging the effects of synaptic input [2]. PICs are enhanced by descending monoaminergic drive from brainstem (i.e. serotonin and noradrenaline release) [2]. Given that afferent stimuli can affect serotonergic neurons in the brainstem, we hypothesised that prolonged LV could alter serotonin release, impairing PIC activity. Thus, the aim of this study was to examine the effect of prolonged LV on PIC strength in tibialis anterior motoneurons.
METHODS:
High-density surface electromyography (HD-EMG) of the tibialis anterior was recorded from a grid of 64 electrodes. Before (PRE) and after (POST) 30 min of 100-Hz LV of the tibialis anterior muscle, 15 male subjects performed 3 isometric triangular contractions of the dorsiflexors to 50% of maximal voluntary torque. After HD-EMG decomposition and tracking of the same motor units (MUs) across contractions, one trial from each time point was selected for the estimation of PIC strength through a paired MU analysis [3], which quantifies MU recruitment/derecruitment hysteresis (ΔF). For each MU pair, the hysteresis of a higher-threshold MU (test unit) was quantified by calculating the difference between the instantaneous discharge rates of a lower-threshold MU (control unit) at recruitment and derecruitment of the test unit. A repeated-measures nested linear mixed-effects model analysis of the whole sample of test units was performed to investigate the effect of prolonged LV on ΔF and a repeated-measures correlation was used to investigate an association between LV-induced changes in ΔF and MU recruitment threshold at PRE.
RESULTS:
HD-EMG decomposition detected 15.1 ± 7.7 MUs per participant, with 9.1 ± 5.3 test units and 41.6 ± 39.0 pairs of MUs to quantify ΔF. ΔF at PRE was 5.4 Hz (95% CI: 4.7 to 6.1 Hz). There was no significant change (p = 0.53) of ΔF from PRE to POST, with a mean difference of 0.08 Hz (95% CI: -0.2 to 0.3 Hz). However, we observed a moderate repeated-measures correlation between LV-induced change in ΔF and MU recruitment threshold (R(rm) = -0.40; p < 0.001).
CONCLUSION:
When considering the whole sample of test units, LV had no effect on the estimate of PIC strength (ΔF). Our results suggest, however, that there is a differential effect of LV on MUs depending on their recruitment threshold. Future research could usefully explore the mechanisms underlying this differential effect on PIC activity after prolonged LV, and its potential implications.
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A -LACTOALBUMIN SUPPLEMENTATION DOES NOT INCREASE PERSISTENT INWARD CURRENTS IN HUMAN SOLEUS MUSCLE

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INTRODUCTION:
Neuromodulation is a fundamental part of normal motor command. In particular, monoamines (serotonin and noradrenaline) facilitate persistent inward currents (PICs) in motoneurons. PICs amplify and prolong synaptic input allowing motor units to fire at higher frequencies, as observed during normal motor behaviour. It has been suggested that PIC amplitude is proportional to the monoaminergic input (serotonin) to motoneurons and may act as a variable gain control mechanism for the motor system. In humans, PIC amplitude can be estimated by calculating the delta F (ΔF) using motor units discharge rates during recruitment and de-recruitment. Serotonin's only precursor is the amino acid tryptophan (TRP) and the use of TRP rich supplements (such as α-lactalbumin) has shown effects on behaviour (e.g.

sleep and mood) and cognition. This suggests that the serotonergic system can be affected by the consumption of TRP rich proteins. The aim of the present study was to evaluate if the consumption of α-lactalbumin could influence estimates of PICs (measured through the paired motor unit technique) in human soleus muscle.
METHODS:
In a crossover, double-blind design, 10 participants were asked to visit the laboratory on two occasions. For each visit, participants performed isometric submaximal triangular contractions (20% of their maximum force) with their plantar flexor muscles. Surface electromyography (EMG) was recorded from two 32-channel electrode matrix over soleus muscle. EMG signals were decomposed into single motor unit discharge events and then converted into instantaneous discharge rates. ΔFs were calculated for pairs of motor units using a fifth order polynomial fit. All testing measurements were performed before and 90 min after consuming either a placebo (PLA) or 40g of α-Lactalbumin (LAC).
RESULTS:
No differences were observed for ΔF between PLA and LAC (p=0.35). Changes in ΔF pre-post supplement were 1.94 (95%CI: 1.44 – 2.44) to 2.16 pps (95%CI: 1.66 – 2.66) for PLA and 2.47 (95%CI: 2.02 – 2.92) to 2.53 pps (95%CI: 1.64 – 3.19) for LAC.
CONCLUSION:
Our results indicate that the consumption of 40g of LAC was not able to upregulate PIC amplitude of human soleus muscle. Possibly due to the inability of LAC to increase the presence of serotonin within the spinal cord.

RESPONSES TO TRANSCRANIAL MAGNETIC STIMULATION OVER BOTH MOTOR CORTICES FOLLOWING UNILATERAL CONCENTRIC VERSUS ECCENTRIC EXERCISE OF THE ELBOW FLEXORS

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INTRODUCTION:
The cross-education effect on strength is greater after eccentric (ECC) compared to concentric (CON) training (1). However, the neurophysiological mechanisms leading to the cross-education effect remain less clear. We have previously reported that a single session of ECC exercise induces greater and longer lasting modulation of responses to cortical stimulation for the exercised elbow flexors compared to CON exercise (2), but less is known about what happens to the contralateral non-exercised homologous muscles. Thus, we compared responses to transcranial magnetic stimulation (TMS) over both motor cortices to assess corticospinal and motor cortical changes following unilateral CON versus ECC exercise of the elbow flexors.
METHODS:
In a randomised cross-over design, 11 adults (9 males, 2 females) performed 3 sets of 10 CON or ECC right elbow flexor contractions (3 second repetition duration) at 75% of respective one-repetition maximum. During this time the left arm was kept by the participants' side and remained at rest. Pre- and post-exercise, maximal voluntary isometric contraction (MVIC) force of the elbow flexors was measured, and single- and paired-pulse TMS assessed resting motor threshold (RMT), motor evoked potentials (MEPs), short- and long-interval intracortical inhibition (2- and 3-ms [SICI2, SICI3] and LICI), and intracortical facilitation (ICF [10-ms]) from both motor cortices. The conditioning stimulus intensity was set to evoke ~50% of the maximum inhibition achievable for the measurement of SICI. Post-exercise, a single right arm MVIC was performed, and then TMS responses were recorded from the left biceps first (~1-10 min post-exercise), followed by the right biceps (~11-20 min post-exercise). Changes in variables pre- to post-exercise were compared between CON and ECC, and between arms by repeated measures analysis of variances.
RESULTS:
MVIC force decreased (P<0.01) after CON (-29±13%) and ECC (-38±13%) exercise without a significant difference between conditions. For the non-exercised left biceps, RMT decreased after CON only (-4.5±3.8% of maximum stimulator output [MSO], p<0.01) and ICF decreased after ECC only (-15.6±20.0%, P=0.028). For the exercised right biceps, RMT increased after ECC only (5.5±5.8% MSO, P=0.01). No significant changes in MEP/MMAX ratio, SICI2, SICI3 and LICI were found after CON and ECC exercise.
CONCLUSION:
Unilateral CON and ECC exercise of the elbow flexors appears to elicit different effects on the excitability of the two motor cortices. However, it is unclear whether the lower ICF and higher RMT observed in the non-exercised arm after ECC plays a role in the known greater cross-education effects with repeated ECC training (1). Thus, further research is required to understand the initial mediating factors that may lead to longer term cross-education effects more clearly.
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2) Latella et al., Scand J Med Sci Sports, 2019

ENTRAINMENT BY RUNNING STEP FREQUENCY SET UP THE CARDIOLOCOMOTOR SYNCHRONIZATION

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INTRODUCTION:
The muscle activation is elicited by the neural drive, which is the sum of the spiking activities of motor neurons. External oscillators may influence the neural drive, probably generating the coherence phenomenon between two signals from different sources (1). We speculate that free-running step frequency (SF) is an external locomotor condition able to pair, by neural control, the cardiac and muscle oscillator frequencies (2,3). That external condition, in turn, could generate a common frequency-inducing synchronization of both signals, known as cardiolocomotor synchronization (CLS), and which can be recognized as entrainment bands of frequencies. We tested the hypothesis that CLS in running spontaneous conditions would emerge at entrainment bands of muscle activation frequencies associated to free chosen SF.
METHODS:
Sixteen male long-distance runners undertook a treadmill assessment running ten three-minute bouts at different speeds (7, 7.5, 8, 9, 10,11, 12, 13, 14, and 15 km·h-1) into two sessions of 5 submaximal bouts of treadmill running interspersed by at least 48 hours. The order of the speeds was randomized over two days. Electrocardiography (ECG) and surface electromyography of the vastus lateralis (VL) and gastrocnemius medialis (GM) muscles were recorded simultaneously with the same signal conditioner to determine the center frequency and CLS. From the ECG signal, the heart rate (HR) was calculated from the reciprocal of R-R time in Hertz. For the SF determination, we have utilized a 120 Hz sample frequency camera to record the last two minutes of each bout. The center frequency was the mean of the

frequency spectrum obtained by wavelet decomposition, while CLS magnitude was determined by the wavelet coherence coefficient (WCC) between the electrocardiography and center frequency signals. The WCC strength magnitudes were very weak (0–.19), weak (.20–.39), moderate (.40–.59), strong (.60–.79), and very strong (.8–1). We assumed that the spontaneous CLS emerged at a WCC ≥ .8.
RESULTS:
The speed affected the HR and the SF; thus, both increased as speed increased. However, the speed did not affect the WCC coefficient values for the temporal series ECG-VL and ECG-GM. At all speeds, for both temporal series, the WCC coefficients were classified as weak synchronizations. The strength of CLS affected the entrainment frequencies between cardiac and muscle systems, for WCC values greater than 0.8 the entrainment frequency was between 2.7-2.8 Hz, confirming our hypothesis. The CLS emerged at faster speeds (13-15 km·h-1) most prevalently but did not affect the muscle activation bands.
CONCLUSION:
Spontaneous CLS occurred at faster speeds predominantly and the entrainment frequencies matched the locomotor task, with the entrainment bands of frequencies emerging around the step frequencies (2.7–2.8 Hz).

VIRTUAL REALITY CAN ALTER SPINAL EXCITABILITY

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C3S - EA4660

INTRODUCTION:
Virtual Reality (VR) is known to induce important brain activations at the level of sensorimotor regions, particularly when participants can interact within their virtual environment (1). However, the question to which extent virtual reality can trigger the sensorimotor system, and more particularly if it can reach lower nervous levels such as the spinal system, remains open. Here, the aim was to assess whether VR simulation of postural challenging and stressful situations (Richie's Plank Experience) can interfere with spinal excitability of postural muscles.
METHODS:
For this preliminary experiments, 8 healthy young participants were enrolled. To assess spinal excitability, H-reflexes of triceps surae muscles have been elicited through electrical nerve stimulation while participants were standing. Participants were equipped with VR headsets. VR set-up consisted in an urban environment in which participants evolved. Participants went through several conditions and situations, during which stimulations were evoked: standing quiet out of VR (noVR), standing in VR at ground level on the street (groundVR), standing on the edge of a builduing (plankVR) and falling from the building (fallingVR). Myoelectrical activity of the triceps surae, body oscillation and head movements were measured throughout the experiment.
RESULTS:
No differences in head rotations and myoelectrical activity was found between conditions. While triceps surae Hreflex (soleus and gastrocnemius Hmax/Mmax) was not affected from noVR to groundVR, a tendency toward a decrease has been observed between noVR and plankVR. The most significant finding was a drastic decrease of Hreflex during falling (-47±26.9 % between noVR and fallingVR, p=0.015).
CONCLUSION:
In actual falling, it has been suggested that spinal excitability might be influenced by vestibulo-spinal projections (2). However, in quiet standing, such as during VR, postural oscillations are not sufficient to activate reflex modulation by the vestibular system (3). On the contrary, visual feedback could have their importance in modulating the spinal excitability even in a quiet posture. A complex visual environment, for example, could also depress the amplitude of the H reflex (4). Here, the absence of difference between noVR and groundVR demonstrated that visual cues cannot solely explain these results. Finally, spinal excitability is also reduced when standing on the edge of a raised platform, revealing that postural anxiety can lead to a reduction of H-reflex (4). As a consequence, in the present study such a decrease of spinal excitability during simulated falling might rather be attributed to inputs from the brain which responds to a situation of danger.
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OP-BM03 Muscle Tendon FCT

COMPARISON OF PHYSICAL, PSYCHOLOGICAL AND INJURY-RELATED OUTCOME MEASURES IN SUB-ELITE MALE YOUTH SOCCER PLAYERS WITH JUMPER'S KNEE: EFFECTS OF A CONVENTIONAL VERSUS AN ALTERNATIVE THERAPY PROGRAM

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INTRODUCTION:
Jumper´s knee (JK), also known as patellar tendinopathy is one of the most prevalent knee disorders in young athletes (1). Conventional (CON) therapy includes eccentric strengthening and stretching of the quadriceps muscles (2). However, effectiveness of this treatment is often unsatisfactory. A novel alternative (ALT) therapy program promises to improve physical, psychological, and injury-related outcome measures by adding isometric strengthening and stretching of the hamstring muscles, as well as proprioception and core stability exercises to the conservative treatment routine. Thus, we examined the effects of a CON versus an ALT therapy program on physical, psychological, and injury-/pain-related parameters in soccer players with JK.
METHODS:
Thirty-four sub-elite male youth soccer players (age range: 15-16 years) with JK were randomly assigned to a CON (n=18) or an ALT (n=16) therapy program. Both programs were conducted until no pain was reported along with full training load. Assessments of muscle power (drop jump, jump-and-reach), change of direction speed [CODS] (acyclic sprint), speed (tapping, 30-m linear sprint), endurance (Yo-Yo intermittent recovery test level 1), the Achievement Motives Scale (AMS) Sport, and injury-/pain-related correlates were performed immediately (T1), 6 (T2), 16 (T3), and 20 weeks (T4) after the respective therapy program.
RESULTS:
Players in the ALT compared to those in the CON group required a shorter program duration (ALT: 47.1±15.6 days, CON: 58.2±24.6 days) and achieved the same (muscle power, speed, endurance) or partially larger (CODS) improvements in physical performances, the same

enhancements in psychological measures (achievement motives), and better values for injury-/pain-related correlates (injury incidence, training interruptions due to pain).
CONCLUSION:
Our results indicate that both, the CON and the ALT therapy programs are effective to enhance physical, psychological, and injury-/pain-related parameters in players with JK. Additionally, the ALT therapy seems to be more efficient than the CON therapy due to the lower program duration.
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RELATIONSHIPS BETWEEN ARCHITECTURE OF TRICEPS SURAE MUSCLE-TENDON UNIT AND KINETIC AND KINEMATIC RESPONSES TO OPTIMAL-HEIGHT DROP JUMPS

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INTRODUCTION:
This study examined the relationships between architecture of triceps surae muscle-tendon unit (MTU) and kinetic and kinematic responses to drop jumping (DJ). Stretch-shortening cycle (SSC) has long been claimed to be attributable to architecture of MTU and joint kinematics. In order to examine SSC effect and to attenuate the possible effects of varied individual responses, subjects performed DJs from optimal heights which maximized their reactive strength index (RSI).
METHODS:
Six healthy, physically active male (age:21.6±1.2yr, height:181.8±8.9cm, mass:84.6±10.4kg) with no history of any medical condition participated to the study. Two-dimensional ultrasonography was used to assess architecture of triceps surae MTU. Passive muscle and tendon stiffness of the plantar flexors were estimated.
The subject-specific optimal drop height (ODH) was determined after a series of DJs. The drop height at which peak RSI has been achieved was considered as the ODH. 3D kinetics and kinematics of lower limb during five DJs from the ODH were investigated. Spatio-temporal changes in vertical ground reaction force (vGRF) and joint angles for hip, knee and ankle were calculated.
Several parameters including duration (T), displacement (D), rate of force development (RFD), peak power (PP) and work (W) for eccentric (ECC) and concentric phases (CON) of landings were calculated. Jump height (JH), take-off velocity (TOV), flight, contact and ECC-CON transition time were also determined (1). Spearman correlation coefficients were used to determine relationships between the parameters.
RESULTS:
The statistics revealed that higher ECC-W is likely to be a precursor for better CON-RFD (r:0.886) which results in higher RSI and JH. RSI was significantly positively correlated with ECC-D and CON-PP (r=-0.943) CON-W, coupled with TOV, was negatively associated with Achilles tendon (AT) stiffness (r=-0.829). There was a moderate negative correlation between RSI and AT stiffness (r=-0.771). None of the muscles' stiffness seemed to contribute RSI except the stiffness of Medial Gastrocnemius (MG) which was associated with ECC-RFD (r=0.829).
Sum of the sagittal plane joint flexion angles at landing was negatively associated with ECC-PP, ECC-W (r=-0.829) and subsequent CON-RFD (r=-0.943). Increased knee and hip flexion angles lengthened the contact time. Low AT stiffness was correlated with increased valgus and eversion angles (r=0.928).
CONCLUSION:
The results indicated that muscle stiffness and eccentric work positively, tendon stiffness and concentric work inversely correlated during DJs. If subjects landed in a more erect posture (more extended ankle, knee, and hip), both ECC-W and CON-RFD would be lower. Our data offers further evidence to the findings of a recent study (2) that MG stiffness could be considered as one of the factors that influence DJ performance.
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MECHANICAL PROPERTIES AND UTE-T2* RELAXATION TIME IN PATELLAR TENDINOPATHY: THE EFFECT OF LOAD MAGNITUDE IN EXERCISE-BASED TREATMENT

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INTRODUCTION:
Loading intervention is currently the preferred management of tendinopathy, but to what extent different loading regimes influence the mechanical response in tendons is scarcely investigated. Therefore, the purposes of the investigation were to examine the effect of exercise interventions with either high or low load magnitude applied to the tendinopathic patellar tendon and the influence on its mechanical, material and morphological properties.
METHODS:
Forty-four men with chronic patellar tendinopathy were randomized to 12 weeks of exercising with either; 55% of 1RM throughout the period (MSR group) or 90% of 1RM (HSR group), and with equal total exercise volume in both groups. Mechanical (stiffness), material (T2* relaxation time) and morphological (cross sectional area (CSA)) properties were assessed at baseline and after 12 weeks of intervention. MRI with ultra-short echo times (UTE) and T2*-mapping was applied to explore if T2* relaxation time could be used as a noninvasive marker for internal material alteration and early change thereof in response to intervention.
RESULTS:
There was no effect of HSR or MSR on the mechanical (stiffness), material (T2* relaxation time) or morphological (CSA) properties, but both regimes resulted in significant strength gain. Further, the T2*-mapping MRI UTE method is an evolving imaging technique for evaluating internal material alterations in chronic patellar tendinopathy, but needs further evaluations.

CONCLUSION:
There were no statistically superior effect of exercising with high (90% of 1RM) compared to low (55% of 1RM) load magnitude on the mechanical, material or morphological properties.

COMPARISON OF VASTUS LATERALIS AND MEDIALIS RATIO AND INTRAGROUP MUSCULAR PATTERN ACTIVATION IN MALE AND FEMALE PROFESSIONAL SOCCER PLAYERS

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INTRODUCTION:
More injuries occur in male's soccer, but it is in female soccer players that the most serious injuries occur (1). To help reduce stress on the knee, in addition of H:Q ratio, how each of the quadriceps and the hamstrings muscles are activated is important, which is called the activation pattern (2). This preliminary study aimed to determine if there are differences in vastus lateralis (VL) and vastus medialis (VM) ratio and intragroup muscular pattern activation in professional male and female soccer players for better understanding and application.
METHODS:
Muscle activation was recorded by surface electromyography in 10 professional soccer players (5 males and 5 females). The players performed the Bulgarian squat (BS) and lunge (LG) exercises. VM, VL, rectus femoris, semitendinosus (ST), and biceps femoris were the muscles analysed.
RESULTS:
The statistical analysis showed no significant differences between both legs ($p>0.05$) therefore only the results of the right leg are showed next. No significant differences were found between sexes in the H/Q ratio ($p>0.05$) but they were found in the VM/VL ratio. In both the LG and the BS the female players showed a smaller VM/VL ratio ($t8 = 3.41$; $p = 0.009$ and $t8 = 3.55$; $p = 0.008$ respectively). When analysing the differences in the intramuscular ratio in the LG exercise significant differences have been found between male and female players in the VL muscle ($t8 = 1.73$; $p =0.014$) and VM ($t8 =.19$; $p =0.022$) showing the female players lower levels of muscle activity in the VL and greater levels in the VM. Similarly, in the BS significant differences were found in the VM ($t8 = 1.159$; $p = 0.007$) and even though it was not a significant difference a tendency in the females can be seen with lower activity in the VL ($p=0.071$), BF (0.065) and greater activity in the ST (0.065) muscles. On the other hand, activation patterns have been used in soccer as a tool in the process of recovery from an injury. For the intragroup muscular pattern in the LG and BS exercises, the female players showed higher activation for the VL muscle ($p < 0.001$) than the male players and lower muscle activation in the VM. No significant differences were found in the rectus femoris, biceps femoris, and semitendinosus muscles ($p > 0.05$).
CONCLUSION:
No significant differences were found between sexes in the H/Q ratio but they were found in the VM/VL ratio. These patterns could be very useful in the recovery process from an injury to return players to their highest performance.
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ACUTE EFFECTS OF MODERATE BACKWARD RUNNING ON THE M. GASTROCNEMIUS MEDIALIS MUSCLE TENDON UNIT MECHANICAL AND ARCHITECTURAL PROPERTIES.

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INTRODUCTION:
Backward (BW) motion has been shown to have a positive effect on the spatiotemporal parameters of the forward (FW) movement [1]. BW walking or running can be seen as a series of eccentric contractions of the lower extremities muscle tendon unit (MTU) [2]. Effects of BW motion on the lower leg MTU properties was examined by means of long lasting interventions [3]. However, also short-term isometric contractions can alter the mechanical properties of the lower leg MTU [4]. Therefore, the aim of this study was to examine the immediate effect of moderate BW running on the lower leg MTU mechanical and morphological properties. We hypothesized that the BW, compared to FW running, will have greater effect on the triceps surae MTU mechanical and morphological properties.
METHODS:
Nineteen males (29±6y, 82±12kg, 180±7cm) randomly assigned in two groups (FW, BW) ran on a treadmill (6km/h) for 10min. We assessed synchronously in a pre-post manner, the mechanical and architectural parameters of the m. gastrocnemius medialis (GM) MTU by means of max. voluntary isometric plantarflexion contractions (HUMAC 2Khz), using ultrasound (Esaote AU5, 31Hz) and capturing the kinematics (Vicon, 200Hz) of the lower limb. A two-way ANOVA (pre-post x FW-BW) was used to find any interaction on the dependent variables (torque, fascicle length (FL), tendon-strain- and stiffness at 50-80% of the max torque; $p<.05$).
RESULTS:
We found no significant interaction on the most measured parameters (Torque:171±45-159±38, 195±39-198±46Nm, Strain:4.5±1.5-4.7±1.8, 5.3±1.3-5.5±1.1%, FL: 35±10-32±5, 32±5-32±5mm; for FW-BW and pre-post respectively). We found a significant main pre-post reduction effect of tendon stiffness in both FW & BW (Stiffness: 1.2±0.8-0.7±0.5, 1.0±0.5-0.7±0.3 kN/strain).
CONCLUSION:
DISCUSSION: The results showed that moderate 10min BW running does not affect the most mechano-morphological properties of the GM-MTU. The reduction of the tendon stiffness (45 % 21% for FW and BW respectively) suggests the existence of adaptational responses in both running modalities. Contrary, Joseph et al (2015) reported after prolonged BW (on decline, 60min) an immediate reduction of max torque, and post 24h an increase of tendon stiffness and a decrease in tendon strain. Similar Peltonen et al (2010) found after 1000 high impact landings no difference in the tendon stiffness. Those differences can be attributed to the load duration and/or the stiffness calculation method. In conclusion, it appears that 10min BW running reduces the tendon stiffness but the contrasting findings to long lasting interventions necessitates further studies to examine possible temporal tendon stiffness adaptational phenomena.
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THE EFFECTS OF ACTIVE HEAT ACCLIMATION ON MUSCLE-TENDON UNIT MECHANICAL PROPERTIES

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INTRODUCTION:
Repeated whole-body or localized heating has been suggested to increase muscle strength (1, 2), potentially due to positive changes in skeletal muscle contractile apparatus (3). However, the changes in the mechanical properties of muscle-tendon unit underlying these heat-induced effects remain unclear (4). This study aimed to determine the adaptations in the mechanical properties of gastrocnemius medialis (GM) muscle-tendon unit and their subsequent impact on motor performance elicited by repeated cycling exercise performed in heat. We expected an improvement in muscle contractile responses, potentially explained by positives changes in skeletal muscle structure, while the effect on muscle-tendon unit properties were exploratory.
METHODS:
Twenty-six recreationally active participants (27±5 yrs) were tested before (PRE) and after (POST) 13 low-intensity cycling sessions, distributed over a 17-days period, either in control (CON: ~22°C, ~35% relative humidity [RH]; n=13) or in hot ambient environment (HOT: ~38°C, ~60% RH; n=13). During testing, participants laid prone with their knee fully extended and their ankle flexed at 90°. Mechanical data, GM electromyographic activity and high-frame rate ultrasound images were collected during electrically-evoked twitch, explosive and maximal voluntary contractions (MVC), ballistic contractions (0 and 2.6 kg load), isokinetic contractions (30, 200 and 400°.s-1) and isometric ramp contractions (from 0 to 90% of MVC). Shear modulus was measured at rest by shear wave elastography in GM in neutral ankle position and in Achilles tendon using a dedicated ultrasound sequence with -25° of plantar flexion. Vertical jumps (i.e. squat jump, counter movement jump and multi-rebound jumps) were also assessed.
RESULTS:
Muscle and core temperature increased after exercising in HOT vs. CON (+2.4°C and +1.7°C, respectively, in HOT vs. +1.5°C and +0.8°C in CON; all $P<0.01$), resulting in effective heat acclimation with significant decreased core temperature and heart rate from the first to the last session (-0.46°C and -14 beats.min-1; both $P<0.01$), while core temperature was unchanged ($P=0.126$) and heart rate decreased in CON (-10 beats.min-1; $P=0.004$). PRE and POST peak twitch amplitude did not change in HOT and in CON (respectively, 16.4±6.6 vs. 15.9±5.0 N.m-1 in HOT and 17.9±5.3 vs. 17.3±4.7 N.m-1 in CON; both $P\geq0.48$), did not affect MVC peak torque (129±25 vs. 137±32 N.m-1 in HOT and 134±42 vs. 135±40 N.m-1 in CON; both $P\geq0.17$) and maximal power during vertical jump ($P\geq0.64$).
CONCLUSION:
Despite effective heat acclimation, no mechanical variables were altered, conversely to literature (2). The exploration of fascicle dynamic during variable loading conditions will provide insights regarding the alterations in muscle force-velocity properties with heat acclimation.
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OP-BM04 Motor learning and Motor control

ACUTE EFFECTS OF VARIOUS NOISE IN DIFFERENTIAL LEARNING OF ROPE SKIPPING ON BRAIN AND HEART RECOVERY ANALYSED BY MEANS OF FUZZY ENTROPY

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INTRODUCTION:
Neural and physiological effects of physical activity, depending on type, intensity and duration, have recently attracted increasing interest. However, the various influences on brain or cardiac function are usually studied separately and modeled linearly. Limitations of these models are now leading to an increasing number of studies based on nonlinear analyses, whose advantages lie in their application to nonstationary signals, higher computational efficiency, and the detection of nonlinear properties. Little is known about (neuro)physiological changes induced by different motor learning approaches. The aim of this study was to investigate the acute effects of a single bout of rope skipping (1) on brain and cardiac activity using fuzzy measure entropy (FuzzyMEn) dependent on different levels of noise within the theory of differential learning.
METHODS:
Thirty-two healthy male right-handers (27.3 ± 4.7 years) were randomly and equally distributed to one of four motor learning conditions with comparable cardiovascular demand: repetitive learning (RL), differential learning with a new instruction (1) every second (DL1), every ten seconds (DL10) and every twenty seconds (DL20). Each subject performed a single bout of rope skipping for three minutes in respect to the specific motor learning approach. Electroencephalography (EEG) and electrocardiography (ECG) were measured simultaneously at rest before and immediately after physical exertion for 25 minutes. After data preprocessing, the time signals were bandpass filtered for the calculation of EEG frequency band (theta, alpha, beta, gamma, total spectrum) and ECG specific FuzzyMEn. All entropy data were normalized to the individual resting phase before exercise.
RESULTS:
EEG frequency band and brain area specific significant changes in FuzzyMEn were found depending on motor learning approaches. Both acute effect and recovery analysis showed different trends of FuzzyMEn depending on frequency band and brain area over time. ECG

FuzzyMEn increased significantly immediately after exercise and decreased in subsequent recovery at rest for all motor learning approaches except DL20.
CONCLUSION:
Conducting rope skipping with different amounts of movement variations influences the complexity of cardiac and brain signals, especially depending on frequency content and brain lobes, during the recovery phase. The found effects of differential learning approach on the recovery metabolism reveal many additional opportunities for future interdisciplinary research areas.
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DIFFERENCES IN INTER-LIMB COORDINATION DURING POLYRHYTHMIC PRODUCTION BETWEEN ARTISTIC SWIMMERS WITH DIFFERENT LEVELS OF EXPERIENCE

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INTRODUCTION:
Artistic swimmers are required to perform very complex coordination tasks. They need to perform above-water movements in synchronization with music, while their under-water movements are performed in cycles to generate lift force to maintain their above-water height. To accomplish the complicated tasks, the ability to produce polyrhythmic motions is required so that artistic swimmers can perform above-water movements and under-water movements with different frequencies. The objective of the present study was to compare the polyrhythmic production capabilities among artistic swimmers with different level of experiences. It was hypothesized that artistic swimmers with a longer period of experience would have higher polyrhythmic production ability than artistic swimmers with lower levels of experience.
METHODS:
Sixteen artistic swimmers participated in the study. All participants were female and divided into two groups based on their experience in artistic swimming. The high experience group (mean age 23.1 ± 2.9 years) had participated in international and national competitions and 13.3 ± 2.6 years of artistic swimming experience. The low experience group (mean age 12.4 ± 1.9 years) had 5.1 ± 1.7 years of artistic swimming experience. Both groups conducted artistic swimming training regularly. Participants were asked to perform three finger and foot tapping tasks in synchronization with a metronome beat. Among the three tasks, one involved tapping with a single rhythm (every 750 ms with both finger and foot); the other two were polyrhythmic tasks (tap every 500 ms with the finger and every 750 ms with the foot, or vice versa). All tapping tasks were done using percussion pads (SPD ONE Percussion, Roland Corporation, Shizuoka, Japan) and recorded by Logic Pro X (Apple Inc., Cupertino, California, USA) at a sampling frequency of 44,100 Hz. All records were converted to a digital audio file (.wav format) and analyzed using MATLAB (R2017b, MathWorks, Inc., Natick, Massachusetts, USA). The percentages of correct response cycles (PCRC) were analyzed using a two-way mixed ANOVA (experience x task), and coefficients of variation of the inter-tap interval (CVITI) were analyzed using a three-way mixed ANOVA (limb x task x experience).
RESULTS:
The results showed a significant interaction between task and experience in PCRC ($F = 5.803$, $p = .008$). Among the three interactions between limb, task and experience in CVITI, only task x experience interaction was significant ($F = 3.813$, $p = .034$). Post hoc analysis showed that the two groups exhibited no statistical differences in the single-rhythm task between the groups. However, in polyrhythmic tasks, artistic swimmers with low experience were significantly outperformed by the high experience group in both PCRC ($p < .01$) and CVITI ($p < .01$).
CONCLUSION:
High experience artistic swimmers have better polyrhythmic production ability than their counterparts with low experience.

ACUTE CARDIOVASCULAR EXERCISE DOES NOT IMPROVE THE CONSOLIDATION OF A COMPLEX WHOLE-BODY TASK IRRESPECTIVE OF EXERCISE INTENSITY

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INTRODUCTION:
A single bout of cardiovascular exercise performed in close temporal proximity to skill practice has shown to enhance motor memory consolidation [1]. In this context, particularly high intensity exercise following practice demonstrated the largest effects [2]. While the majority of evidence is derived from simple fine motor skills, recent data form our lab suggest that results may differ in more complex whole-body tasks [3]. Thus, the aim of this study was to investigate the effects of post-practice exercise at different intensities on motor memory consolidation in a whole-body task.
METHODS:
For this purpose, 42 healthy young adults (age: 25.6 ± 4.6; BMI: 22.6 ± 2.3) practiced a novel balancing task, immediately followed by either (i) high-intensity interval exercise at 90%/60% Wmax (EX-H; n = 14), (ii) moderate-intensity interval exercise at 45%/25% Wmax (EX-M; n = 14), or (iii) seated rest (REST; n = 14) for 17 min. The motor skill required participants to balance on a tiltable (20°) platform (stabilometer) for 30 seconds. Participants performed five blocks of three trials (i.e. 15 trials) during skill practice, followed by a retention test (1 block of 3 trials) one day and seven days later. Time in balance (platform within ± 5° from horizontal) for each trial was calculated as the main outcome. Between-group differences in motor memory consolidation (i.e. offline gains = percent skill change from last practice block to retention blocks) were analyzed using ANOVA.
RESULTS:
Skill improvements during practice were comparable between groups ($F_{2,39} = 0.233$; $p = 0.793$). Similarly, no group differences existed for offline gains at 1- and 7-day retention tests, respectively (1d: $F_{2,39} = 2.351$; $p = 0.109$; 7d: $F_{2,39} = 1.323$; $p = 0.278$).
CONCLUSION:

Contrary to previous studies, we could not confirm beneficial effects of post-practice exercise on motor memory consolidation. Remarkably, the missing effects were irrespective of exercise intensity and evident at both, 1- and 7-day retention. The present data suggest that the promising findings gained from simple fine-motor skills might not generalize to more complex whole-body movements.
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OP-BM05 Shoulder

VALIDITY OF A FREEHAND THREE-DIMENSIONAL ULTRASOUND SYSTEM TO ASSESS SHOULDER MUSCLE GEOMETRY

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INTRODUCTION:
Function and capability of a skeletal muscle critically depend on its morphology and geometry. Although the freehand three-dimensional (3D) ultrasound system provides accurate assessment of muscle morphology and geometry [1], the accuracy has been validated by examining only fusiform and pennate muscles in lower limb. The purpose of this study was to verify the accuracy of the freehand 3D ultrasound system for measuring volume, cross-sectional area, and 3D surface geometry of the shoulder muscles that are assumed to difficultly measure due to its curvedness, broadness, and deepness.
METHODS:
The supraspinatus, infraspinatus, and posterior deltoid muscles of five healthy men were scanned in prone posture immobilized by a custom-made rigid support. Two-dimensional (2D) ultrasound images of the transverse plane were acquired by moving the ultrasound probe with reflective markers along with the muscle path several times for covering broad muscle geometry, while simultaneously measuring the 3D position and orientation of the ultrasound probe by a motion capture system. The 3D image was reconstructed from 2D images using a calibration between 2D images and 3D world coordinate system. Prior to the reconstruction, the spatial calibration was performed using a cross-wire phantom and consequently the 2D images could be reconstructed into 3D space with error of less than 0.3 mm in multiple sweeps. The boundaries of each muscle were manually segmented, and then volume, cross-sectional area, and surface distance were calculated. The parameters were verified by comparing those derived from 3T magnetic resonance imaging (MRI) with same posture of each participant.
RESULTS:
Differences in volume and area were -1.24 ± 4.39 cm3 and -0.18 ± 0.95 cm2 (less than 2%) for the supraspinatus, 0.90 ± 2.92 cm3 and -0.22 ± 0.49 cm2 (less than 2%) for the infraspinatus, and -0.31 ± 2.17 cm3 and 0.88 ± 1.62 cm2 (less than 7%) for the posterior deltoid. Average and maximal surface distances were 1.32 ± 0.28 mm and 6.29 ± 3.13 mm for the supraspinatus, 1.53 ± 0.37 mm and 6.81 ± 1.58 mm for the infraspinatus, and 2.23 ± 0.47 mm and 10.73 ± 1.61 mm for the posterior deltoid.
CONCLUSION:
The measurement errors of 3D ultrasound imaging with respect to MRI were negligible for the muscle volume, cross-sectional area, and surface geometry. Our findings demonstrate that the freehand 3D ultrasound system can be used for assessing muscle morphology and geometry even for the complicated shape of shoulder muscles.
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CORRELATION OF KINEMATICS WITH BALL VELOCITY IN BASEBALL PITCHERS DURING MAXIMAL EFFORT PITCHING: BETWEEN- AND WITHIN-SUBJECT COMPARISON

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INTRODUCTION:
Majority of the previous studies on the pitching mechanics in baseball have focused on the correlation of kinematic variations with the ball velocity between subjects. However, the within-subject pitching mechanics may not be as consistent as previously reported (1), and those findings on between-subject might not be applicable when instructing the pitching mechanics to increase ball velocity within an individual pitcher. Therefore, the purpose of this study was to identify and compare the between- and within-subject kinematic variables correlating with ball velocity in collegiate baseball pitchers during maximal effort pitching.
METHODS:
6 collegiate baseball pitchers performed a total of 58 maximal effort pitch trials (9 to 10 pitches per subject), and their kinematics were analyzed using a 200Hz three-dimensional motion capture system (Vicon Motion Systems, UK). Joint angle and angular velocity of each body segment at four instances (MKE: Maximum Knee Elevation, SFC: Stride Foot Contact, MER: Maximum Shoulder External Rotation, and BR: Ball Release) and three phases (Stride Phase: MKE-SFC, Arm Cocking Phase: SFC-MER, Arm Acceleration Phase: MER-BR) in the pitching cycle were calculated. Spearman's rank correlation coefficient was obtained to identify the relationship between kinematic variables and ball velocity at each instance and phase of pitching cycle for both between- and within-subject.
RESULTS:
In between-subject, variables such as trunk separation angular velocity during Stride Phase, upper torso lateral tilt angle during Arm Cocking Phase, and shoulder horizontal adduction angle during Arm Acceleration Phase showed strong correlation with ball velocity (all $|r|>0.6$, $p<0.05$). However, in within-subject, different variables such as upper torso forward tilt angle at SFC, pelvis lateral tilt angle at SFC and during Arm Cocking Phase, shoulder horizontal abduction angle and elbow extension angular velocity during Arm Acceleration Phase, and trunk separation angle at BR showed strong correlations with ball velocity (all $|r|>0.6$, $p<0.05$). Also, each within-subject correlation differed from one subject to another.
CONCLUSION:

The results of between-subject analysis did not match those of within-subject analysis, and this was also true for the most of within-subject results comparing one subject to another. Within-subject kinematic variations, along with those of between-subject's, should be considered through the whole pitching cycle when instructing the pitching mechanics to increase the ball velocity within an individual baseball pitcher.

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CHANGES IN MUSCLE COORDINATION DURING FUNCTIONAL SHOULDER MOVEMENT IN BREAST CANCER SURVIVORS

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INTRODUCTION:
Persistent pain located in the ventral and dorsal region around the shoulder is a common clinical issue among breast cancer survivors, which affects motor function of the shoulder girdle (1). Thus, studying the recruitment of muscles by means of surface electromyography (SEMG) can contribute to the understanding of the changes in muscle coordination occurring in breast cancer survivors suffering from persistent pain. In this case-control study, we investigated the changes in the coupling of muscle pairs during functional shoulder movement.
METHODS:
Eleven cases and 11 matched controls took part in the study. The functional shoulder movements consisted of dynamic arm flexion (0-90o), abduction (0-90o) and a shoulder shrug composed of 2-s concentric, 2-s isometric and 2-s eccentric contractions repeated five times. The SEMG of ventral muscles, i.e., pectoralis major (PM), deltoideus anterior (DA), deltoideus medialis (DM) and dorsal muscles, i.e., upper trapezius (UT), middle trapezius (MT) and latissimus dorsi (LD) were collected. Normalized mutual information (NMI), a measure of functional connectivity between muscle pairs (2) was computed over 0.5-s epochs during the three investigated dynamic shoulder movement after detecting onset and offset of the five repetitions used to define concentric (1st tertile), isometric (2nd tertile) and eccentric (3rd tertile). A three-way analysis of variance was applied on averaged NMI values with group (case/control), contraction type (concentric/isometric/eccentric) and muscle pairs of the body region as independent factors.
RESULTS:
The NMI values were between 36-93% lower for cases compared with controls in the dorsal region for all movements and 32% higher in the ventral region during shoulder shrug ($P \leq 0.05$). The NMI values were also 44-116% higher for eccentric compared with isometric or concentric contraction ($P \leq 0.05$). Finally, the NMI values were higher for DM-DA/DM-PM and LD-MT compared with the other muscle pairs in the ventral and dorsal region, respectively ($P \leq 0.05$).
CONCLUSION:
The present findings especially revealed enhanced coupling in the dorsal region but also reduced coupling between muscle pairs in breast cancer survivors with persistent pain during functional shoulder movement. This suggests the presence of altered coupling and decoupling strategies in muscle pairs (3). Moreover, computing NMI during dynamic contractions can be helpful to understand muscle pairs coordination during isometric, concentric and eccentric contractions.

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INFLUENCE OF THROWING DISTANCE ON 3D KINEMATICS OF THE LINEOUT THROWING PERFORMANCE IN RUGBY UNION – A CASE STUDY ON AN INTERNATIONAL PLAYER

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INTRODUCTION:
In rugby union, the lineout throw requires several skills so that the ball to be projected at appropriate height, velocity and angle to be caught by a jumper at variable distances. The scientific literature highlighted the importance of the thrower kinematic analysis, but assessed throw accuracy with various method more or less specific to match condition (1, 2). In addition, more information is needed regarding changes to the throwing technique with varying distance. The aim of this study consisted in identify the influence of throwing distance on 3D kinematics parameters of the lineout throwing.
METHODS:
An international level rugby player participated in this study. The throws were made under controlled and reproducible conditions: toward an automatic robot simulating the jumper ascent. An 11-camera motion analysis system was used to record the coordinates of 88 markers positioned on anatomically sites of the subject body and 5 on the ball. After a static acquisition, the participant made a total of 30 throws over 3 distances: 6m, 10m and 15m. Throw accuracy was evaluated depending on the ball impact location on the target. Ball kinematics parameters were evaluated using the ball markers. The body markers of the static acquisition were used to scale a fullbody osteo-articular model (3) processed on OpenSim (4). Then, this model was used to estimate articular kinematics during the ejection phase. The influence of throw distance was identified using analysis of variance.
RESULTS:
Results showed a significant decrease in throw accuracy at 15m ($p<0.05$). The ball kinematics was impacted by the throw distance with an increased ball ejection velocity ($p<0.001$) and ball spin rate ($p<0.01$) at 15m. We also notice a modification in joint range of motion during the ejection phase. The range of knee flexion, thorax flexion, scapula abduction and elevation, clavicle protraction and elevation and wrist pro-supination all increased during throws at 15m ($p<0.01$).
CONCLUSION:
The decrease in throw accuracy observed at 15m indicates that the participant is able to maintain a stable performance level over short and medium distances, but not over the longest distance. Both thrower and ball kinematics were also modified during the throw at 15m. The increase of ball ejection velocity and ball spin rate reflects certain principles of the dynamics, essential for throwing in varying distance conditions. To modify these ball kinematics, the thrower uses an increased articular range of motion from the lower limbs (knee), but also from the upper limbs (thorax, scapula, wrist, clavicle). The 3D kinematics analysis proposed in this study offers a better understanding of

the propulsive strategy involved in the throwing phase over various distances, and provides to sport staff important information to design individual training programs.
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ASSESSMENT OF SHOULDER JOINT STRENGTH PRODUCTION AND MUSCULAR BALANCE OF TENNIS PLAYERS

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INTRODUCTION:
Tennis is a multifactorial and complex sport where the intense and repeated actions of the dominant upper limb (e.g. internal rotation) make possible to transfer kinetic energy to the ball. These systematic actions affect different joints, leading to unilateral musculoskeletal imbalances and injuries. Our study aimed to compare the shoulder strength production and muscular balance between dominant and non-dominant upper limbs in tennis players.
METHODS:
Thirteen competitive male tennis players (mean ± SD: 18.1 ± 5.7 years, 65.3 ± 8.0 kg of body weight 176.0 ± 5.6 cm of height, 21.0 ± 2.0 BMI and 13.5 ± 4.8 h/week of training) voluntarily participated in this study. Subjects performed 10 internal and external shoulder rotation repetitions of both upper limbs at 90 and 180º/s in an isokinetic dynamometer (Biodex Medical Systems, Inc. USA), which is indicated for the evaluation of muscular functionality. Peak torque/body weight (pTQ/BW), average power, total work and agonist/antagonist peak torque ratio were assessed. All data was checked for distribution normality and paired samples t-test used to compare dominant and non-dominant upper limbs (with statistical level set at 5%).
RESULTS:
Dominant upper limb (compared to the non-dominant) showed: (i) higher strength values in the shoulder internal rotation at 90º/s (pTQ/BW: 64.1 ± 12.2 vs 52.0 ± 9.6 %, average power: 39.5 ± 13.1 vs 31.9 ± 8.9 W and total work: 594.6 ± 189.8 vs 470.2 ± 119.9 J) and at 180º/s (pTQ/BW: 63.1 ± 10.4 vs 48.9 ± 10.5 %, average power: 67.6 ± 18.7 vs 52.5 ± 18.9 W and total work: 594.5 ± 153.5 vs 465.0 ± 140.6 J), all for $p \leq 0.05$; (ii) higher strength values in the shoulder external rotation at 90º/s (average power: 22.0 ± 4.7 vs 20.7 ± 6.4 W) and at 180º/s (average power: 33.2 ± 7.2 vs 30.4 ± 10.8 W and total work: 300.9 ± 71.9 vs 269.5 ± 77.2 J); and (iii) no differences in external rotation at 90º/s (pTQ/BW: 37.5 ± 5.3 vs 33.9 ± 6.1 % and total work: 335.3 ± 71.6 vs 297.4 ± 79.2 J) and 180º/s (pTQ/BW: 41.3 ± 7.3 vs 35.1 ± 4.5 %), all for $p \geq 0.05$. Also, external/internal shoulder ratios revealed a weaker shoulder balance of the dominant upper limb antagonist muscle (60.1 ± 11.5 vs 66.3 ± 12.5 % at 90º/s and 66.6 ± 14.1 vs 74.2 ± 14.6 % at 180º/s).
CONCLUSION:
Due to the extreme use of the dominant upper limb in favor of the contralateral during internal rotation, tennis players show substantially asymmetry (>10%) in shoulder rotation strength, power and total work, and imbalance between external/internal rotation (values should be between 66-75%). Therefore, it is recommended to implement compensatory strength and flexibility training to ensure muscular balance and reduce the risk of athlete's shoulder instability who make repeated movements in the sport, where the internal rotation speed of the upper limb is extremely high

FREESTYLE TURN IN PREPUBERTAL SWIMMERS IS INFLUENCED BY BREATHING DURING THE APPROACH PHASE.

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INTRODUCTION:
Turn technique is a crucial aspect for successful of the swimming competition1,2, especially for short course race as 50 and 100 meters. The aim of this study was to examine in prepubertal swimmers the effects induced by two different breathing techniques during the freestyle turn's approach phase on kinematic parameters of the other turn's phases and on turn performance.
METHODS:
Thirty-four prepubertal swimmers (mean ± SD: 10.59 ± 0.97 years) were divided into two groups: No Breath (NB) and Breath Stroke (BS). In the NB group (n=17) swimmers did not breathe at the last stroke during the approach phase, whilst in the BS group (n=17) breathed. Swimmers performed three freestyle turns as fast as possible into a 25 meters pool with 5 minutes of rest between the repetitions. Each trial was recorded by two underwater and two surface cameras in order to obtain lateral and frontal views. 2D video analysis allowed to measure temporal and distance parameters chosen for the biomechanical analysis of freestyle turn's phases2. Temporal parameters examined were total turn time, swim-in time, rotation time, wall contact time while distance date recorded were swim-in distance, glide distance and surfacing distance.
RESULTS:
Statistical analyses showed that total turn time was significantly lower in NB group than in BS group (p=0.049). Swim-in time was significantly lower in NB than in BS (p=0.02) and swim-in distance was significantly higher in the NB group than in the BS group (p=0.0001). Rotation time was found to be significantly lower in NB than in BS group (p=0.0001). No difference appeared between the two groups in wall contact time (p=0.18). Glide distance was significantly higher in NB group than in BS group (p=0.0001) as well as the surfacing distance (p=0.043). A significant positive relationship appeared between swim-in time and rotation time (p=0.0002), and a significant negative relationship between swim-in time and glide distance (p=0.01) was found. Furthermore, a significant negative relationship was found between surfacing distance and total turn time (p=0.0003)
CONCLUSION:
This study shows that in prepubertal swimmers not breathing (NB) at the last stroke during the approach phase positively affects the kinematic parameters of the subsequent turn phases, thus improving turn outcome. These results should encourage coaches to teach prepubertal swimmers the not breathing technique before the turn, in order to reduce the turn execution time, ameliorating turn performance. Finally, the cameras setting used in this study might be easily reproduced in the pools, facilitating its adoption by swim coaches.
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OP-BM06 Jumping

MUSCLE SYNERGIES AND JOINT MECHANICS DURING SINGLE-LEG LANDINGS IN THE PRESENCE OF PERTURBATIONS

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INTRODUCTION:
Stability training in the presence of perturbations is an effective means of reducing fall risk and enhancing muscle strength and sensory information processing. We investigated the effects of perturbations induced by unstable surfaces during single-leg landings on the mechanical loading and modular organization of the leg muscles. We hypothesized a modulation of neuromotor control when landing in the unstable condition resulting in an increase of lower-leg muscle loading.
METHODS:
Fourteen healthy adults performed 50 single-leg landings from a height of 30 cm onto two ground configurations: stable solid ground (SG) and unstable foam pads (UG). Ground reaction forces (GRF), joint kinematics and electromyographic activity (EMG) of 13-muscles of the landing lower limb were measured. Using a classical inverse dynamic approach, we calculated the resultant joint moments in the lower leg and we extracted muscle synergies from EMG data via non-negative matrix factorization. A two-way ANOVA for repeated measures or statistical parametric mapping were used to investigate the effect of ground condition on every parameter using ground (SG – UG) and joint or muscle as independent variables.
RESULTS:
Three synergies related to the touchdown, weight acceptance and stabilization phase of landing were extracted from both SG and UG trials. We observed a widening ($p < 0.001$) and a shift later in time ($p = 0.007$) in the touchdown's motor primitive when landing on UG as compared to SG. Furthermore, the motor modules of the touchdown synergy showed an altered contribution of Gluteus Medius ($p = 0.015$) and Gastrocnemius Lateralis ($p < 0.001$) muscle and an increased ($p = 0.001$) coactivation index at the knee joint in UG. In the weight acceptance and stabilization synergy we did not observe any statistically significant ($p>0.05$) differences between the two conditions. Landing on UG resulted in a reduction of the ankle's dorsiflexion range of motion ($p = 0.004$), ankle joint moment lever arm of the GRF ($p = 0.014$) and resultant ankle joint moment ($p = 0.003$).
CONCLUSION:
Our findings show, that the participants used their experience and awareness of the ground characteristics to proactively deal with the expected perturbation before touchdown when landing on UG. The proactive nature of the found adjustments is reflected in the fact that the modulation of the neuromotor control mainly happened in the touchdown synergy, consequently avoiding reactive adjustments in the weight acceptance and stabilization synergy. Finally, the reduced resultant ankle joint moments indicate a lower mechanical loading of the plantar flexors in the UG condition probably due to the proactive motor control.

A JOINT LEVEL ANALYSIS OF LOADED VERTICAL JUMPS USED TO ASSESS FORCE-VELOCITY RELATIONSHIPS.

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INTRODUCTION:
Assessing multi-joint force-velocity (FV) relationships from vertical jumping has received increasing attention as a tool to monitor training adaptations and as a basis for individual training prescriptions in athletes (1). When jumping with gradually increasing loads, the mass is usually added at a bar, placed at the shoulder. Although the technical execution of the jumps may appear similar at various loads, the relative contribution of the involved joints may change. Here, we aimed to investigate whether the joint work contributions from the hip, knee, and ankle joints were similar across loads while assessing the force-velocity relationship during vertical jumping in an unconstrained (free-weight) and a constrained condition (smith-machine).
METHODS:
Sixteen female athletes (age 21±3 years; height 172±7 cm; body weight 74±9 kg) performed a total of 480 vertical jumps. The testing protocol consisted of a series of countermovement jumps (CMJ) with and without a smith machine, as well as squat jumps (SJ) with a smith machine. Both types of jump were initially performed with bodyweight, accompanied by an incremental loading protocol of 20, 40, 50 and 70 kg to assess the FV-relationship. Three-dimensional kinematic and kinetic data was obtained using an optical motion capture system (16 Oqus cameras, Qualisys AB, Gothenburg) and floor-mounted force plates (Advanced Mechanical Technologies Inc., USA) for all trials . Joint work for all jumps were then calculated using inverse dynamics (Visual3D, C-motion, Inc., Germantown, MD). A one-way ANOVA with Bonferroni post-hoc correction was used to assess whether the differences in relative joint contribution were significant.
RESULTS:
With increasing loads (0, 20, 40, 50, and 70 kg) the relative hip joint contribution increased, respectively, for the free-weight CMJ (17±7, 27±6, 30±6, 30±6 and 32±6%: $p<0.05$), the smith-machine CMJ (20±5, 28±5, 30±4, 31±4 and 30±4%: $p<0.05$) and the smith-machine SJ (19±6, 28±4, 31±4, 32±4, 32±4%: $p<0.05$). Reciprocally, the knee joint contribution decreased with increasing loads for the free-weight CMJ (57±7, 45±5, 40±5, 41±6, 38±5: $p<0.05$), the smith-machine CMJ (51±4, 43±5, 40±5, 41±4, 41±5: $p<0.05$), and the smith-machine SJ (49±5, 42±4, 39±4, 38±5, 39±5: $p<0.05$). The relative joint work contribution from the ankle did not vary between loads in any of the three jump conditions-($p>0.05$).
CONCLUSION:
The relative work contributions from the hip and knee joints changed significantly from the light to heavy loads. This observation implies that the lower-body-system operates differently at different loads and results of the FV-relationship test may not appropriately reflect the force-velocity properties of the active muscle. Caution is therefore advised when interpreting the results of such a test.

THE EFFECT OF TRAINING WITH COMPRESSION STOCKINGS ON JUMPING AND RUNNING PERFORMANCE AMONG RUNNERS

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INTRODUCTION:
Controversy exists as to the effect of wearing compression stockings on performance amongst runners. The aim of this randomized clinical trial was to assess the effect of wearing compression stockings for few weeks during all training on running and jumping performance. We hypothesized that if the athlete, on a regular basis, would train wearing the stockings, his/her recovery would improve followed by an improvement in performance.
METHODS:
Twenty-four experienced runners were randomly allocated to the compression stockings group or control group. The research group performed all training wearing calf compression sleeves and the control group continued training without compression stocking. Subjects were assessed prior to and after 8-week training program. Outcome measurements included: forward two leg jumping test (in cm) and 5 km running test (in min). During the running test, heart rate was continuously evaluated by a heart rate monitor watch which documented running pace, average heart rate and maximum heart rate
RESULTS:
A high compliance was demonstrated and the participants reported feeling comfortable when wearing the compression stockings. No interaction between group and time was found, implying that the intervention of compression stockings did not contribute to a change in performance. Males exhibited a better time performance vs. females (21.56(±2.93) vs. 24.31(±3.25) min) and a better jumping distance (203.8±33.89cm vs.166.4±26.17cm). Level of significance was p< .05.
CONCLUSION:
Wearing compression stockings while training for a few weeks did not contribute to an improvement in running and jumping performances. As such, wearing compression stockings during sports competitions should be freely permitted.

MAXIMIZING USE OF THE HIP EXTENSORS RELATIVE TO THE KNEE EXTENSORS DURING SQUATTING: A CLASSIFICATION AND REGRESSION TREE ANALYSIS

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INTRODUCTION:
The squat is a common exercise performed in rehabilitation and sport performance settings and can be performed in various ways to bias the demand on the hip and/or knee extensors. Previous research has reported that the demand on the hip extensors relative to the knee extensors is influenced by the difference in sagittal plane inclination of the trunk relative to the tibia.[1] To date it is not known what combination of trunk/tibia inclinations in relation to squat depth should be used to maximize use of the hip extensors relative to the knee extensors. The purpose of this study was to determine what combination of trunk and tibia inclination and knee flexion angle is required to maximize the average hip/knee extensor moment ratio (HKR) during squatting using classification and regression tree (CART) analysis.
METHODS:
Kinematic and kinetic data were obtained using 3D motion analysis from 16 participants during the execution of 8 different back squat types to peak knee flexion, in which trunk and tibia inclinations were manipulated. The average HKR was calculated during the lowering (eccentric) phase of each squat, and 3D angles (trunk-tibia and knee flexion) were extracted at peak knee flexion. Only squat conditions that were hip extensor biased (average HKR > 1.0) were analyzed. CART analysis was performed to identify the cut-offs required to maximize the average HKR, defined as the upper quartile of the sample distribution. The area under the receiver operating characteristic (ROC) curve was calculated to verify the overall accuracy of the model.
RESULTS:
Of the 128 data points obtained (16 subjects x 8 squat conditions), a total of 57 trials were hip extensor biased. For these trials, the trunk-tibia and peak knee flexion angles ranged from -18.7° to 40.3° and 64.8° to 145.7°, respectively. CART analysis indicated that the average HKR was predicted primarily by the trunk-tibia angle, and secondarily by knee flexion. The average HKR was maximized (>= 1.89) when the trunk exceeded the tibia by more than 11.0°, with the knee flexion angle between 65° and 97.1°. The area under the ROC curve was 87.1% ($p < 0.001$), with a sensitivity of 64.3% (ability to predict a high hip extensor biased squat) and specificity of 88.4% (ability to predict a lower hip extensor biased squat).
CONCLUSION:
To maximize strengthening of the hip extensors relative to the knee extensors during squatting, practitioners need to consider the position of the trunk relative to the tibia and the depth of the squat. Specifically, trunk inclination in the sagittal plane should exceed tibia inclination by at least 11° at a range of knee flexion between 65° to 97°.
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VERTICAL JUMP POTENTIATION AFTER TWO BACK-SQUAT PROTOCOLS DIFFERING IN VOLUME: IS IT INFLUENCED BY THE FORCE-VELOCITY PROFILE?

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INTRODUCTION:
The vertical jump is a primary action for performance in many sports. Post-activation performance enhancement (PAPE) consists of a transitory increase of voluntary movements performance following a conditioning activity (CA) (1,2). The force-velocity (FV) profile depicts the mechanical limits of the entire neuromuscular system to produce force, velocity and power during countermovement jump (CMJ) (3). Specifically, the maximal power output (Pmax) is considered the most determinant variable for CMJ performance (4), explaining a significant part of the CMJ height variance (~50%). However, it remains unknown whether Pmax could also explain the magnitude of the change

in CMJ height. This study aimed to evaluate the PAPE effect in CMJ height following 2 squat protocols differing in volume, and to explore the possibility of predicting the change in CMJ height based on the individual FV profile.
METHODS:
Twenty-three male athletes were tested in 4 sessions. The FV profile during the CMJ exercise was determined in the session 1 (3), and the squat one-repetition maximum (1RM) was evaluated in the session 2 (5). The squat protocols (low-volume: 1 set of 3 repetitions at 65%1RM; high-volume: 3 sets of 3 repetitions at 65%RM) were randomly performed during sessions 3 and 4. CMJ height was assessed before and 2, 4, 8, and 12 minutes after the squat protocols. The subjects were divided in two groups based on their median Pmax value for the statistical analysis (Low-Pmax group [n = 12] = 25.3 ± 3.0 W/kg; High-Pmax group [n = 11] = 33.3 ± 3.2 W/kg).
RESULTS:
The results revealed higher CMJ height values for the low-volume protocol compared to the high-volume protocol ($p < 0.001$; 95% confidence interval = 0.52, 1.54 cm), but the main effect of time ($p = 0.198$) or the interaction time × protocol ($p = 0.112$) and time × group ($p = 0.076$) were not significant. The FV profile was able to explain a significant part of the unloaded CMJ height variance (55.9%) but explained less than 12.5% of the variance in the change in CMJ height.
CONCLUSION:
These results suggest that the low-volume squat protocol could be a more effective and less fatiguing strategy to induce PAPE in CMJ height, while the Pmax level does not seem to determine the change in CMJ height (i.e., comparable PAPE effects between Pmax groups). Although assessing the FV profile might help coaches to chronically improve CMJ performance through individualized training programs, the FV profile seems to be a poor predictor of the acute change in CMJ height induced by different squat protocols.
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OP-BM07 Bait Balance

CHANGES IN POSTURAL SWAY COMPLEXITY AFTER 12 WEEKS OF RESISTANCE TRAINING IS RELATED TO REGULATION OF BDNF CONCENTRATION IN OLDER ADULTS

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INTRODUCTION:
Age-related brain changes is one of the major factors of impaired postural control, and therefore, aging is associated with increased risk of falls in older adults [1]. A large body of literature recommend to utilize postural complexity as a measure to show readiness of the system for balance control against external perturbation, which can be calculated by using entropy analysis of the center of pressure (COP) trajectory [2]. On the other side, resistance training (RT) has shown to improve balance control and increase brain-derived neurotrophic factor (BDNF) [3, 4] which is a key neurotrophin for neuroplasticity, synaptogenesis and neural survival in brain [4]. So far, no studies have examined the extent to which after resistance training, regulated BDNF levels associates with postural control adaptations. Therefore, this study aimed to examine whether there is an interaction of BDNF levels modulation and postural complexity changes post RT intervention in older adults.
METHODS:
13 sedentary older adults (mean age: 69.01 ± 5.27 years) underwent 12 weeks of RT for lower limb muscles 2 times/wk (EXP group) while 9 older participants (66.89 ± 6.62 years) served as a passive control group (CON group). Both groups were tested at baseline and post-intervention. COP trajectory was measured using a single force plate in 4 stance conditions: 2 Single Task Stance (STS) conditions where participants performed a quiet standing task with eyes open (STS-EO) and eyes closed (STS-EC), followed by 2 Dual Task Stance (DTS) conditions where the same quiet standing task was repeated while performing a mathematical counting task (DTS-EO and DTS-EC). Wavelet Entropy (WE) of the COP sway vector was calculated using MATLAB for all the 4 stance conditions. Lastly, blood samples were collected and serum BDNF levels were estimated at both testing time points.
RESULTS:
Pearson's correlations showed a significant negative relationship between post WE and post serum BDNF levels of EXP group in all 4 stance conditions: STS-EO ($r = -0.68$, $p = 0.01$), STS-EC ($r = -0.56$, $p = 0.04$), DTS-EO ($r = -0.71$, $p = 0.007$), and DTS-EC ($r = -0.61$, $p = 0.02$). On the contrary, there was no significant association between pre WE and pre BDNF levels in both EXP and CON groups ($p>0.05$) as well as between post WE and post BDNF levels in the CON group ($p>0.05$).
CONCLUSION:
The present study demonstrates an interplay between BDNF concentration and postural complexity after resistance training. Specifically, we showed that increased BDNF following 12 weeks of RT was associated with reduced entropy (WE) of COP and vice-versa. We propose that exercise-induced changes in central BDNF concentration may play as a mediating role for postural adaptations linked to attentional or automatic control of balance [5].
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A NORMAL GAIT REFERENCE MODEL FOR A GYROSCOPE-BASED GAIT ANALYSIS SYSTEM

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INTRODUCTION:

Gyroscope-based gait analysis systems measure 3-dimensional lower limb angular velocity. Their advantages are moderate cost level, ease of use and accuracy (1). The method gives detailed information about gait which can be used to support rehabilitation and diagnostics. However, understanding the movement from angular velocity measurements is challenging and there are not many previous studies giving background information on how they should be interpreted. Furthermore, it has been shown that height, weight and walking velocity have an effect on gait (2, 3). The aim was to define a normal gait reference model for gyroscope-based systems and analyse the effect of height, weight and walking velocity on the model.
METHODS:
Gait data were collected using Fujitsu KIDUKU Walking Monitoring system (4) from 60 healthy subjects while walking a 10 m distance for three times. The sensors were positioned above the lateral malleolus. A normal gait reference model was formed using linear length normalisation method (5). Statistical analysis was performed to define the correlation between the individual factors and points of interest of the reference model. The points of interest (5) were selected as the minimum or maximum values of specific gait cycle phases.
RESULTS:
A normal gait reference model consisting of mean angular velocity values for three rotation axes was formed. Several statistically significant dependencies were found while analysing the effect of individual factors to the reference model. Walking velocity affected the most to the model shape by increasing the angular velocity during peaks. The points of interest, where statistical analysis gave highly significant ($p<0.001$) results, were initial contact ($r=-0.46$), load response phase min ($r=-0.60$), pre-swing phase min ($r=-0.55$) and swing phase max ($r=0.57$). Highly significant results were also found for the effect of subject's height to pre-swing minimum ($r=-0.33$) and swing maximum ($r=-0.39$) and for weight to load response minimum ($r=-0.30$). Walking velocity also increased the relative duration of swing phase ($p=0.001$, $r=-0.30$). The body mass index by contrast increased the relative duration of the double stance phase ($p<0.001$, $r=0.46$). The effect of walking velocity, height and weight should be considered in the normal gait reference model.
CONCLUSION:
A reference model for normal gait was proposed and statistical evidence presented of the notable effect of height, weight and walking velocity to the model. The results of gyroscope-based gait analysis system can be compared with the reference model, which thus can assist in the interpretation of measurements. Limited information is currently available about normal gait shank angular velocity. Therefore, the results of the study are considered valuable.
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VALIDITY OF CHANGE OF DIRECTION TESTING USING ROBOTIC RESISTANCE TECHNOLOGY

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INTRODUCTION:
Change of direction (CoD) is fundamental to many sport performances and is defined as the skills and abilities needed to change movement direction, velocity, or modes (1). Overall time of CoD tests has been considered a valid representation of this ability. However, recently this has been challenged as such measures favor linear sprint capacity and do not quantify the different phases of a CoD test such as the initial acceleration, deceleration and re-acceleration. In fact, measures of the center of mass (COM) during CoD tests has been called for to better understand this important athletic quality (1). The purpose of this study was to determine if a robotic resistance device could provide valid measurements of athlete COM velocity during CoD tests.
METHODS:
Ten male athletes (age 22±4 years; height 179±12 cm; body weight 81±16 kg) and one female athlete (age 22 years; height 163 cm; body weight 70 kg) completed two modified 505 tests (m505) turning off the left and right foot under different loaded conditions (3, 6 and 9 kg) using a robotic resistance device (1080 Sprint, 1080 Motion AB, Lidingø, Sweden). Specifically, the athlete performed the initial acceleration to deceleration (phase 1a) running toward and the re-acceleration (phase 1b) running away from the robotic resistance device (ROB). Three-dimensional kinematic and kinetic data for all tests was obtained using an optical motion capture system (16 Oqus cameras, Qualisys AB, Gothenburg) and floor-mounted force plates (Advanced Mechanical Technologies Inc., USA). Velocity of COM, COMpelvis and CAR (marker placed on carabiner at point of attachment to athlete/belt pelvis) was calculated using Visual3D (C-motion, Inc., Germantown, MD) with CoD defined as time when velocity changed direction (ROB). Then, COM, COMpelvis, CAR and ROB velocity for 1.5 seconds prior to and after CoD was compared for different time intervals (0.5, 1.0 and 1.5 seconds) using correlational (r) and Bland Altman analysis. A total of 43 tests for each loaded condition were analyzed.
RESULTS:
Good to excellent correlations were observed for all time intervals for the ROB vs CAR (range: $r=.99$ to $r=1.00$), ROB vs COMpelvis (range: $r=.89$ to $r=1.00$) and ROB vs COM comparison (range: $r=.79$ to $r=.99$), with the exception ROB vs COM comparison for the 1.0 to 1.5 second interval ($r=.54$). The smallest biases were observed for the ROB vs CAR comparison (range: -.06 to .05 m/s), which increased to the ROB vs COMpelvis (range: -.246 to .128 m/s) and ROB vs COM comparison (range: -.486 to .082).
CONCLUSION:
The robotic resistance device provide valid measurements of athlete velocity during a m505 test allowing for valid continuous or phase specific outcome measurements to be obtained in laboratory and field conditions. The observed lower correlations and greater biases for the ROB vs COM comparison may be due to the moving arms and legs as the point of attachment from the device is at the pelvis.

EVALUATION OF POSTURAL CONTROL AND PROPRIOCEPTION IN WOMEN WITH OSTEOPOROSIS, BEFORE AND AFTER AN EXERCISE TRAINING

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INTRODUCTION:
Osteoporosis (OP) is a skeleton systemic disease characterized by a reduced bone mass and deterioration of micro-architecture. OP is often accompanied by an increased risk of fall and consequently a high risk of fracture. Since postural control and proprioception are two of the most significant factors in falls and injury prevention, exercise training, including specific balance and proprioceptive exercises, could be the keys to reducing the risk of fall and fractures. This study was aimed at assessing proprioception and postural control, using Delos Postural Proprioceptive System (DPPS; Delos, Turin, Italy), in persons with osteoporosis, before and after an exercise training.
METHODS:

A cohort of 29 women with osteoporosis aged 66.20±5.80 were involved in the study. The participants will perform training, structured in 2-days per week, to improve joint mobility, muscle force and balance. Moreover, an additional activity between walking, cycling, or swimming was requested to improve endurance and reach the weekly exercise recommended by World Health Organization. Finally, every six weeks, the trainer upgraded the exercise program following the principle of frequency, intensity, time and type. DPPS was used to assess postural control and proprioception in single-limb stance, respectively, with open and closed eyes. The parameter considered is the stability index (SI; percentage score where 100% is a theoretical task performed with maximum stability).
RESULTS:
No significant differences were found in terms of dominant and non-dominant limbs. Thus, the analysis was performed on the average results of two limbs. The SI improved from 84.14%±10.10 to 86.96%±5.60 with opened eyes ($p < 0.05$) and from 52.22%±13.87 to 56.25%±17.60 with closed eyes ($p < 0.05$).
CONCLUSION:
In people with osteoporosis, fall prevention is essential to decrease the risk of fall, build confidence for performing daily-life activities and improve the quality of life. Moreover, preventing falls decrease the costs for the health care systems. Physical activity should be integrated with pharmacotherapy in osteoporosis treatment since it benefits bone tissue and improves global fitness. In particular, including balance exercises in a training program is effective in improving postural control and proprioception. The latter seems to have greater benefit and is very important in poorly lighting places or conditions of sudden instability.
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VALIDITY OF DOUBLE INTEGRATION METHOD TO ESTIMATE CENTER OF MASS KINEMATICS IN GOLF SWING

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INTRODUCTION:
Performance in golf requires a specific and mastered dynamic movement to control the club head with power and precision. Center of mass (COM) trajectory analysis could reveal the movement strategy used by golfers throughout the swing. No study has investigated so far the calculation methods and their inherent errors for estimating the position of the COM for a golf swing. The aim of this study is to compare two COM estimation methods, the kinematic and the double integration ones to quantify the error made on the COM displacement estimations.
METHODS:
Ten sub-27 handicap golfers participated in this study. Ten swings were performed with each of the three clubs tested (7-iron, pitching wedge and driver). For the first series of swings, 10 swings of about 65% of maximal power were made with the pitching wedge. For the second and third series, 10 maximal shots were made with the 7 iron and the driver. Trajectories of 43 three-dimensional markers (Qualisys motion capture system) at 250 Hz and ground reaction forces data from (Kistler force plate) at 1000 Hz were recorded synchronously. For both methods the data was filtered with a fourth order, zero phase-lag, low-pass Butterworth filter with a cut-off frequency of 10 Hz. Prior to the double integration, the weight of each subject was also subtracted from the vertical reaction force data. Using the kinematic method, the golfer model was composed of 17 segments (head, 2× upper arm, 2× lower arm, 2× hands, 2× thigh, 2× shank and 2× feet, upper trunk, lower trunk, pelvis and golf club). Whole body COM, was estimated as the weighted sum of individual segments in accordance with Delevas parameters. Using the double integration method, whole body COM was estimated using double cumulating trapezoïdal integration of ground reaction forces along each axis.
RESULTS:
Preliminary results show a similar pattern of displacement of the COM in the vertical and medio-lateral axis of the golfers using the two different methods. Nevertheless, even if the global displacement pattern is the same for those two axis, the amplitudes obtained by the double integration method are largely underestimated compared to the results obtained with the gold standard kinematic method. Moreover, along the antero-posterior axis of the golfer, both the pattern and the amplitude of displacement of the COM using the double integration method are different from the ones obtained with the kinematic method.
CONCLUSION:
The double integration method provides non reliable values concerning global displacement of COM during golf swing. Even if the global pattern seems to allow for a temporal interpretation of the displacement of the COM during a swing, the values are largely underestimated and can therefore not be considered as the real displacement of the golfers global COM during a swing. It is therefore concluded, based on the preliminary results, that the kinematic method remains the most accurate method of estimating the displacement of the golfers COM during the golf

OP-MD01 Covid 19

SUPERVISED AND UNSUPERVISED HOME-BASED EXERCISE PROGRAM FOR WOMEN WITH OSTEOPOROSIS: FOCUS ON ADHERENCE DURING COVID-19 PANDEMIC

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INTRODUCTION:
Osteoporosis is a disease characterized by a reduced bone mass. It is accompanied by an increased risk of fracture with consequent pain, decreased physical and social functional capacity and quality of life. Many studies have shown that an exercise program is important for maintaining or increasing bone mineral density in people with low bone mass. However home physical activity during the pandemic of coronavirus disease 2019 was the only way to keep people affected by osteoporosis active. This study aims at investigating the adherence to an exercise program specifically designed for women with postmenopausal osteoporosis when administered as individual home training (IHT) or online group training (OGT).
METHODS:

40 women, aged between 67 ± 6,5 years were recruited for the study. They were recruited to the Institute Orthopedic Rizzoli in Bologna. A randomization was performed in order to divide the women in two groups: Individual Home Training (IHT) or Online Group Training (OGT). The OGT group was supervised by the trainers during exercise session utilizing a video conferencing software. The IHT group instead received a book with the exercises explained, a diary and a training program. Every 6 weeks the program was changed and the group met the trainers in order for them to explain on video call the new excercise the group had to perform. The group was also monitored thanks to a call which every fifteen days investigated if there where any problems performing the program.
Each exercise session was divided into: warmup, balance, strength, impact and cool down. Both groups did 24 weeks of training, twice a week for 1-hour session. The total of the training sessions was 48 (100%). The adherence was registered with a diary for the home's group and with a register for the online group. After 6 months we evaluated the percentage of adherence. People with an adherence rate of less than 50% were considered non-adherents to the program.
RESULTS:
The adherence in both groups was 65% (26 women), while 35% was not adherent (14 women:7 OGT and 7 IHT). The causes of not adherence depend on: family problems 50%, health issue 14%, work duties 14% and IT ability and possibility to have broadband connection 21% (only of the OGT group).
CONCLUSION:
The relationship between trainers and participants is important in maintaining adherence to a physical activity program. When physical contact is not allowed, as happened during the pandemic periodfrequent contact by telephone or other appropriate technological tools can help maintain the adhesion. Despite the home environment often prevents participation in a physical activity program, online training promotion represents an indispensable opportunity to reach elderly people who are unable to go to the gym.

TIME-COURSE RECOVERY OF CENTRAL AND PERIPHERAL PHYSIOLOGICAL ADAPTATIONS BY HIGH-INTENSITY INTERVAL TRAINING AFTER COVID-19

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INTRODUCTION:
Inactivity is a major risk factor of chronic diseases and death, as relevant as smoke, hypertension, and high cholesterol [1]. A simple decrease in the number of daily steps (e.g. from 10'000 to 3000) has a dramatic impact on metabolic health parameters, leading to anabolic resistance, peripheral insulin resistance and dyslipidaemia. Concomitantly, inactivity induces a reduction in cardiorespiratory fitness [2], muscle oxidative metabolism, muscle mass and strength [3]. Although several alternative solutions were implemented by individuals to maintain physical fitness, a high percentage of people reduced their level of habitual physical activity during lock-down for Covid-19 pandemic. This study aimed to: i) evaluate the impact of three months of reduced activity on central and peripheral physiological adaptations to exercise; ii) monitor time-course changes of those functional indexes of muscle oxidative metabolism to 8-week high-intensity interval training (HIIT).
METHODS:
Nine moderately-trained individuals (age: 30.1±5.4ys; weight: 61.6±7.4kg; height: 1.69±0.6m) participated in the study. Effects of reduced habitual physical activity levels, monitored by an accelerometer positioned on the waist, were evaluated before (PRE) and after (LOCK) twelve weeks of lock-down. Then, all subjects were tested after 4 (T4) and 8 (T8) weeks of supervised HIIT training, based on the ACSM guidelines. At each time-point, peak values of pulmonary O2 uptake (V'O2peak) and cardiac output (Q'peak) were evaluated during an incremental exercise test on the cycle ergometer. Muscle oxidative capacity was estimated by recovery rate (k) of muscle O2 consumption (mVO2) during 10-15 repeated arterial occlusion after a brief exercise by near infra-red spectroscopy. VO2 kinetics (tau) were determined during three repetitions of moderate-intensity constant work-rate exercise.
RESULTS:
From PRE to LOCK, habitual physical activity level (12103 to 3996steps/day, p=0.008), V'O2peak (42.5±7.2 and 37.8±7.8mL/min, p=0,012), Q'peak (20.9±2.2 and 18.8±2.8L/min, p=0.023), k (1,69±0,09 to 1,25±0,20min-1, p=0.045), t (25.9±9.9 and 32.0±9.2, p=0.035) significantly decreased. V'O2peak (40.5±7.4mL/kg/min p=0.044), k (1.33±0.24min-1, p=0.013), tau (28.6±11.0s, p=0.041) significantly improved from LOCK to T4 but they did not reach PRE values. At T8 V'O2peak (41.4±7.6mL/kg/min), Q'peak (22.6±4.8L/min), k (1.51±0.35min-1),tau (25.2±5.8s) were not different from PRE values
CONCLUSION:
During Covid-19 pandemic the reduction of habitual physical activity levels impaired central and peripheral determinants of muscle oxidative metabolism. Eight weeks of HIIT were an effective intervention to restore maximal oxygen consumption to pre lock-down values. Interestingly, peripheral determinants of maximal oxygen consumption showed an improvement after four weeks, whereas cardiovascular adaptation needed the entire intervention to recover to pre lock-down values
[1] Booth et al., 2017
[2] Krog-Madsen et al., 2010
[3] Narici et al., 2020

TRAINING PERIODIZATION IN ELITE U-17 FEMALE SOCCER PLAYERS DURING COVID-19-RELATED RESTRICTIONS

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INTRODUCTION:
Continuous interruptions in regular activities caused by government regulations due to COVID-19 have forced coaches, athletic trainers and sports experts to continually readjust training programs to avoid de-training and reduce the risk of injury(1). The current season started after a period of complete lockdown with many athletes in a deconditioned state. For these reasons, focusing the first part of the season including strength training is essential to increase performance and reduce the risk of injury(2). Therefore, this study has two major aims: i)to verify the effects of long-term combined protocols based on strength training (ST), change of direction (COD) and repeated-sprint ability (RSA) during a season conditioned by the COVID-19 pandemic restrictions on physical performance parameters; ii)to preserve performance during sudden interruptions of the teams activity because of quarantines, through home-based circuit training (CT)
METHODS:

Eighteen young high-level female soccer players (age:15,9±0,8yrs, bw:54,6±5,6kg, height:161,2±6,5cm) from the same team followed 24-wk of training periodization (4 d/wk) without official matches. In the first period (8-wk), during 2 days of soccer training, a combined protocol of COD and ST based on bodyweight exercises was inserted. In the second period (16-wk) the combined protocol included RSA and ST with medicine balls, plyometrics and suspension training exercises. There were 2 COVID-related interruptions (14 days each) in the teams activity at the 7th and 21st wk, during which athletes only performed a CT (4 d/wk, alternating 2 full-body workouts). The CT program included 3 warm-up exercises (20/10s, 3 cycles), 7 stations (30/15s, 4 cycles) and 2 core-exercises (30/15s, 2 cycles) with 2min of rest between cycles. Athletes were tested on squat jump (SJ), countermovement jump (CMJ), Yo-Yo test (YYIRT1) and Bangsbo Sprint Test (BST) at the beginning of the season(T1), after 8 wk(T2) and after 24 wk(T3). Data were tested for normal distribution using a Shapiro-Wilk test and were analyzed through a repeated-measures ANOVA
RESULTS:
Jump performance improved($p<0,01$) significantly (SJ:T1=0,33±0,02m; T2=0,35±0,03m; T3=0,37±0,04m. CMJ:T1=0,34±0,03m; T2=0,37±0,03m; T3=0,38±0,04m). A significant increase($p<0.01$) occurred in YYIRT1 distance (T1=702,22±227,61m; T2=766,67±295,61m; T3=868,89±322,87m). A significant difference was found in mean sprint time (BST) between T1 and T3($p<0,05$) and T2 and T3($p<0,05$) but not between T1 and T2($p=0,138$)
CONCLUSION:
Combined protocols utilized at the beginning of a season conditioned by the severe lockdown of the previous months significantly improved performance parameters in young female soccer athletes. Moreover, CT seems to be an easy-to-use tool for maintaining physical performance during periods of forced quarantine. The main limitation of this study is the lack of a control group.
1. Pedersen,S.,et al.,(2021).Frontiers in Physiology,12,232.
2. Guerrero-Calderón,B.(2021).Soccer & Society,22(1-2),85-95

THE RELATIONSHIP BETWEEN TETHERED SWIMMING AND LONG-DISTANCE SWIMMING PERFORMANCE

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INTRODUCTION:
Due to coronavirus disease (COVID-19), swimmers around the world were forced to stop their training routines in swimming pools, confined to their homes trying to create training conditions in order to maintain their fitness level and avoid excessive detraining. Tethered swimming incremental test was previously indicated as useful to define exercise intensity zones for domain-specific training [1]. The aim of this study was to analyze tethered swimming relationship to long-distance swimming performance.
METHODS:
Twelve competitive swimmers (eight male and four female) underwent the following evaluations: 1) Maximal tethered swimming force, which consisted on two 30 seconds maximal efforts in tethered apparatus (Cefise®) with a 10 minutes rest interval to maximum and mean force determination (Fmax and Fmean) and 2) a incremental test with a conventional load system tied to the swimmer with increments of 5% per minute (range 30-100% of Fmean). Oxygen uptake (VO2) was assessed by an automatic and portable system (K4b2 Cosmed, Italy) for direct breath-by-breath analysis of pulmonary gas exchange, which was attached to the swimmer by a snorkel with a tri-dimensional valve (Aquatrainer®). Maximum oxygen uptake (VO2max), respiratory compensation point (RCP) and gas exchange threshold (GET) were determined, as well as the respective exercise intensities (iVO2max, iRCP and iGET). Swimming performances of 200, 400, 800 and 1500 m were accessed in competition environmental and converted in swimming velocity (V200, V400, V800 and V1500, respectively).
RESULTS:
VO2max (3187.0±565.8 ml·min-1) was correlated to Fmean (17.4±3.8 kg; $r=0.68$, $p<0.05$) and Fmax (18.4±4.1 kg; $r=0.65$, $p<0.05$). The same was observed regarding RCP (2808.6±522.4 ml·min-1; Fmean $r=0.63$, $p<0.05$) and Fmax ($r=0.60$, $p<0.05$) and GET (2150.5±483.3 ml·min-1; Fmean $r=0.72$, $p<0.01$ and Fmax $r=0.67$, $p<0.05$). Fmean was correlated to iVO2max (8.5±1.3 kg; $r=0.77$, $p<0.01$), iRCP (7.4±1.2 kg; $r=0.73$, $p<0.01$), iGET (5.0±1.0 kg; $r=0.66$, $p<0.05$) and V800 (1.24±0.14 m·s-1; $r=0.58$, $p<0.05$). Fmax was correlated to iVO2max ($r=0.74$, $p<0.01$), iRCP ($r=0.73$, $p<0.01$) and iGET ($r=0.66$, $p<0.05$). iVO2max was also correlated to V200 (1.46±0.13 m·s-1; $r=0.60$, $p<0.05$), V800 ($r=0.65$, $p<0.05$), and V1500 (1.25±0.11 m·s-1), but not V400 (1.34±0.12 m·s-1; $r=0.72$, $p<0.01$).
CONCLUSION:
Tethered swimming may represent a useful method for home-based training of swimmers aiming not only the maintenance of fitness level and avoid excessive detraining but also long-distance swimming performance enhancement and evaluation and control of training, while maintaining training specificity, namely the “feel for the water” in lockdown periods.
1 Pessôa Filho DM, Siqueira LOC, Simionato AR, Espada MAC, Pestana DS, DiMenna FJ. A Rapidly-Incremented Tethered-Swimming test for Defining Domain-Specific Training Zones. J Hum Kinet. 2017; 57: 117-128. doi:10.1515/hukin-2017-0053.

RETURN TO GYMNASTICS TRAINING IN THE UK FOLLOWING THE FIRST COVID-19 NATIONAL LOCKDOWN: A MIXED-METHODS ANALYSIS

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INTRODUCTION:
In March 2020, following the outbreak of COVID-19 (coronavirus), the UK entered its first national lockdown to reduce the spread of the virus and as a result, all organised sport was suspended. The national lockdown created a unique opportunity to explore the process of returning to gymnastics training after several months away from the gym, with particular interest towards training load and injury.
METHODS:
Twenty-six (11 males; 15 females; age 11.9 ± 1.7 years), national squad gymnasts from three gymnastics disciplines (Men’s artistic, Women’s artistic and Trampoline gymnastics) recorded training load and injury for a minimum of 10 weeks (average± SD; 16.3 ± 3.8) whilst returning to gym-based training. Injury was captured using the Oslo Sports Trauma Research Center Questionnaire on Health Problems questionnaire. A complaint that had a moderate or severe influence on training or performance was categorised as a substantial injury, whilst any other complaint was categorised as a niggle. At the end of data collection, 3 coaches were interviewed to further explore the experiences and practices of returning to training. Training load was analysed as week-to-week changes. Generalised linear mixed-effects models were used for the analysis of training load and injury. Interviews were analysed using thematic analysis [1].

RESULTS:
Home-based training during lockdown was seen as beneficial in maintaining a level of fitness. Coaches described a gradual increase in training to reduce the risk of injury and this partly explains a non-significant association between week-to-week changes and the risk of a substantial injury in the subsequent week (P=0.441). However, week-to-week changes in training load following periods of additional restrictions (additional lockdown, periods of isolation or substantial restrictions), were not always gradual. There was a significant association between an injury in the preceding week (niggle or substantial injury to a different body part) and a substantial injury in the subsequent week (RR: 5.29, P=0.011). Monitoring training, particularly internal load and response to training, were described to be a useful practice during the process of returning to training. At the time of interview, coaches believed that although the short-term development of their gymnasts were affected, the long-term development would not be impacted from COVID-19.
CONCLUSION:
It is anticipated that learnings from this study can be applied to future practices and situations, particularly when gymnasts are away from the gym for an extended period. This includes continuing to train where possible outside the gym, increasing training gradually whilst returning to gymnastics training to reduce the risk of sustaining a substantial injury, and that niggles, as well as substantial injuries to other body parts, are shown to be useful in identifying gymnasts at an increased risk of another substantial injury.
[1] Braun & Clarke (2006)

INDIVIDUALIZED COGNITIVE AND PHYSICAL EXERCISE FOR INDIVIDUALS WITH DEMENTIA: RESULTS OF AN EXPERT REVIEW ON THE USABILITY OF THE INCOPE-APP

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INTRODUCTION:
Due to enhanced safety efforts during the COVID-19 pandemic, physical exercise treatment was restricted in many German nursing homes. As a consequence, especially individuals with dementia (IWD) may suffer from inactivity and reduced quality of life. The tablet-based InCoPE-App (Individualized Cognitive and Physical Exercise) was specifically developed for nursing home staff to individually test and train motor and cognitive performance in IWD. The InCoPE-App is developed following the procedure of user experience research, where the involvement of both end users as well as experts during the app development is recommended. Here, we present the results of a qualitative expert usability review of the InCoPE-App (1.0) prior to the deployment to end users.
METHODS:
We recruited seven experts of sports science, computer science, and psychology and applied a think-aloud technique. Experts were given a protocol including five tasks within the InCoPE-App: (a) Create a participant, (b) test a participant, (c) create an exercise plan, (d) train a participant, and (e) simultaneously train two participants. The experts were encouraged to think out loud while performing these tasks. All verbalized thoughts were recorded, transcribed and analyzed by two researchers. We grouped similar themes into categories and noted the frequencies of the mentioned issues. Furthermore, we analyzed success of task completion, as well as time needed to perform the tasks.
RESULTS:
The experts completed tasks (a)-(d) without any problems. Three out of seven experts were not able to find the function to train two participants simultaneously. Mean time for the completion of all tasks was 32.12 minutes (SD=7.46). The problems uttered during the think aloud approach can be categorized and ranked by frequency as follows: (1) screen layout (n=11; e.g. small fonts and closely spaced buttons), (2) overall usability (n=9; e.g. drag and drop function), (3) navigation or logical structure (n=9; e.g. training of two participants), (4) comprehensibility (n=9; e.g. wording), and (5) graphics (n=5; e.g. size of pictures).
CONCLUSION:
In times of pandemic, the InCoPE-App enables implementation of physical exercise treatment without external experts (e.g. physiotherapists). The app was designed to be used by nursing home staff and must therefore be structured in a simple and comprehensible way. Our expert usability review revealed main problems regarding the screen layout of the InCoPE-App. Furthermore, the function to train two participants simultaneously must be easier to use. The issues will be fixed in a second development iteration. Subsequently, the revised version of the InCoPE-App (2.0) will be tested in a usability study in both a laboratory and a field setting by nursing home staff, where special attention will be paid to the issues revealed by the expert review.

IMPACT OF COVID-19 LOCKDOWN ON PROFESSIONAL SOCCER PLAYERS' MATCH PHYSICAL ACTIVITIES

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INTRODUCTION:
Match physical activities require a high level of effort to sustain the demands of the game. Those physical activities are influenced by fatigue, pacing strategies, physical fitness of players, and several contextual factors (Paul DJ et al., 2015). During the mid-late 2019-20 season, training and official matches of the Italian Serie A were cancelled to diminish the spread of the COVID-19. During the lockdown, players only performed individual home-based training sessions which likely impaired their physical capacities (Rampinini E et al., 2021). When the championship restarted, there was a greater frequency of matches that were played in stadiums without fans. The combination of these factors may have influenced match running activities. Accordingly, this study aimed to investigate the effect of COVID-19 lockdown on match physical activities in professional soccer players.
METHODS:
A semi-automatic video tracking system was used to investigate differences in physical activities between matches played in two periods before (PRE1 and PRE2) and the period after (POST) the COVID-19 lockdown by 265 male professional soccer players (observations n=929). Variables considered for the analysis were: total distance (TD, m·min-1), very high-speed distance (VHS, >20 km·h-1, m·min-1), sprint distance (SPR, >25 km·h-1, m·min-1), accelerations distance (ACC, >2.5 m·s-2, m·min-1) and decelerations distance (DEC, <-2.5 m·s-2, m·min-1). Differences between periods were examined using linear mixed models considering data of the entire match or data divided in 15-min intervals.
RESULTS:
TD and VHS during POST were significantly lower than both PRE1 and PRE2 ($p<0.001$, d small to moderate). SPR did not show significant differences between the three periods ($p>0.636$, d trivial). ACC and DEC during POST were significantly lower than PRE2 ($p<0.015$, d small).

TD during each match interval in POST was significantly lower compared to each correspondent interval both in PRE1 and PRE2 ($p<0.024$, d small to moderate), except for the last 15-min, which showed no differences between POST and PRE2 ($p=0.997$, d trivial). VHS during POST was lower than PRE2 in all intervals ($p<0.003$, d small), except for the first and the last interval of the match ($p=0.999$, d trivial) and was lower than PRE1 during the second and the fourth interval ($p<0.001$, d = small). SPR, ACC and DEC during match intervals only showed some small differences between periods.
CONCLUSION:
The current findings show that TD and VHS significantly decreased after the lockdown, while there were only some small decrements in SPR, ACC and DEC. The temporal distribution of running activities was similar in PRE1, PRE2 and POST. Practitioners should be aware that long periods of de-training, combined with the absence of fans, the high frequency of matches and a non-optimal mental state, may decrease overall soccer match physical activities, but may not affect high intensity actions, such as sprinting and accelerating/decelerating.

IMPACT OF LOCKDOWN RESTRICTIONS ON PHYSICAL ACTIVITY PROGRAMS IN NURSING HOMES DURING THE COVID-19 PANDEMIC

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INTRODUCTION:
The lockdown during the COVID-19 pandemic significantly influenced lives of many people. Especially nursing homes were negatively affected by contact restrictions and associated reduced activity offers. Thus, many nursing home residents suffered from inactivity and consequently reduced quality of life. Here, we present results of an analysis of physical activity offers in German nursing homes during the first lockdown in 2020.
METHODS:
We recruited 18 nursing homes from a larger longitudinal study in the area around Karlsruhe and the Rhine-Neckar metropolitan region (Germany). An online questionnaire was developed, consisting of 21 questions divided into four categories: (1) general information about the nursing home and their individual COVID-19 situation, (2) physical activity offers before and (3) during the COVID-19 pandemic, and (4) desired support. Results were descriptively analysed using SPSS Statistics (v. 25).
RESULTS:
Nine nursing homes completed the questionnaire. Prior to the COVID-19 pandemic, they offered an average of four different physical activities (range 1-7), with 13 residents participating (range 5-20), delivered by an average of two instructors. During the lockdown, five nursing homes completely cancelled their physical activity offers, while three reduced it and one adapted group size and did not allow external instructors. Reasons for cancelling physical activity offers include e.g.: external political requirements (n=5), spatial limitations (n=5), limited internal instructors (n=3), and fear of infection (n=4). Five nursing homes reported reduced physical and cognitive abilities in their residents caused by lack of exercise.
CONCLUSION:
During lockdown, more than 50% of responding nursing homes completely canceled physical activity programs, while the remaining ones were forced to adapt their offers. Additionally, a majority observed negative effects on physical and cognitive abilities of their residents. Aiming to prevent such a decline, we strongly recommend, in line with literature [1], to continue existing physical activity offers. The survey moreover showed that nursing homes would like to get appropriated support. Possible actions, aiming to maintaining physical activity offers during a pandemic, include 1) further education of nursing home staff, 2) implementation of mobile applications, and 3) providing nursing homes with adequate physical activity instructions.
References:
[1] Frahsa A, Altmeier D, John JM, Gropper H, Granz H, Pomiersky R, Haigis D, Eschweiler GW, Nieß AM, Sudeck G and Thiel A (2020) "I Trust in Staffs Creativity" - The Impact of COVID-19 Lockdowns on Physical Activity Promotion in Nursing Homes Through the Lenses of Organizational Sociology. Front. Sports Act. Living 2:589214. doi: 10.3389/fspor.2020.589214

THE IMPACT OF UK COVID-19 RESTRICTIONS ON MOTIVATION, TRAINING HABITS AND PERFORMANCE GOALS OF MALE AND FEMALE ENDURANCE RUNNERS.

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INTRODUCTION:
Restrictions enforced by the COVID-19 pandemic and associated national lockdowns resulted in a change of lifestyle for many UK residents. Although running was permitted as a form of daily exercise, clubs could no longer meet and mass participation events were cancelled, replaced by virtual races. This study aimed to identify how these changes impacted male and female endurance runners in regards to training habits, motivation and setting of performance goals.
METHODS:
Endurance runners completed an anonymous online survey (Qualtrics, Provo, UT) comprised of 59 optional questions; divided in to five sub-sections; (i) athletic ability, (ii) goal setting, (iii) training habits prior to and (iv) during lockdown, (v) sociodemographic. Participants were recruited via snowball sampling (December 2020-March 2021) through contacts and social media networks. Data were analysed from 524 runners (266 females, 236 males). Descriptive statistics and paired sampled t-tests ($p<0.05$) were used to detect changes in running behaviour, Pearson Chi-square tests were performed to identify differences between the sexes.
RESULTS:
Runners reported a significant drop in motivation ($p<0.05$) during lockdown. Stress relief/psychological reasons were identified as the main motive to run compared to previous incentives such as personal goal achievement and competition. Athletes ran more frequently during lockdown (no. days per week, $p<0.05$) despite no significant increase in total weekly mileage.
Males reported a significantly higher weekly running volume than females ($p<0.05$). A higher percentage of males reported a perceived improvement in fitness levels compared to females ($p<0.05$) and were more likely to achieve their 2020 running goal (40% males vs. 34% females). Males also felt more confident participating in mass participation events (62% males vs. 54% females).
Virtual events proved popular, with 69% of respondents participating; this was particularly true of female runners with 75% racing virtually. Prior to lockdown, female runners were significantly more likely to run with club members or friends ($p<0.05$); lockdown resulted in over 80% of respondents having to run alone.

CONCLUSION:
The study identified sex differences in training habits, particularly running volume. Coaches and athletes should consider this impact to prevent future disparities between male and female runners. As the UK emerges from lockdown, runners should be encouraged to evaluate their goals, motivation and consider how best to fulfil their needs e.g. social running, which may help maintain adherence to the sport. Mass participation events should consider why females are more apprehensive to participate and provide reassurance. Future studies are required to see if virtual races remain popular and whether a lack of club coaching and track sessions has impacted training intensity. Finally, with in-person competition returning and gyms opening, injury prevalence requires monitoring.

THE ANALYSIS OF HEALTH BEHAVIOR AND DEPRESSION DURING THE COVID-19 ON HUNGARIAN ADOLESCENT

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Introduction
The coronavirus epidemic has impacted our daily life. Several governmental restrictions were applied (e.g., school closer) to slow the spread of the virus, but social exclusion in the quarantine increased vulnerability for mental health and health behaviors. Therefore, the aim of this study is to describe the students health behavior and depressive symptoms during the home-school in Hungary.
Methods
A total of 705 high school students were participated in our study (Mean age = 15.9; SD = 1.19). The self-administered questionnaire package included social demographic data, questions about eating habits (food consumption and breakfast), physical activity, sedentary behavior, and substance use. Depressive symptoms were measured with the Child Depression Inventory.
Results
The participants reported 21.7% of daily fruit and 22.4% of daily vegetable intake. The frequency of consuming on daily sweets was 13.2%, on daily soft drinks was 12.3%, and on daily energy drinks was 4.5%. More than one-third of the sample (35.5%) was considered to have breakfast every school day, and on weekends the breakfast willingness rises to 68.1% on both days. Only 4.5% of the students meet the recommended daily physical activity guideline and their most preferred physical activity was strength training (26.6%). However, walking (17.4%), jogging (14.1%), and biking (6.8%) were also popular. Analyzing screen time, we found that 86.1% of the participants spend four or more hours in front of the screen. The substance use showed that 80.1% of the sample didnt smoke, but 10.2% reported daily smoking. More than half of the students (58.6%) didnt drink any alcohol, but 7 (1.0%) participants reported daily alcohol consumption during the home confinement. Most of the participants (97.0%) did not use any drugs during the "stay-home" period. Investigated among depressive symptoms showed that, 45.4% of the participants had high risk of depression.
Discussion
This study aimed to explore health behavior and depression during the home-school in Hungary. Comparing with previous studies, we found that the vegetables and fruit consumption were not changed, but it was a pleasant result that the sweetened beverages and energy-dense food were reduced during the stay-home period. Our finding on physical activity and screen time was consistent with other studies: physical activity was decreased, and screen time was increased. Despite the obligatory confinement, a notable percentage of adolescents engaged in substance use, however it was significantly reduced compared with previous studies. Home confinement had a significant impact on depressive symptoms. It seems adolescents with depressive symptoms have doubled compared with the post-pandemic period. We believe our study provided helpful information on adolescent health behaviors that can help create regulations to help adolescents pursue a healthy lifestyle even during the quarantine.

DO FREQUENT USERS OF PSYCHOLOGICAL SKILLS BENEFIT MORE FROM BRIEF PSYCHOLOGICAL SKILLS TRAINING?

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Teaching interventions that help enhance performance is a key role for sport psychologists. The COVID-19 pandemic and social distancing meant sport psychologists had to conduct a great deal of work online. Online delivery could offer a scalable approach to teaching intervention techniques. A recent study of 44,742 participants found that brief instructional videos delivered by Olympian Michael Johnson associated with positive emotions and improved performance (Lane et al., 2016). Lane et al. (2016) found that teaching brief interventions were effective, raising positive emotions and increasing effort. Research shows that people use psychological skills acquiring such skills via experience. The present study invested the extent to which frequent users of psychological skills benefited more from using brief psychological training than less frequent users.
The BBC lab UK dataset (Lane, Totterdell et al., 2016) was used. In the present, control data are drawn from participants who did not complete the interventions (n = 13265) and not reported by Lane et al. (2016). Lane et al. (2016) used an active control in their study; the present control study is closer to a no-treatment group. The intervention group comprised participants who completed active training (n = 32198), that is, all 12 different interventions were merged. The study asked participants to complete measures before completing a competitive computer task which lasted less than 30 seconds to complete. After completing measures, an intervention which lasted approx. 45 seconds in length was delivered by former Olympian Michael Johnson. Post competition, participants completed a measure of effort. Psychological skills data was assessed before competition using an 8-item shortened version of the original Test of Performance Strategies (Thomas et al., 1999). Data were grouped into a high frequency use of psychological skills (N= 10508), medium use (N = 19902) and low use (n = 15053).
Repeated measures MANOVA results indicated a significant interaction effect whereby participants who received an intervention and were frequent users of psychological skills before the study made the greatest progress (Partial Eta2 = .049). A main effect was evidence for using interventions over the control group (Partial Eta2 = .001). Frequent use of psychological skills was associated with better performance, positive emotions, and exerting more effort (Partial Eta2 = .023).
Findings suggest that brief interventions in the form of short videos can help participants perform better, feel positive emotions and exert more effort. Findings suggest that regular use of psychological skills training appears to provide a useful platform for further learning. Future research should investigate the active ingredients involved in developing the motivation to want to learn and use psychological skills, and how people process feedback from performance so to help further learning.

COVID-19 LOCKDOWN: ITALIAN SPORTS COMMUNITY MANAGEMENT

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INTRODUCTION

The outbreak of the coronavirus disease (COVID-19) created an international health emergency. Schools as well as recreational and sports centers were closed, sporting events were forbidden. This “abrupt stoppage” in sport activity affected athletes, coaches, and sport managers, at multiple levels. Sports represent the core activity of an athlete’s and coaches’ life, challenging their psychological resilience. Sport managers, must guarantee the sports associations’ “economic survival” [1]. Regarding this matter, a web-based survey was carried out within the Italian sports community, to explore the potential influencing factors on the onset of distress from the suspension of sports activity. It would, provide a theoretical basis for psychological and organizational interventions.

METHODS

Data were collected from the following 1,741 self-selected volunteers: 800 athletes (aged 28.30±10.93); 73 Paralympic athletes (aged 42.11±13.70), 558 coaches (aged 36.91±11.93); and 310 sports managers (aged 42.07±13.38). To assess the level of psychological stress, an Impact of the Event Scale-Revised (IES-R) questionnaire was used.

RESULTS

The results indicated that 34.92% of the participants were affected by subjective distress while 26.36% rated their psychological impact from the sports activity interruption as severe. Separated one-way ANOVA tests showed significant differences in the IES-R total score (TS), indicating that the level of stress, in terms of gender revealed that women were more stressed than men ($p = 0.000$), for “sports roles” in which the manager and coaches were more stressed than the athletes ($p<0.05$), and “type of sport” in which fitness and individual athletes were more stressed than team athletes ($p<0.01$). The middle-level athletes showed significantly more hyperarousal levels than high-level athletes ($p = 0.012$). Comparing Paralympic athletes with non-disabled athletes, significant differences both in total scores and all the subscales were found ($p<0.001$). Paralympic athletes showed lower scores than non-disable athletes.

DISCUSSION

The COVID-19 pandemic and relative quarantine have led to undesirable psychological pressure on the sports community in Italy, likely with long-term consequences. The results of this survey may raise awareness of this problem and help athletic associations to have appropriate guidelines in order to better sustain their memberships and organize an optimal resumption of their sports activities. Along these lines, social interactions, which are typical of team sports, are crucial to warrant resilience and psychological health. The Paralympic athletes showed a high resilience to stressful events. The athletes by managing independently the new rules and measures, thanks to a clear communication, could improve their adaptive stress reaction.

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ACUTE EFFECTS OF CARDIOVASCULAR AND CREATIVE ACTIVE BREAKS IN PRIMARY SCHOOL

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INTRODUCTION

The increasing need to face the problem of sedentarism induced teachers and researchers to find new useful intervention methodologies in school context. Active Breaks (ABs) include brief periods of physical activity as a part of the curriculum. The Covid-19 pandemic, with its access restrictions to public recreational and sportive areas, negated the possibility to keep children active as schools remain to be the last bastion where physical activity is achievable. This study aimed to investigate two different protocols of Abs acute responses between periods of academic instruction, on attentive skills and academic achievement in a primary school.

METHODS

A total of 141 children (aged 9.61 ± 0.82), divided in 6 classes, underwent Stroop color and Word test and the Math test at baseline and at the end of the interventions. The classes were randomly assigned to three groups, Fitness experimental group (FIT), Creative experimental group (CREAT) and Control group (CON), based on the type of protocol used during the three Abs, performed with the music and scheduled in the same school day. The degree of enjoyment was evaluated through the modified Physical Activity Enjoyment Scale (PACES). Successively all participants were divided in three groups: low, medium and high level of enjoyment.

RESULTS

The RM-MANOVA showed significant differences between the FIT and CON in Math test ($p=0.035$) and Stroop Color and Word interference test ($p=0.038$). One-way separated ANOVA showed that CREAT and FIT groups had higher degree of enjoyment than the CON one (both $p<0.001$). Medium and high enjoyment groups achieved higher scores than the low one in Math test ($p=0.040$ and $p<0.001$, respectively).

DISCUSSION

This study reaffirmed how classroom active breaks positively affect attention and academic performance in children. These effects are more pronounced when these interventions enhance children’s motivation and higher level of enjoyment. Physical activity, especially performed with music, is closely linked with enjoyment. Enjoyment is a fundamental factor in the learning process and helps children to better retain information, develop new knowledge, and showed a positive correlation with students use of cognitive learning strategies [1]. The cardiovascular approach provides the highest results in term of short-term efficacy, enhancing physiological arousal. The better time on/off, comparing to the creative protocol, may have allowed the proper exercise volume (duration x intensity). In contrast, the creative protocol, even though was less intense in term of work/rest ratio, provides constantly new stimuli and motivation improvements. This report provided useful information for teachers to organized future Abs between curricular lessons in primary schools.

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PRE VERSUS POST- COVID-19 NEUROMETABOLIC AND STRUCTURAL ALTERATIONS IN HUMAN BRAIN: PRELIMINARY OBSERVATIONS FROM MRS/MRI NEUROIMAGING IN 3 OLDER ADULTS

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INTRODUCTION:
COVID-19 is often associated with chronic neurological and psychological symptoms, like loss of smell, cognitive impairment and anxiety or depression. These persistent complaints could be triggered by brain structural and neurochemical abnormalities. Neuroimaging studies and autopsies have shown alterations in the brain similar to those often seen in normal aging. As a vast amount of research has shown that exercise may help to prevent age-related structural and functional changes in the brain, it might also be beneficial against COVID-19-induced brain abnormalities.
METHODS:
Data were collected from nine older adults who were participating in a randomized controlled trial designed to examine the effect of a 12 week resistance exercise program on brain and blood biomarkers and cognitive function. During the study, three subjects presented mild COVID-19 symptoms not requiring hospitalization. Post-COVID-19 data were collected 7-16 days after recovery. Two of these three subjects were assigned to the experimental group and had completed 18-20 resistance training sessions (twice a week) prior to their infection with COVID-19. All seven other subjects had been assigned to the control group. Proton magnetic resonance spectroscopy (MRS), magnetic resonance imaging (MRI), hospital anxiety and depression scale (HADS), Montreal Cognitive Assessment (MOCA) and ELISA-based blood levels of inflammatory markers were measured.
RESULTS:
We observed neurochemical changes in all three subjects after mild COVID-19. A meaningful elevation of myo-inositol (mIns) levels and a trend towards decreased glutamate-glutamine (Glx) levels referenced to creatine (Cr) was found in the left hippocampal cortex (HPC), each present in two of the three subjects. There were no changes in blood IL-6 or TNF-α levels. However, increased mIns/Cr levels were accompanied by HPC gray matter volume reduction in one subject and increased anxiety in another subject. The two subjects with decreased Glx/Cr levels did not show declines in HPC gray matter volume. Interestingly, the latter two subjects were also the ones that were allocated to the resistance training condition.
CONCLUSION:
This is the first study to compare pre- and post-COVID-19 brain imaging data in the same subjects. Alterations in mIns/Cr and Glx/Cr were each present in two out of three subjects after mild COVID-19. This may respectively indicate local neuroinflammation and impaired synaptic plasticity. Such abnormalities in the HPC are considered detrimental for learning and memory formation. Despite these neurochemical changes, our results suggest that subjects participating in resistance exercise training could be protected against structural alterations in the HPC. Future studies with larger sample sizes are required to confirm our findings and prove if the protective effect of exercise against HPC volume loss translates to prevention of long-lasting neurological and psychological complaints post-COVID-19.

PREVENTING PHYSICAL DECLINES DURING COVID-19 USING REMOTE PHYSICAL ACTIVITY INTERVENTIONS IN COMMUNITY DWELLING OLDER ADULTS

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INTRODUCTION:
Physical inactivity lead to health declines but COVID-19 lockdown exacerbated this vicious circle. Geronto-technology could help older adults to become/remain physically active as up to 50% of seniors have access to technologies and used Internet daily. Thus, implementing remote physical activity could be a solution to maintain their health and respect covid-19 restrictions. We aimed to assess the effects of remote physical activity interventions on physical performance among community-dwelling older adults.
METHODS:
During the COVID-19 1st wave, 56 older adults (> 60-years old), living at home and previously inactives (Ex: <2h/week) completed a 12-weeks intervention (3-times/weeks). Participants were randomized into 2 groups: interactive (IG; n=32) or video (VG; n=24). The IG was trained in group by a kinesiologist, via Zoom© whereas the VG did the same sessions but individually with pre-recorded videos through a dedicated website. A decisional tree was used to determine the physical activity capacity to ensure safety and adequacy. Anthropometric characteristics, functional capacities (unipodal / bipodal balances, 5-rep sit-to-stand, 3-meter TUG & 4-meter walking tests), muscle power (10-rep chair test), muscle endurance (30sec chair test), quality of life and perceived health (EQ-5D), and level of physical activity (RAPA) were assessed pre- and post-intervention via Zoom or lime-survey software.
RESULTS:
The drop-out rate was higher in VG (46%) compared to IG (16%). The adherence to the intervention was similar in both group (>80%). Quality of life, functional capacities, muscle power and endurance improved in both groups ($p < 0.05$). Physical activity level and perceived health improved only in IG group. The changes in muscle power and endurance were significantly greater for the IG group than the VG group.
CONCLUSION:
Remote physical activity interventions appear to be effective to counteract physical decline among older adults. Nevertheless, the interactive modality seems to be more effective in increasing muscle parameters and generates greater retention. Before to address specific exercise recommendation, further studies examining the virtual/interactive sessions ratio are needed to evaluate the most effective.

MOTIVATION, SPORT SKILL, AND PARTICIPATION IN SPORTS ORGANIZATIONS ARE ASSOCIATED WITH DIFFERENT PHYSICAL ACTIVITY BEHAVIOUR BEFORE AND DURING COVID-19

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INTRODUCTION:

The sudden emergence of the Coronavirus-2019 (COVID-19) pandemic has affected people's habitual exercise behaviors around the world and has led to a decline in global PA levels. Since the outbreak of COVID-19 in January 2020 in China, Chinese adults' PA participation has also underwent a gradual recovery from a decline to pre-pandemic levels. It is of importance to understand the changes and determinants of Chinese adults' PA levels before and during the pandemic which will provide important information for the government to formulate future PA promotion policies.
METHODS:
A total of 1028 adults (aged 19-59 years) were recruited from four urban and rural regions in China using stratified three-stage probability sampling. A battery of validated National Fitness Status Survey was employed to assess PA levels and related PA determinants. Data collection was conducted in December 2019 (prior to the COVID-19 pandemic) and July 2020 (seven months after the outbreak of the COVID-19 pandemic), respectively.
RESULTS:
We observed that, compared with the data before the pandemic, individuals' weekly moderate-to-vigorous-intensity PA (MVPA) decreased significantly from 139 minutes to 120 minutes, seven months after the outbreak ($p = 0.01$), with female and rural populations displaying more significant decreases ($p = 0.02$). Further, the proportion of individuals meeting the PA guidelines dropped from 36% to 32%. PA determinants before and during the pandemic included sports skills, self-determined motivation, gender, and support from sports organizations. Specifically, with each additional sport skill, individuals' extent of being physically active increased 1.21 times during the pandemic ($p < 0.01$). Similarly, their degree of being physically active increased 1.06 times during the pandemic when self-determined motivation increased by 1 point ($p = 0.03$). Moreover, after the outbreak, males were 2.08 times more likely to be physically active than females ($p < 0.01$) and with each additional sport skill, males' degree of being physically active during the pandemic was 1.13 times higher than that of females ($p < 0.01$). In addition, PA levels of those who dropped out from sports organizations after the outbreak was about 56% of that of individuals who joined sports organizations after the outbreak ($p = 0.04$).
CONCLUSION:
This study showed a significant change in Chinese residents' PA after the outbreak of the COVID-19 pandemic. For the individuals who were physically active before the pandemic, the accumulation of motor skills and relatively strong self-determined motivation ensured the maintenance of adequate PA levels after the outbreak of the COVID-19 pandemic. In contrast, organizational membership and the acquisition of more motor skills could better improve personal PA levels among inactive populations.

INFLUENCE OF A VIRTUAL EXERCISE PROGRAM THROUGHOUT PREGNANCY DURING THE COVID-19 PANDEMIC ON EPISIOTOMY DELIVERY RATES.

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INTRODUCTION:
The situation caused by COVID-19 has led to changes in lifestyle, significantly affecting the physical and emotional health of the pregnant population. Mobility restrictions and home confinement have decreased exercise and increased stress, related to a multitude of complications during pregnancy and childbirth. One such complication is perineal injury that significantly affects the quality of life of pregnant women after delivery. A high percentage of these perineal traumas are caused by instrumental delivery and episiotomy. Recent studies show that these surgical procedures are related to increased long-term complications for womens health1. Therefore, it is necessary to establish a non-invasive new strategy, especially during the COVID pandemic, to reduce the risk of these injuries.
METHODS:
A randomized clinical trial design (NCT04563065) was used. Data were collected from 85 pregnant women without obstetric contraindications who attended their pre-natal medical consultations in the Madrid area. Women were randomly assigned to the intervention (IG) or the control group (CG). All women agreed to participate through informed consent. A virtual program of moderate and supervised exercise was conducted as an intervention from 8-10 to 38-39 weeks of pregnancy based on the Barakat Model2 and following the recommendations of international clinical guidelines3. Study adherence was sealed at 80%. Data of episiotomy rates were collected from medical records.
RESULTS:
Overall, 18.8% of study participants had an episiotomy. Significant differences were found between the study groups in the percentage of episiotomies ($\chi 2$ (2) = 9.490; $p = 0.009$) showing a lower episiotomy rate in the IG (5/11.6%) in relation to the CG (11/26.2%).
CONCLUSION:
A virtual program of supervised exercise throughout pregnancy during the current COVID-19 pandemic may help reduce rates of episiotomies during delivery in healthy pregnant women.
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CHANGES IN HEALTH BEHAVIORS AND LIFESTYLE ADAPTATIONS AMONG OLDER ADULTS AFTER THE COVID-19 LOCKDOWN IN SPAIN ACCORDING TO DIFFERENT PATHOLOGIES.

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INTRODUCTION:
Lockdown due to COVID-19 had an overall negative impact on physical activity levels, sleep quality, food habits, and mental and physical well-being (1). However, few studies have examined the consequences of release from lockdown on these factors in older adults, despite its highlighted relevance (2). Since chronic morbidities are common in this population, this study aimed to investigate how different pathologies independently influenced the changes in health behaviors and lifestyle adaptations after emerging from a strict 2-month lockdown.
METHODS:
Telephone-based structured interviews involving a total of 1426 Spanish older adults (80.4±5.6 y, 67% women) with pathologies such as hypertension, depression, dementia, cancer and pulmonary, cardiovascular and osteomuscular diseases were conducted at the end of the lockdown period and 7 months later. We collected information about sociodemographic factors, lifestyle-behaviors, social participation, and mental and physical health. Furthermore, participants were classified based on the changes related to this period. Multinomial logistic regression analyses adjusted for the main confounders were used to assess outcome changes from the lockdown to the post-lockdown period using the not changing groups as reference. All results were involved to $p<0.05$.
RESULTS:
People with hypertension were more likely to decrease their frequency of alcohol consumption (odds ratios (ORs)= 2.40, [1.01-5.66]), continue to be non-drinkers (ORs= 1.92, [1.02-3.61]), and worsen their physical component summary (PCS) score (ORs= 2.41, [1.29-4.52]) than to stay the same after lockdown. Similarly, people with osteomuscular diseases also had a higher likelihood of decreasing their frequency of alcohol intake (ORs= 2.41, [0.10-5.81]) and worsening their PCS score (ORs= 2.23, [1.15-4.33]). Older people with pulmonary diseases were less likely to reduce their sedentary time (ORs= 0.36, [0.14-0.92]) and more likely to worsen their mental component summary (MCS) score (ORs= 2.12, [1.03–4.35]). However, older people with cancer had a greater chance of improving their PCS score (ORs= 5.84, [1.99-17.2]). People with cardiovascular diseases, depression and dementia did not experience statistically significant changes.
CONCLUSION:
Older adults with osteomuscular disease and those with hypertension have decreased their frequency of alcohol intake and worsened their PCS, although only the latter remained abstainers. Furthermore, this pandemic has also had a negative effect on older adults with pulmonary disease, showing a more sedentary lifestyle and worsening of MCS. However, those with cancer have improved their PCS. This data can help create specific interventions for those populations that have been most affected after the pandemic.
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A STRATEGY TO IMPROVE PHYSICAL FITNESS AND PHYSICAL ACTIVITY LEVEL DURING A GLOBAL PANDEMIC: AN ONLINE HANDBALL4HEALTH-BASED PROGRAMME

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INTRODUCTION:
Handball4Health (H4H) is a research and community intervention project that aims at improving physical fitness, health and well-being through recreational team handball (TH) practice. In Portugal, this programme targets inactive over 50-year-old men and women and the activity consists mainly of playing recreational small-sided TH with adapted rules. The outbreak and spread of SARS-CoV2, led the world to a lockdown, and consequently, H4H face-to-face sessions were suspended. The H4H participants were required to stay at home creating the conditions to potentially decrease their physical activity (PA) level and increase sedentary behaviour. After the first two weeks of lockdown, the H4H programme returned as online adapted exercise sessions.
METHODS:
Twenty-six participants (13 men and 13 women) that performed the H4H adapted online exercise sessions were tested for physical fitness and PA before and after 4 weeks of supervised home-based training. Six weekly sessions were offered to the participants. Participants' age, stature, body mass and fat mass were 67.2±4.6 years, 163.0±9.4 cm, 72.6±12.7 kg and 31.6±7.2%, respectively. The average weekly attendance was 2.5±1.4 (0.5-5.5) sessions. The adapted H4H online exercise programme comprised 45-min sessions with a 15-min warm-up consisting of running, coordination, strength, flexibility and balance exercises, followed by TH specific ball exercises. Additionally, 2 sets (30-min) of different aerobic and strength training circuits for the main muscular groups were delivered. The space and material required for the participants to engage in the activity were 2x3m2 and a ball. Participants' physical fitness, namely, lower body strength, and PA level were measured by sit and stand test and international PA questionnaire, respectively.
RESULTS:
After 4 weeks, the participants showed a significant improvement in lower body strength (22±3 to 24±4 repetitions; $p\leq0.001$) and a significant increase was observed for vigorous PA from 22±36 to 65±41 min/day ($p\leq0.001$) and 569±1097 to 2128±1308 met/day ($p\leq0.001$) and total PA from 2260±1703 to 3869±1973 met/min ($p=0.002$). Nevertheless, sedentary behaviour (sitting time) increased from 60±39 to 287±202 min/day ($p\leq0.001$).
CONCLUSION:
During the full lockdown period in Portugal imposed by COVID-19 pandemic, the participants' sitting time increased, however, by performing a H4H adapted home-based exercise programme it was possible to increase their lower body strength by 9%, and vigorous and total PA. Additionally, the participants were able to meet the WHO PA guidelines (1) and maintain social interaction.
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EXISTENTIAL CHALLENGES FOR INTERNATIONAL SPORT EVENTS IN THE PURSUIT OF POPULATION PHYSICAL ACTIVITY LEGACIES: NAVIGATING CONTESTED TERRAIN.

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The pursuit of population physical activity (PA) legacies as an outcome of hosting international sports event is a subject of academic and policy debate. This presentation considers emerging and existential challenges in the pursuit of such public health goals in the 21st century based on a recent systematic review, international Delphi study and environmental audit completed by a multinational research team. The forthcoming Tokyo 2020 Olympic and Paralympic Games have already been disrupted by an unprecedented confluence of negative impacts related to the global COVID-19 pandemic and the ongoing effects of climate change. Added to these environmental challenges are a range of ongoing organizational and research problems that continue to hamper long-term legacy planning and evaluation related to international sport events. The challenges associated with hosting the Tokyo Olympics provide context for considering the changing nature of international events and their contested public health impacts.
A recent systematic review considered the dual threats of infectious diseases and climate change, which have intersected dramatically with the Tokyo Olympic and Paralympic Games leading to a one-year postponement and relocation of long-distance running and race-walking events to the northern prefecture of Hokkaido. Environmental threats challenge the capacity of event organizers to effectively leverage hosting in the pursuit of legacy objectives, including the promotion of population PA. A series of environmental audits were also conducted in the vicinity of Tokyo's Olympic and Paralympic venues to ascertain levels of support for community PA using observational methods, including the validated Irvine-Minnesota Inventory. Several issues were identified during the pre-COVID-19 build-up, including accessibility challenges, lack of amenities, environmental nuisance (tobacco smoke, heat island effects and vegetation overgrowth), and disaster risk. Finally, an international Delphi study was undertaken to consolidate expert consensus relating to organizational, policy and research challenges associated with the pursuit of population PA outcomes associated with event hosting. Experts were pessimistic about the capacity of event hosting to achieve population PA increases and noted limited tangible outcomes beyond infrastructure and facilities. Opportunities were identified in relation to long-term legacy planning, funding, stakeholder involvement, and research and evaluation.
Based upon the tripartite assessment of the extant literature, Tokyo-based environmental audits, and international expert consensus, this presentation offers a range of novel strategies across policy, research, environmental development to address potential existential challenges for international sports mega events that seek to leverage hosting to achieve population PA legacies.

OP-MH01 Sports Med Injuries / ACL

MECHANISMS OF SPORT-RELATED INJURIES IN PHYSICAL EDUCATION TEACHER EDUCATION STUDENTS: A DESCRIPTIVE ANALYSIS OF 896 INJURIES

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INTRODUCTION:
The aim of this study was to determine sport-related injury mechanisms in Physical Education Teacher Education (PETE) students.
METHODS:
This prospective cohort study (40-weeks) in first-year PETE students obtained self-reported characteristics of injuries (body part, injury setting, injury mechanism and movements related to the cause of injury). Students (N=759) from the academic years of 2015-2016, 2016-2017 and 2017-2018 participated in this study. Descriptive data analysis was conducted on the injury characteristics.
RESULTS:
In total 896 injuries were registered by 489 (64%) students. Large proportions of the injuries resulted from both non-contact (N=496, 56%) and contact (N=381, 42%) mechanisms. The most common injury mechanism was gradual onset non-contact (N=275, 31%). High proportions of non-contact injuries were found in curricular practices (N=120, 44%) and extra-curricular practices (N=30, 38%). Injuries during extra-curricular games were mainly contact related (N = 133, 81%). Furthermore, injury onset was most commonly associated with a landing (N=179, 29%), a fall (N=158, 25%), an explosive movement (N=114, 18%).
CONCLUSION:
The most common injury mechanism was gradual onset non-contact. For practices (curricular and extra-curricular) and extra-curricular games, the most common injury mechanism were respectively non-contact and contact with an person. Furthermore, injuries were most commonly associated with landings, falls and explosive movements.

GENE-GENE INTERACTIONS BETWEEN ITGB2, AND COL5A1, AND TNC ARE ASSOCIATED WITH MODULATING ACL RUPTURE SUSCEPTIBILITY

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INTRODUCTION:
Variants within the collagen type V alpha 1 chain gene (COL5A1) and the tenascin C gene (TNC) have been associated with susceptibility to anterior cruciate ligament (ACL) rupture. Interestingly, bioinformatic analyses and a preliminary genetic association study have highlighted variants within the gene, ITGB2, encoding the beta 2 subunit of integrin to be associated with ACL rupture susceptibility. In addition, a recent study showed that cyclic stretching of human periodontal ligament cells exhibited differential expression of key genes including ITGB2, TNC and COL5A1. Therefore the aim of this study was to test for the association of allelic interactions between ITGB2, COL5A1 and TNC with ACL rupture risk as a proxy of gene-gene interactions between these genes.
METHODS:
A total of 232 asymptomatic controls (CON) and 253 cases with surgically confirmed ACL ruptures (ACL) of whom 149 sustained a non-contact mechanism of injury (NON) were genotyped for ITGB2 rs2230528, COL5A1 rs12722 and TNC rs1061694. Inferred allele combinations were constructed between ITGB2-COL5A1 and ITGB2-TNC using the individual genotype data and the frequencies of the allele combi-

nations were compared between the groups. Statistical analyses were conducted using the programming environment R, R package SNPassoc and haplo.stats. A significance level of p<0.05 was set for all statistical analyses.
RESULTS:
The ITGB2-COL5A1 T-C allele combinations were more often associated (p<0.001) with the CON (35%) group compared to the ACL (24%) or the NON (24%) groups. While the C-T alleles were more often associated (p<0.001) with the ACL (32%) and NON (31%) groups compared to the CON (15%) group. Similarly, the ITGB2-TNC T-C alleles were more often associated (P<0.001) with the CON (30%) compared to the ACL (20%) or the NON (20%) groups. While the C-T allele combination was more often associated (p<0.001) with the ACL (28%) and NON (28%) compared to the CON (13%) group.
CONCLUSION:
The findings from this study have highlighted specific increased and decreased risk associated allele combinations for ACL rupture. These findings suggest that biological interactions between specific allelic gene variants of ITGB2-COL5A1 and ITGB2-TNC influence susceptibility to ACL ruptures and are potential new therapeutic targets of clinical relevance.

THE EFFECT OF FOCUS OF ATTENTION INSTRUCTION ON KNEE KINEMATICS DURING A LATERAL CUT MANEUVER FOLLOWING THE IMPLEMENTATION OF AN ACL INJURY PREVENTION PROGRAM.

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INTRODUCTION:
Non-contact anterior cruciate ligament (ACL) injuries continue to be more prevalent in female athletes than in male athletes. A deleterious health consequence of ACL injury is post-traumatic osteoarthritis (PTOA), which causes long-term disability, and has led to widespread promotion of ACL injury prevention. The focus of ACL injury prevention programs is avoiding injurious movement mechanics that decrease ACL injury risk, such as increased knee valgus and decreased knee flexion during jump landings and cutting maneuvers. The type of verbal instruction received during such programs may effect motor skill acquisition and motor learning. In theory, using an external focus of attention (EFA) rather than an internal focus of attention (IFA) is thought to be better for enhancing motor performance (short-term demonstration). Few studies have investigated focus of attention effects on motor learning (long-term skill acquisition) during an ACL injury prevention program. The purpose of this study was to compare the effect of EFA and IFA instruction on knee kinematics during a lateral cut maneuver in female athletes following a 6-week ACL injury prevention program.
METHODS:
Thirty-one female recreational athletes (24.5 ± 1.8 years) with no history of lower extremity injury or surgery participated in the study. Subjects completed an ACL prevention program twice a week for 6 weeks (n=16 IFA; n=15 EFA) at 10 exercise stations focused on improving neuromuscular strength, plyometrics and movement mechanics with either EFA or IFA cues. Knee kinematics were collected during a lateral cut maneuver pre and post-exercise training. Data was smoothed with a 4th order, zero-lag Butterworth filter with a frequency cut-off of 12 Hz. A mixed model 2x2 (EFA/IFA x Pre/Post) ANOVA was performed with p <.05 level set apriori.
RESULTS:
A significant main effect was found in knee valgus by time (F=5.78, p=.02), but not for time x group interaction (F=2.75, p=.11). Post-hoc t-tests indicated a significant difference between EFA pre and post-test results (t=3.31, p=.005). Average knee valgus angles changed from 1.96° valgus to 1.89° varus in EFA group, compared to 0° to .77° varus in IFA group. There were no significant differences in knee flexion by time (F=1.31, p=.26) or interaction (F=2.12 p=.16).
CONCLUSION:
EFA instruction during an ACL prevention program may improve injurious movement patterns, but the changes may not be clinically significant. Other factors that need to be considered in future studies are the stage of motor learning the participant is in, how the learner interprets instructions during the intervention, and whether novice vs. expert learners have a preferential style that maximizes their learning. Further research is needed to determine how EFA and IFA instruction can influence motor learning so coaches and health care practitioners can maximize instruction that appropriately address specific populations during motor skill tasks.

COLLAGEN GENE VARIANTS ARE ASSOCIATED WITH KNEE JOINT LAXITY MEASUREMENTS

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INTRODUCTION:
Knee joint laxity is a complex phenotype which is determined by several extrinsic and intrinsic, including genetic, factors. Knee joint laxity is itself a modulating intrinsic factor for several exercise-associated phenotypes, including risk of ACL rupture. Variants within genes encoding components of the extracellular matrix, such as collagens, have been implicated in modulating measurements of joint range of motion and laxity. Several of these variants have also been reported to modulate the risk of ACLand/or other musculoskeletal soft tissue injuries. Therefore, the aim of this study was to investigate whether CCOL1A1, COL5A1, COL11A1 and COL11A2 variants are associated with knee joint laxity measurements.
METHODS:
114 moderately active uninjured consenting participants between the ages of 18 and 50 years were recruited. The y all completed sporting activities, medical and injury questionnaires. Knee joint laxity assessments were measured in the non-dominant leg and included genu recurvatum using a goniomete,; anterior-posterior knee laxity using a KT-1000 arthrometer, and external-internal rotational laxity using the RKT device. Using donated blood samples, participants were genotyped for COL1A1 (rs1107946, rs1800012), COL5A1 rs12722, COL11A1 rs3753841 and COL11A2 rs1799907.
RESULTS:
The COL1A1 rs1107946 GG genotype was associated with increased external laxity, internal laxity and slack (P<0.050) .Furthermore, the presence of the GG genotype (P<0.01), together with body mass (P<0.001), were significant predictors of the external-internal rotational measurements in multiple linear regression models. In the anterior-posterior knee laxity measurements, the COL1A1 rs1800012 GG genotype was significantly overrepresented in high active (P=0.046) and maximum (P=0.029) displacement measurements. Additionally, the presence of the GG genotype at both COL1A1 rs1107946 and rs1800012 variants (P<0.010) was also a significant contributor for active displacement, together with age (P<0.050) and body mass (P<0.050), for maximum displacement in multiple linear regression models. The presence of at least two of the three COL5A1 rs12722 CC, COL11A1 rs3753841 CC and COL11A2 rs1799907 AA genotypes was associated

with low measurements of passive (P=0.023) and active (P=0.042) genu recurvatum. Similarly, the genotype combinations (P<0.050) were a significant predictor, together with age (P<0.050), sex (P<0.001), body mass (P<0.05), of passive genu recurvatum measurements in multiple linear regression models.
CONCLUSION:
The findings from this study provide evidence that variants within collagen encoding genes modulate knee joint laxity measurements. The inclusion of these collagen variants improved the multiple linear regression models by increasing the amount of explained variance .The results of this study may provide insight into a potential mechanism whereby these genetic variants may modulate other exercise-related phenotypes, specifically ACL ruptures.

TYPICAL RISK PATTERN FOR ANTERIOR CRUCIATE LIGAMENT INJURY IS LARGELY PRESENT IN HEALTHY ATHLETES: BIOMECHANICAL SCREENING THROUGH WEARABLE SENSORS

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INTRODUCTION:
The incidence of Anterior Cruciate Ligament (ACL) injury is growing with particular regards to young and female athletes' populations. Recently, specific biomechanical patterns involving multiple joints have been described in ACL injured players1. The rehabilitation programs after ACL injury are increasingly relying upon the avoidance of such biomechanical risk factors. It is not clear whether and to what extent such patterns are present in the healthy athletes' population. The aim of the present study was to investigate the presence of biomechanical risk patterns for ACL injury in a healthy population during the execution of high-dynamics movements.
METHODS:
Thirty-four competitive young, healthy athletes (22.8±4.1 years, 18 males and 16 females, Tegner Level 9) were enrolled. Every athlete performed a test battery of five motor tasks: drop jump (DJ), lateral landing (LL), frontal deceleration (DEC), single-leg hop (SLH), change of direction (COD). Three valid repetitions per leg of every task were performed. Kinematical data of ankle, knee, hip, and trunk joints were collected through a set of 15 wearable inertial sensors (Xsens). According to the current literature on ACL injury pattern, 9 risk factors were identified: limited knee and hip flexion, ankle plantarflexion, high knee valgus and internal hip rotation, high internal/external hip and ankle rotation, high trunk contralateral rotation and ipsilateral tilt. A movement was considered "at-risk" in the presence of at least 5 simultaneous risk factors. The central strike of each task was isolated, and risk factors were assessed at initial contact and at the maximum knee flexion angle. The number of athletes with at-risk movements was assessed with specific regard to gender, movement complexity, and limb dominance.
RESULTS:
The presence of the risk pattern was identified in 22 athletes (65%). Half of them (11 athletes, 32%) exhibited the risk pattern in at least two tasks and 5 (15%) in more than two tasks. One out of three female and one out of two male athletes exhibited at least one risk pattern. 74% of the risk patterns were found in either the COD, the DEC, or the SLH task. A similar amount of risk patterns was found for tasks exhibited with dominant and non-dominant limbs.
CONCLUSION:
A large presence of the typical biomechanical risk pattern for ACL injury was identified in a young, healthy, and competitive athletes' population. Female athletes seem more prone to fall in dangerous patterns. The incidence was higher in complex tasks mimicking pressing, single-leg landings, and cuts: such movements should be investigated in sport-specific environments for a wider comprehension of the risk level. The early identification of at-risk athletes might promote preventative training strategies focused on increasing movement quality.

DIFFERENT LOAD TYPES AND DYNAMIC POSTURAL CONTROL: AN APPROACH TO DETERMINING INJURY RISK UNDER REAL CONDITIONS

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INTRODUCTION:
Non-contact injuries such as anterior cruciate ligament ruptures typically occur under loaded conditions. Therefore, risk factors and mechanisms of these injuries should also be regarded under loading conditions and not only during rest [1]. In this context, the observed results and changes seem to depend on the type of load implemented during the assessment [2]. Therefore, the current study aimed to compare the influence of two different load types with comparable conditions on dynamic postural control, one of the essential factors in situations where non-contact injuries mainly occur, i.e., landing, cutting, stopping [3]. It was hypothesized that dynamic postural control would decrease differently after both types of load.
METHODS:
128 sport students (64 males and 64 females, age: 23.64 ± 2.44, height: 176.54 ± 8.96 cm, weight: 68.85 ± 10.98 kg) participated in the study. They were tested with the Y-Balance Test before and after a loading protocol. 64 subjects conducted a modified version of the Wingate Anaerobic Test on a cycle ergometer. The other 64 subjects completed a comparable protocol on a treadmill. Heart rate was measured throughout both protocols with a Polar® Sensor.
RESULTS:
A three-way mixed ANOVA (load type × leg × time) revealed a significant interaction for load type × time ($F_{3, 378} = 10.99$, $p < .001$, $\eta_p^2 = .08$, 90% CI [.04, .12], 1-ß > .99). Moreover, a significant effect of time ($F_{3, 378} = 26.68$, $p < .001$, $\eta_p^2 = .18$, 90% CI [.12, .23], 1-ß > .99) but no differences between the legs ($F_{1, 126} = 0.59$, $p = .44$, $\eta_p^2 < .01$, 1-ß = .12) were found.
CONCLUSION:
The study aimed to investigate the influence of two different load types on dynamic postural control as a predictor of an athletes injury risk. Dynamic postural control was detrimentally affected after cycling but not after running. Consequently, although the amount of physiological internal load was comparable, the different protocols led to different changes of dynamic postural control. These findings indicate a load type dependence of dynamic postural control that must be considered while assessing an athletes injury risk.
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3. Güler Ö, Aras D, Akça F, Bianco A, Lavanco G, Paoli A, et al. Effects of Aerobic and Anaerobic Fatigue Exercises on Postural Control and Recovery Time in Female Soccer Players. International Journal of Environmental Research and Public Health. 2020;17(17):6273.

PREVALENCE AND SEVERITY OF HEALTH PROBLEMS IN UNIVERSITY FOOTBALL PLAYERS

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INTRODUCTION:
The majority of the epidemiological studies in football are based on a time-loss definition, where injuries are recorded if a player is unable to participate in training or match play. However, the approach involved in this definition underestimates the magnitude of injuries with which athletes are able to continue training and competing. The first step of prevention research related to health problems is to understand the extent of the injury and illness. Therefore, this study aimed to examine the prevalence and severity of health problems in university football players using a new method based on all physical complaints.
METHODS:
Ninety-four university football players were followed prospectively during the entire 2020 competitive season of 37 weeks. Of the toral duration, the period from 30 March to 28 June (13 weeks) was defined as the self-training period (SP), because each participant trained at home due to the spread of coronavirus disease 2019, and as the football period (FP) from 29 June to 13 December (24 weeks). All participants were asked to complete the Japanese version of the Oslo Sports Trauma Research Center (OSTRC) Questionnaire on Health Problems (OSTRC-H2.JP) every Sunday [1]. The prevalence and severity score of injuries and illnesses were calculated once a week based on the OSTRC methodology [2] and presented with 95% confidence interval (CI).
RESULTS:
The response rate to the OSTRC-H2.JP was 89.0% on average through all weeks. During the SP, the average weekly prevalence of all health problems was 13.3% [95% CI: 11.2%–15.4%], of which 7.3% [95% CI: 5.8%–8.9%] were categorized as substantial. The average prevalence of weekly injuries and illnesses were 12.1% [95% CI: 10.1%–14.1%] and 1.3% [95% CI: 0.6%–2.0%], respectively. During the FP, the average weekly prevalence of all health problems was 22.9% [95% CI: 21.0%–24.7%], of which 15.3% [95% CI: 13.7%–16.9%] were substantial. Of these, the average prevalence of injuries and illnesses were 21.7% [95% CI: 19.9%–23.5%] and 1.1% [95% CI: 0.7%–1.6%], respectively. The average weekly prevalence of acute injuries was 17.7% [95% CI: 16.0%–19.4%], whereas that of overuse injuries was 4.4% [95% CI: 3.5%–5.3%]. The average severity score for all health problems was 74.0. The ankle, foot, and thigh were the body regions commonly affected by acute injuries, while the thigh, lower back, hip/groin, and foot were predominantly affected by overuse injuries.
CONCLUSION:
The results indicated a high prevalence of health problems among university football players. Approximately 15% of the players were categorized as having substantial health problems during the FP, indicating that the health problems affected their sports participation and performance. Prevention of injury and illness should be based on investigations defining all physical complaints.
1. Mashimo et al. (2021) 2. Clarsen et al. (2014)

INJURY EPIDEMIOLOGY IN PROFESSIONAL BALLET: A FIVE SEASON PROSPECTIVE COHORT STUDY OF 1596 MEDICAL ATTENTION INJURIES AND 543 TIME-LOSS INJURIES

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INTRODUCTION:
Incidence rates ranging from 0.6–4.4 injuries per 1000 h have been reported in professional ballet dancers. To date, however, injury epidemiology research has been poorly aligned with the International Olympic Committee consensus statement and STROBE recommendations. We aimed to describe the epidemiology of medical attention and time-loss injuries, and identify potential risk factors for injury across five consecutive seasons at an elite professional ballet company.
METHODS:
A prospective cohort study design was employed to investigate medical attention and time-loss injuries across 123 professional ballet dancers over five consecutive seasons. Dance exposure and medical data were recorded by the company Artistic Scheduling Manager and Chartered Physiotherapists, respectively. A Poisson generalized linear mixed model was used to calculate incidence rates for medical attention and time-loss injuries. A shared frailty model was used to identify associations between dance exposure, individual characteristics, and injury risk.
RESULTS:
A total of 1596 medical attention injuries and 543 time-loss injuries were observed across 417,693 hours of dance exposure. The incidence rate (per 1000 h) of medical attention injury was 3.9 (95% CI: 3.3–4.4) for females and 3.1 (95% CI: 2.6–3.5) for males. The incidence rate (per 1000 h) of time-loss injury was 1.2 (95% CI: 1.0–1.5) for females and 1.1 (95% CI: 0.9–1.3) for males. First Soloists and Principals experienced between 2.0–2.2 additional medical attention injuries per 1000 hours and 0.9–1.1 additional time-loss injuries per 1000 hours compared to Apprentices ($p \leq .025$). Further, intra-season differences were observed in medical attention, but not time-loss, injury incidence rates with the highest incidence rates in early (August and September) and late (June) season months. Shared frailty models revealed a significant linear relationship between week-to-week change in exposure and overuse injury risk (+1 median absolute deviation hazard ratio (HR): 1.27, 95% CI: 1.06–1.53, $p = .011$). Risk of overuse injury was greater in soloists and first soloists compared to the corps de ballet (HR: 1.47, 95% CI: 1.01–2.15, $p = .045$), and in dancers with a higher rate of previous injury (+1 injury·1000 h-1 HR: 1.06, 95% CI: 1.02–1.10, $p = .005$). For traumatic injuries, only age was significantly associated with injury risk (+1 year HR: 1.05, 95% CI: 1.01–1.09, $p = .005$).
CONCLUSION:
This is the first research to report the incidence rate of medical attention and time-loss injuries in professional ballet dancers. Incidence rates differed across company ranks and months, which may inform targeted injury prevention strategies. Further, periodization strategies

may be beneficial to manage the large rehearsal and performance loads undertaken by professional ballet dancers. This may be particularly prudent for senior-ranking dancers, older dancers, and dancers with high rates of previous injury

WHAT IS AN INJURY? A QUALITATIVE EXAMINATION OF FIELD HOCKEY COACHES

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INTRODUCTION:
Contextual issues in sport influence injury rates. Therefore, understanding a coach's perceptions of what constitutes an injury should be used to inform communication about epidemiological definitions of injury in field hockey. The aim of this study was to examine coach's perceptions of injury definition in field hockey.
METHODS:
A qualitative study, using semi-structured interviews was carried out with field hockey coaches over a six-week period (February-April 2019). Interviews exploring attitudes of coaches towards injury were recorded and transcribed. Interviews were conducted either face-to-face or through a skype or phone call. Fourteen head and assistant coaches from seven Irish Hockey League (IHL) clubs were approached to participate, of whom 13 agreed to be interviewed. Thematic analysis was used to explore the perceptions of coaches as to what constituted an injury in their view.
RESULTS:
The majority of coaches (12/13) reported that they would define an injury as "anything that's potentially of pain or potential threat to performance". Only one coach disagreed, stating that "an injury is something would stop you playing" and describing those affecting performance as "niggles". Some coaches did also mention a time-loss definition but considered that these would represent serious injuries. Others considered serious injuries to relate to "muscle [injuries] and the mental side of [injuries]" and minor injuries as "things like blows and cuts and [skin] breakages".
CONCLUSION:
Coaches tend to refer to a broad definition of injury in relation to field hockey. They are aware of the impacts that physical pain can have on athlete's performance, but also that injuries which require time-loss tend to be more severe. Future consensus statements for field hockey should recommend broad definitions of injury, including the any physical complaints definition preferred by coaches and recommended in other statements related to team sports.

A COMPARISON OF DIFFERENT PRESSURES AND PATTERNS OF INTERMITTENT PNEUMATIC COMPRESSION ON THE ANKLE-DORSIFLEXION RANGE OF MOTION

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INTRODUCTION:
Intermittent pneumatic compression (IPC) has been known to increase a flexibility, pressure-to-pain threshold (PPT) and blood flow [1,2]. However, it remains unknown whether these IPC-induced alternations are affected by compression pressures and patterns. Thus, this study aimed to investigate the effects of pressures and patterns of IPC on the ankle-dorsiflexion range of motion (ROM), PPT and popliteal artery blood flow.
METHODS:
Nine university-aged intermittent team sports players (age, 21.6±0.5 years; height, 1.76±0.05 m; body mass, 71.4±9.3 kg; football, n=5, basketball, n=4) were participated in this study. Exclusion criteria were existing lower extremity chronic conditions, history of acute lower extremity injury within the 6 months before data collection, and history of lower extremity surgery. After a familiarisation, participants completed four experimental trials (SHAM: wearing IPC devices with no compression, SQUEEZE80: sequential compression to 80 mmHg of chambers, BOOST80: concurrent compression to 80 mmHg of chambers, BOOST135: concurrent compression to 135 mmHg of chambers) using a randomised cross-over design. In the experimental trials, participants performed a 30-min IPC or SHAM treatment in the supine position. Ankle-dorsiflexion ROM was measured using the Weight-Bearing Lunge Test (WBLT) before the treatment (Pre) and at 0 min (Post-0) and 20 min (Post-20) after the treatments. The PPT, popliteal artery blood flow and muscle hardness were also measured at Pre, Post-0 and Post-20. Mean changes (Δ) from the Pre to Post-0 and Post-20 for these variables were calculated.
RESULTS:
There were trial×time interactions for the ΔWBLT performance ($p<0.01$) and Δpopliteal artery blood flow ($p=0.03$), but not ΔPPT ($p=0.37$) and Δmuscle hardness ($p=0.80$). ΔWBLT performances at Post-0 and Post-20 were higher in SQUEEZE80 (Post-0: +1.4 cm, $p<0.01$, Post-20: +1.1 cm, $p<0.01$), BOOST80 (Post-0: +1.5 cm, $p<0.01$, Post-20: +1.3 cm, $p<0.01$) and BOOST135 (Post-0: +2.0 cm, $p<0.01$, Post-20: +1.8 cm, $p<0.01$) than in SHAM. Moreover, in only BOOST135, Δankle-dorsiflexion ROM improved at Post-0 (+1.1 cm, $p<0.01$) and Post-20 (+1.2 cm, $p<0.01$) compared with that at Pre. Δpopliteal artery blood flow at Post-0 was higher in BOOST135 than in SHAM (+43.4 mL/min, $p<0.01$) and SQUEEZE80 (+34.9 mL/min, $p<0.01$).
CONCLUSION:
Increased ankle-dorsiflexion ROM reduces the risk of some lower extremity injuries [3]. In addition, increased blood flow may enhance exercise recovery [4]. The present study revealed that IPC treatments, irrespective of pressures and patterns of IPC, improved ankle-dorsiflexion ROM compared with no compression. However, in only BOOST135, popliteal artery blood flow significantly increased immediately after IPC treatment. Thus, IPC using concurrent compression of chambers with high pressure was effective to increase ankle-dorsiflexion ROM and popliteal artery blood flow.
References:
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OP-MH02 Children

RELATIONSHIP AMONG GROSS MOTOR COORDINATION, AGE, BMI AND PHYSICAL ACTIVITY IN ITALIAN CHILDREN

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INTRODUCTION:
Physical activity (PA) is essential for maintaining psychophysical health in children. However, some studies suggested that an insufficient amount of activity from the age of 6 [1] led to an increased risk of overweight and obesity in childhood also involving a great difficulty in acquiring an adequate motor coordination level [2]. The aim of the study was to analyse the chronological trend and the relationship among gross motor coordination, BMI, Daily Physical Activity in children aged 8-11 years.
METHODS:
This cross-sectional study included 924 children (Male=501) recruited from primary schools (8y=284; 9y=325; 10y=315). Gross motor coordination was evaluated with Körperkoordinationstest für Kinder (KTK) using age- and gender- specific reference values, defined as motor quotient MQ [2]. Physical activity (PA) was recorded by using the PAQ-C Italian version [3]. Height and weight were taken according to the standard procedures described by the International Society for the Advancement of Kinanthropometry to calculate body mass index (BMI). Children were classified as underweight (UW), normal weight (NW), overweight (OW), and obese (OB) using age- and gender-specific cut-off points [4].
RESULTS:
KTK performance significantly decreased across age (MQ 8y=98.6 ±13.01; 9y= 93.1 ±13.57; 10y=89.7±13.88; p<.001) and it was globally higher in male (Male=95.2±13.11; Females=90.8 ± p<.001). PA was not different among ages and gender (Males=2.83 ±0.6; Females= 2.76±0.6; p=n.s.). A physiological increasing trend in BMI (8y=17.9±3.34; 9y= 18.9±3.78; 10y= 19.3±3.89; p<.001) was measured in the whole sample. MQ is higher in NW subjects than in OW and OB (NW=95.77±14.08; OW=91.55±12.47; OB=88.30±13.89; p<.001) as well as in UW compared with OB (UW=94.70±15.04; p<.001)
CONCLUSION:
The GMC is significantly influenced by BMI levels with OW and OB subjects showing lower MQ than NW subjects. PA levels do not appear to significantly influence GMC values. The results open some questions about the causes of the reduction of GMC and its tendency to decrease with age; they could have answers from further research in which GMC is studied in subjects of a wider age range, with heterogeneous provenance and in longitudinal form.

CHANGES IN BREATHING RESERVE IN CHILDREN DURING GROWTH.

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ECOLE NORMALE SUPERIEURE DE RENNES

INTRODUCTION:
Breathing reserve (BR) is the difference between maximal voluntary ventilation (MVV) and maximal ventilation ($\dot{V}$Emax). Assessing BR is important to evaluate the respiratory conditions of children and to quantify dyspnea during exercise (Goddard and Sonnappa 2020). During the pubertal period, the growing child is subject to important morphological changes in anthropometric characteristics and lung volume. These changes may have direct consequences on MVV and $\dot{V}$E (Prioux et al. 1997). Therefore, the aim of our study was to analyze the effects of age and gender on BR in healthy untrained children during growth. We hypothesized that (i) BR increases significantly with age, and (ii) during the pubertal period, the changes of anthropometric characteristics induce concomitant changes in BR.
METHODS:
186 healthy untrained children (122 boys and 64 girls) aged 10-16 years participated in this study. During 3 years, at the same time point, the children performed a maximal graded test (MGT) on a bicycle ergometer. During this test, maximal ventilation ($\dot{V}$Emax) and maximal oxygen uptake ($\dot{V}$O2max) were measured. Forced vital capacity (FEV1) and maximal voluntary ventilation (MVV) were also measured during our study. Breathing reserve (BR) was expressed as a percentage of theoretical MVV which was obtained by multiplying the FEV1 by 35. For various reasons, some children did not complete the 3-year testing protocol. This resulted in 409 test results which analyzed ventilatory and cardiorespiratory parameters. The data were assessed by one-way analysis of variance (ANOVA) and two-way ANOVA, which was accompanied by a Newman Keuls test when p was significant ($p<0.05$).
RESULTS:
Height, weight, and lean body mass (LBM) increased between 11-16 years old. For boys, $\dot{V}$O2max, $\dot{V}$Emax, FEV1, and MVV increased ($p<0.05$) between 12 and 16 years. For girls, $\dot{V}$O2max only increased ($p<0.05$) between 11 and 12 and 14 and 15 years. Increases in $\dot{V}$Emax, FEV1, and MVV were observed between 10 to 12 years and stabilized afterwards. No differences in BR were observable in 11 to 16 years old boys and in 10 to 15 years old girls. Additionally, our result shows that BR in girls was higher than those of boys ($p<0.05$) between 11 and 15 years old.
CONCLUSION:
No significant changes were observed in BR when compared to age. The changes of BR during growth seem to be independent from changes in anthropometric characteristics.

IS CHANGE IN MENTAL HEALTH ASSOCIATED WITH A CHANGE IN PHYSICAL ACTIVITY AMONG 11- AND 12-YEAR-OLDS? – THE HEALTH ORIENTED PEDAGOGICAL PROJECT (HOPP)

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INTRODUCTION:
Physical activity (PA) in adolescents may enhance resilience towards mental health problems (1). International public health guidelines for PA recommend researching change in PA and associated health outcomes in adolescents over time using valid and reliable tools. The present study assesses the relationship between change in mental health and objectively measured moderate to vigorous PA (MVPA) among adolescents in Norway.
METHODS:

This one-year follow-up study is part of a controlled longitudinal school-based PA intervention program in Norway. Participants were 11-year-olds when recruited from three different classes between 2016 and 2018 and followed until the age of 12. Adolescents were included if they had data on the self-reported strength and difficulties questionnaire (SDQ-S) and MVPA as measured on an activity monitor (wGT3X+ Actigraph). MVPA is calculated by summing minutes in moderate and vigorous intensity divided by number of valid days. For SDQ-S, internalizing scores encompass emotional and peer problems and externalizing scores encompass conduct problems and hyperactivity, while total difficulty score (TDS) is a summary of all four sub domains. Paired samples t-test was used to evaluate the 1-year change for all 3 dependent SDQ-S variables and the independent MVPA variable, before calculating their association using multiple linear regression. Results from the regression analysis was presented as beta values. Covariates were included for the adjusted analysis: sex, change in waist/height ratio (WHtR) and intervention/ control school. An alfa of <0.05 was used.
RESULTS:
In 2016, n=203 were included, 44% boys and 56% girls, in 2017 n=184, 45% boys and 55% girls and in 2018 n=134, 52% boys and 48% girls. SDQ-S scores were low, <9.60 out of 40 (SD 4.5) for TDS and <4.80 out of 20 (SD 2.62) for internalizing- and externalizing scores. There was no significant change in SDQ-S scores in any time-period. There was an overall decline in MVPA from 11- to 12-year-olds for all time-periods. This decline was significant among the adolescents recruited from 2017 (mean difference 9.49, t(183)= -5.00, p <0.001). The same time-period showed a significant association between MVPA and internalizing – and externalizing scores (beta 0.34, p <0.001 and beta 0.18, p < 0.001, respectively). MVPA explained 12% of the total variance for internalizing scores (R square 0.12), and 3% for externalizing scores (R square 0.03). After adjusting for covariates, the association remained significant.
CONCLUSION:
In general, SDQ-S scores were low. However, our results imply that a significant decline in MVPA from 11- to 12-year-olds could have an impact on internalizing- and externalizing problems in this age-group. In particularly, MVPA seem to have the strongest impact on internalizing problems in this group of adolescents.
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CHARACTERISTIC ANALYSIS ON INFLUENCING FACTORS OF MYOPIA IN SCHOOL-AGE CHILDREN IN HEFEI, CHINA

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INTRODUCTION:
This study aimed to investigate the influencing factors in different degrees of myopia, which provides reference data for exploring the related elements of childrens myopia and developing myopia prevention and control work.
METHODS:
Ocular examination and questionnaire survey methods were implied to investigate the 1-4 grades of students in two primary schools in Hefei, China. Using hierarchical logistics regression to analyze the factors related to the occurrence of different degrees of myopia, with exploring the relationship between outdoor activity time and myopia after adjusting different factors via multi-factor logistics regression.
RESULTS:
A total of 1824 primary school students aged 7-10 years were involved in this study, and the detection rate of myopia was 18.1%. The positive rate of myopia also increased with the increase of age. Age, parental myopia, tilted head > 30° when reading and writing, usually rubbing the eyes and using anti-fatigue eye drops were risk factors affecting vision (OR values were 1.527, 3.249, 1.545, 1.703, 2.936, P values were all < 0.05). The results of stratified analysis showed that the main factors affecting mild myopia were age, parental myopia, usually rubbing the eyes and using anti-fatigue eye drops (OR values were 1.494, 2.985, 1.742, 2.202, and P values were all < 0.05); the main factors affecting moderate and high myopia were age, parental myopia, tilt head > 30° when reading and writing, and using anti-fatigue eye drops (OR values were 1.740, 5.745, 3.205, 9.513, P values were all < 0.05). Multi-factor logistics regression analysis showed that outdoor activity less than 3 days per week was negatively associated with myopia after adjusting the above factors (OR=2.161, P < 0.05).
CONCLUSION:
Age, parental myopia and usually rubbing the eyes are common risk factors for school-age children with different degrees of myopia. In addition, using anti-fatigue eye drops is a risk factor for mild myopia. tilt head > 30° when reading and writing is a risk factor for moderate and high myopia; Time spent outdoors was negatively associated with myopia in school-age children.

ASSOCIATION OF PHYSICAL DEVELOPMENT TO REFRACTION AND OCULAR BIOMETRICS IN CHINESE SCHOOLCHILDREN

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INTRODUCTION:
The prevalence of myopia has sharply increased worldwide, especially in East Asia. The prevalence of myopia is more than 70% in Chinese 6-18 years old children and adolescents. Genetic and environmental factors play a major role in myopia development; in the effort to consider other factors, the physical development is noted to be associated with refraction, although the consensus has not been achieved in this topic. Therefore, this study aimed to investigate the associations of anthropometric indicators and physical fitness to ocular biometrics in Chinese schoolchildren.
METHODS:
A total of 1804 participants aged 6-10 years were recruited in this study, all of them underwent a comprehensive eye examination. The ocular biometrics, including the spherical refraction (SR), cylindrical refraction (CR), axial length (AL), corneal curvature (CC), and anterior chamber depth (ACD) were measured with standard methods, and then the AL/CC ratio was calculated. In addition, the spherical equivalent refraction (SER) was calculated as SR+1/2CR, and myopia was defined as an SER≤−0.5 dioptre (D). According to the National Standard of Physical Fitness Test, the anthropometric indicators of height and weight, and the physical fitness indicators of lung capacity, 50-m run, sit and reach, and 1-min rope skipping were tested. All ocular biometrics data of right eye were chosen for analyses.
RESULTS:
The overall prevalence of myopia was 27.03%. The bivariate correlations showed that both height and weight were negatively associated with SER (p<.01), and positively associated with AL, AL/CR, and ACD (p<.05; p<.01); the physical fitness indicator of lung capacity 1-min rope skipping were negatively associated with SER (p<.01), and positively associated with AL and AL/CR (p<.05; p<.01), while the 50-m run

was positively associated with SER (p<.01) and negatively associated with AL (p<.01). In the multiple linear regression model, the higher height, heavier weight, and more 1-min rope skipping count were associated with lower SER (p<.01) and longer AL (p<.01) without controlling for any covariates; when the age and gender were controlled, however, it was found that the higher height was associated with longer AL (p<.01) and more 1-min rope skipping count was associated with lower SER (p<.01).
CONCLUSION:
The higher height was associated with longer AL and more 1-min rope skipping count was associated with lower SER after controlling for age and gender in 6-10 years old Chinese schoolchildren. The results suggested that the development of refraction could be related to physical development, the comprehensive strategies should be applied to prevent myopia as early as possible in schoolchildren.
Acknowledgement: Supported by National Key R&D Program of China (2020YFC2006801) and Fundamental Research Funds for the China Institute of Sport Science (20-13).
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ASSOCIATION OF GRIP STRENGTH INDICES WITH OBESITY, PHYSICAL ACTIVITY AND SCREEN TIME AMONG ADOLESCENTS RELATIVE TO AGE AND GENDER

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PRINCESS NOURAH BINT ABDULRAHMAN UNIVERSITY

INTRODUCTION:
In adults, grip strength is an important indicator of overall health and strongly correlates with a lower risk of cardiovascular disease. Little research has been reported on the relationships of grip strength with adolescents' lifestyle behaviors. Purpose: To investigate the associations of adolescents' grip strength with lifestyle behaviors including physical activity, screen time, sleep duration and dietary habits among secondary school students
METHODS:
A multistage stratified cluster sampling technique was used to collect lifestyle data from Saudi adolescents (ages 14 to 19 years). Body weight, height and waist circumference were measured and body mass index (BMI) and waist to height ratio were calculated. Grip strength was measured using digital dynamometer. Lifestyle behaviors data were collected using validated self-reported questionnaires (ATLS questionnaire)
RESULTS:
A total of 784 adolescents (52.1% were females) with mean age of 16.4 ± 0.95 years were included in the analysis. Absolute grip strength, relative to body weight, or to waist to height ratio (W-H-ratio) showed significant difference in relation to age (p<0.001) and gender (p<0.001), with males (35.4 ± 7.0) having higher mean values than females (19.4 ± 4.7). Absolute grip strength was significantly (p<0.001) higher in overweight/obese than in non-overweight/non-obese children. However, grip strength relative to body weight or to W-H-ratio was significantly (p<0.001) higher in non-overweight/non-obese children compared with children with overweight or obesity. Also, there were significant (p<0.001) overweight/obesity by gender interactions. No differences were observed in mean effects of all grip strength indices in relation to activity levels or screen time. Absolute mean grip strength, while controlling for age, was positively associated with BMI (r= .29, p<.001), W-H-ratio (r= .36, p<0.001), and vigorous physical activity (r= .13, p<0.001), negatively with screen time (r= -.13, p<0.001), sleep (r= - .17, p<0.001), and sugary foods intake (cake/donuts (r= -.084, p<0.05) and chocolate/candy (r= -.14, p<0.001). No significant associations were observed between grip strength and other lifestyle parameters. Multiple regression analyses indicated that grip strength can be predicted from gender, body weight, BMI, and age, with an adjusted R squared of 0.720
CONCLUSION:
Multiple lifestyle behaviors such as engaging in vigorous physical activity, less screen time, good sleep, and lower intake of sugary foods influence grip strength in adolescents. Lifestyle behaviors as a cluster might affect good health in adolescents, however, such a relationship needs to be investigated further if it can be sustained from adolescence to adulthood. This study highlights the need for assessing overweight/obesity and lifestyle behaviors when examining grip strength differences in patients, as lifestyle behaviors appear to associate with overall health

RELATIVE HANDGRIP STRENGTH IS A BETTER INDICATOR THAN ABSOLUTE HANDGRIP STRENGTH FOR THE ASSESSMENT OF HEALTH-RELATED MUSCULOSKELETAL FITNESS IN CHILDREN

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INTRODUCTION:
The handgrip strength (HGS) is part of many physical fitness test batteries in children, and it has been the most widely applied field-based test to assess musculoskeletal fitness. The aim of this study was to investigate whether relative HGS in children provides a better assessment than absolute HGS for the evaluation of health-related musculoskeletal fitness.
METHODS:
This study included 62 school children (32 boys and 30 girls) from the United Kingdom between 6 and 10 years of age. Written informed consent was obtained from the parents prior to testing. The participants completed the Alpha-Fit test battery, which included HGS, standing long jump, 4x10m shuttle run (4x10m SRT), and 20m shuttle run tests (20m SRT). Percentile scores for the results from each test were calculated. Height and weight were measured, and BMI was calculated. Relative HGS was calculated as the mean absolute HGS from both hands divided by body weight. The participants were divided based on their BMI assessment: 'healthy' (n=30, BMI percentile score < 85) and 'overweight and obese' (n=32, BMI percentile score > 85). Comparisons were made by using the percentile scores. Furthermore, the participants were also divided by BMI and gender to compare both absolute values and percentile scores of all tests: 'healthy boys' (n=15), 'overweight and obese boys' (n=17), 'healthy girls' (n=15), 'overweight and obese girls' (n=15).
RESULTS:
The percentile scores of the standing long jump, 4x10m SRT, and 20m SRT in the 'healthy' children were significantly better than the 'overweight and obese', and showed better health-related motor, musculoskeletal and cardiorespiratory fitness. However, the absolute HGS percentile score was lower for the 'healthy' children, and did not show a significant difference between the groups (67.8 for 'healthy' vs 74.7 for 'overweight and obese'). Similar findings were registered when the absolute HGS and its percentile score were adjusted for gender: 14.41 ± 3.51 kg for 'healthy' boys vs 16.26 ± 4.14 kg for 'overweight and obese' boys, and percentile score of 61.61 ± 23.56 vs 68.05 ± 28.90, respectively, (p > 0.05); 15.68 ± 3.79 kg for 'healthy' girls vs 17.17 ± 3.20 kg for 'overweight and obese' girls, and percentile score of

74.03 ± 26.75 vs 82.28 ± 22.12, respectively, (p > 0.05). Therefore, both the absolute value of the HGS and its percentile score did not differentiate between healthy and overweight children. On the other hand, the relative values of the HGS were significantly better in favour of the 'healthy' boys (0.50 ± 0.08 vs 0.41 ± 0.09 kg/kg body weight, p < 0.05) and girls (0.52 ± 0.09 vs 0.39 ± 0.05 kg/kg body weight, p < 0.001).
CONCLUSION:
The relative HGS is a better indicator than the absolute HGS for assessing health-related musculoskeletal fitness in children. Future research should establish percentile scores for the relative values of the HGS test in children in order to accurately assess their health-related muscular strength.

CATEGORIZING TEN SPORTS ACCORDING TO BONE AND SOFT TISSUE PROFILES IN ADOLESCENTS

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INTRODUCTION:
Considering the different loading and training characteristics of the sports practiced during growth, it is important to specify and categorize the bone and soft tissue adaptations in adolescent athletes. This study aimed to categorize ten different loading sports and a non-sport group and identify the differences in bone density and soft tissues
METHODS:
The sample included 625 adolescents (10 to 17 years old) of ten sports (soccer, basketball, volleyball, track & field, judo, karate, kung-fu, gymnastics, baseball and swimming) and a non-sport group. Dual energy X-ray absorptiometry assessed areal bone mineral density (aBMD), bone mineral apparent density (BMAD) and soft tissues (lean soft tissue and fat mass). The results were adjusted for sex, years from age of peak height velocity (PHV), lean soft tissue, fat mass and weekly training volume.
RESULTS:
The comparisons among groups showed that soccer had the highest whole body aBMD (mean ± SEM: 1.082 g/cm2 ±0.007) and lower limbs aBMD (1.302g/cm2 ± 0.010). Gymnastics presented the highest upper limbs (0.868 g/cm2 ± 0.012) and whole body BMAD (0.094 g/cm2 ± 0.001). Swimming presented the lowest aBMD values in all skeletal sites (except at the upper limbs) and whole body BMAD. The soft tissue comparisons showed that soccer had the highest lean soft tissue (43.8 kg ± 0.7). The lowest fat mass was found in gymnastics (8.04 kg ± 1.0).
CONCLUSION:
The present study investigated and categorised for the first time ten different sports according to bone density and soft tissue profiles. Soccer and gymnastics sport groups found to have the highest bone density in most body segments and both sports were among the groups with the lowest fat mass.

OP-MH03 Cancer

EFFECTS OF SUPERVISED AEROBIC-STRENGTH TRAINING ON COGNITIVE FUNCTIONS AND PHYSICAL FITNESS IN TESTICULAR GERM-CELL CANCER SURVIVORS

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INTRODUCTION:
Chemotherapy-induced late toxicity can be associated with cognitive impairment in testicular germ cell cancer (TGCC) survivors. On the other hand, regular exercise has a potential to improve cognition. Our study was aimed at evaluating effects of supervised exercise intervention on cognitive functions, fitness and metabolism in TGCC survivors.
METHODS:
Ten men (age 43.0±8.5yrs; examined 6yrs after platinum-based chemotherapy) underwent 6-month supervised aerobic-strength exercise intervention (strength training 2x1h/week & aerobic training 1x1h/week). Learning ability and working memory were assessed by Ray Auditory Verbal Learning test (RAVL). Body composition (bioimpedance); metabolic parameters (serum glucose, insulin, total & HDL-cholesterol) and fitness performance (hand & leg dynamometry) were assessed. Habitual physical activity and sleep quality were measured by GENEActiv (Activinsights; UK) for 7 consecutive days.
RESULTS:
Significant increase in learning (p=0.03) was observed after 6-month intervention, with concomitant improvement in working memory assessed by delayed recall (p=0.03). No change was observed in body weight, body composition (muscle, fat, visceral fat) and metabolic parameters (fasting serum glucose, insulin, cholesterol). However, muscle strength (knee flexion) increased significantly in response to 6-month training (p=0.03). The negative association was observed between sedentary behaviour and learning ability (RAVL; p=0.04). Exercise-induced change in length of the sleeping period was positively associated with exercise-induced change in working memory assessed by delayed recall (RAVL; r=0.86; p=0.01).
CONCLUSION:
Supervised 6-month aerobic-strength training improved learning ability, working memory and increased maximal voluntary contraction at knee flexion in testicular germ-cell cancer survivors. Our results support the role of regular physical exercise in the prevention and treatment of chemotherapy-induced late toxicity in TGCC survivors.
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IS THE TWO-POINT METHOD FEASIBLE FOR ONE-REPETITION MAXIMUM ESTIMATION DURING LEG-PRESS EXERCISE IN BREAST CANCER SURVIVORS?

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INTRODUCTION:
Breast cancer is the most prevalent type of cancer in women worldwide, with almost 2.1 million new patients diagnosed every year [1]. A side effect of the treatment is the loss of approximately 25% of the lower body muscle mass compared to healthy subjects [2]. Resistance training is an effective intervention to increase muscular strength levels in breast cancer survivors [3]. Approaches to precisely estimate the one-repetition maximum (1RM) in order to prescribe the relative load without excessive effort are needed, particularly in this population. The recent literature suggests that using only 2 loads (the two-point method) is enough for predicting the 1RM with the same acceptable precision that using multiple loads (multiple-point method) [4]. Since the leg-press exercise has a great potential to be used with breast cancer patients due, among other reasons, to its safety features, this study aimed to examine the feasibility of the two-point method for estimating the one-repetition maximum (1RM) during the bilateral leg-press exercise in female breast cancer survivors.
METHODS:
Twenty-one female breast cancer survivors (aged 50.2 ± 10.8 years) participating in the EFICAN project [5] performed an incremental loading test to 1RM on the bilateral leg-press exercise with the mean velocity being recorded. The 1RM was estimated through five loads [(~45, 55, 65, 75 and 85% of 1RM; i.e., the multiple-point method)] and only the two distant loads (~45 and 85% of 1RM, i.e., the two-point method) using the individual load–velocity relationships as the load associated with a general minimal velocity threshold of 0.24 m/s.
RESULTS:
A trivial effect size (ES = 0.08 for the multiple-point and 0.16 for two-point) and nearly perfect correlations (r = 0.94 for the multiple-point and 0.95 for two-point) were observed for two 1RM prediction methods. The absolute errors in the prediction of the actual 1RM did not differ (p = 0.77) between the multiple-point linear (5.6 ± 6.1 kg) and two-point models (5.8 ± 6.7 kg). Heteroscedasticity of the errors (i.e., r2 > 0.10) was not observed either in with multiple-point linear or with the two-point models.
CONCLUSION:
The main findings of this study indicate that the two-point method is a feasible method for the estimation of the 1RM in female breast cancer survivors with comparable precision than the multiple-point method during the bilateral leg-press exercise.
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EXERCISE TRAINING DURING CHEMOTHERAPY BENEFITS QUALITY OF LIFE AND STRENGTH IN WOMEN WITH BREAST CANCER: PRELIMINARY RESULTS OF AN RCT

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INTRODUCTION:
Standard chemotherapy regimens for early-stage breast cancer typically contain sequential doxorubicin and cyclophosphamide (AC) followed by a taxane (T) agent. Despite clinical efficacy, chemotherapy is associated with physiological and psychological side effects, that impair patients quality of life. Exercise training may have an important role in the rehabilitation of cancer survivors. Here, we aimed to assess the effects of a supervised exercise training program (SETP) in women with early-stage breast cancer undergoing AC followed by T, using data from an ongoing randomized controlled trial (ISRCTN32617901).
METHODS:
Thirty-eight women were randomly (1:1) assigned to a SETP group (51.7 ± 7.5 years; n= 21) or usual care (UC) group (52 ± 10.5 years; n= 17). The SETP involved 3 sessions per week of aerobic training combined with resistance training, started 1-2 days after the 1st AC cycle, and was conducted over the chemotherapy period of each patient (28 to 32 weeks). In this analysis, we evaluated handgrip strength (kg), 30-second sit to stand test (STS; repetitions) and health-related quality of life (assessed by the EORTC QLQ-C30), comprising physical (PF), role (RF) and emotional functioning (EF), as well as fatigue and global health status/ quality of life scale, which were assessed at baseline (t0), at the end of AC (t1), and at the end of T (t2). Data are presented as median ±SD or as median (P25-P75). Significance was set at P<0.05.
RESULTS:
No significant differences were observed between groups at t0. Between-group analysis (SETP vs. UC) showed a significant difference in PF [86.7 (80-98.3) vs. 80.0 (53.3-85)], RF [83.3 (66.7-100) vs. 66.7 (37.5-91.7)], global health status/ quality of life [66.7 (52.1-66.7) vs. 50 (41.7-66.7)] and fatigue [22.2 (2.8-33.3) vs. 33.3 (22.2-63.9)] at t2, and in STS test at t1 [19.0 (16.5-20.0) vs. 14.5 (12.0-15.5)] and t2 [20.0 (18.0-22.0) vs. 14.0 (13.0-15.3)], favoring the SETP. The EF [t0: 75 (62.5-79.2) vs. t1: 83.3 (66.7-91.7)], STS test [(t0: 14.0 (13.0-16.0) vs. t1: 19.0 (16.5-20.0); t0 vs. t2:20.0 (18.0-22.0)] and handgrip strength of the upper tumor side limb (t0: 24.5 ± 4.8 vs. t2: 26.2 ± 3.9) significant improve in SETP. In contrast, a significant decline in PF [t0: 90.0 (81.7-100) vs. t1: 80.0 (55.0-86.7); t0 vs. t2: 80.0 (53.3-85)], RF [t0: 100 (100-100) vs. t2: 66.7 (37.5-91.7); t1: 75.0 (66.7-100) vs. t2)] and handgrip strength of the upper tumor side limb (t0: 24.9 ± 5.8 vs. t1: 22.8 ± 4.8) and of contralateral limb (t0: 26.3 ± 4.3 vs. t1: 25.2 ± 3.8; t0 vs. t2: 25.1 ± 3.6) were observed in UC. Fatigue significantly increased in UC [t0: 11.1 (2.8-22.2) vs. t1:33.3 (22.2-55.5); t0 vs. t2: 33.3 (22.2-63.9)].
CONCLUSION:

These preliminary results revealed that, compared to UC, exercise training had an effective role in preventing the decline in physical function and health-related quality of life, and mitigating fatigue during the chemotherapy, justifying the importance of add this approach to supportive care in oncology.
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RESISTANCE TRAINING CAN INDUCE HYPOALGESIA IN WOMEN WITH PERSISTENT PAIN AFTER BREAST CANCER TREATMENT

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INTRODUCTION:
Persistent pain in and around the surgical area affects 25-60% of all women who have received treatment for breast cancer (1). Resistance training (RT) is an effective non-pharmalogical approach to managing a variety of adverse effects to breast cancer treatment (2), but little is known of potential pain-relieving benefits. RT has been shown to induce a transient reduction in sensitivity to noxious stimuli known as exercise induced hypoalgesia (EIH) in pain free and chronic pain populations (3), but the EIH response to a single bout of RT in breast cancer survivors with persistent pain has yet to be investigated. Therefore, the aim of this study was to examine the acute effect of a single bout of RT on mechanical pain sensitivity in women with persistent pain after breast cancer treatment.
METHODS:
Twenty breast cancer survivors with self-reported pain ≥ 3 on a 0-10 numeric rating scale after treatment for breast cancer participated. Three sessions were completed: 1) Familiarization 2) Normalization and 3) Investigation. In the normalization session, one repetition maximum (1RM) were assessed in each of the following exercises in chronological order; 1) Box squat, bench press, trapbar deadlift, bench pull and lat pulldown. In the investigation session, 3 sets of 10 repetitions at 60% of the established 1RM were performed for each exercise with 3-minute rest periods in between sets. Pressure pain thresholds (PPTs) were measured Pre and Post training over 17 locations distributed across the dorsal- and ventral shoulder regions of the affected side. Each location was measured twice, and a third time if the coefficient of variation was ≥ 20%. Movement-evoked pain (MEP) were assessed on an 0-10 numeric rating scale (0 = No pain, 10 = maximum pain) immediately following each set.
RESULTS:
PPTs of the ventral shoulder region increased following a single bout of submaximal RT ($P \leq 0.05$), indicating a localized reduction in pain sensitivity for this area. In contrast, there were no apparent change in PPTs located on the dorsal shoulder region ($P \geq 0.05$). There were no significant differences in MEP between exercises ($P \leq 0.05$), indicating that MEP was not affected by exercise order.
CONCLUSION:
A single bout of submaximal RT is sufficient to reduce PPTs for the ventral shoulder region of breast cancer survivors with persistent pain after treatment. Submaximal RT can be performed without concomitant short-term exacerbation of MEP, which provide further support to the use of RT as a safe and effective training modality for survivors of breast cancer.
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TRAINING ADAPTATION IN AN ELITE ATHLETE AFTER BREAST CANCER DIAGNOSIS. A CASE REPORT.

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INTRODUCTION:
Breast cancer (BC) is the most common cancer in women worldwide, with an incidence rate in 2020 of 24.5% (1). Exercise has shown to be an effective tool to reduce treatment-related side effects (2),improve health, quality of life and risk of recurrence (3).The aim of this study was to evaluate the physical condition and the capacity to return to competition of a 28-year-old female 400m hurdles elite athlete, during adjuvant chemotherapy and radiotherapy, and being on endocrine therapy (ET), after the diagnosis of a hormone receptor positive/human epidermal growth factor receptor 2 negative BC.
METHODS:
The present study lasted 14 months and started one year after BC diagnosis, when the athlete had been on ET. During this time, she was tested 4 times (T1-T4) to measure body mass (BM), body mass index (BMI), percentage of total fat mass (TFM%), total fat-free mass (TFFM%), bone mineral density (BMD), 1 repetition maximum load (1RM) and maximal power (MP) in bench press (1RMBench and MPBench) and half squat (1RMSquat and MPSquat), maximum oxygen uptake (VO2max), 400m dash and hurdles performance. A time T0 was established, with the athlete´s values prior to diagnosis, as baseline values to compare. The athlete continued her regular training with a 10% reduction in aerobic power intensity and a 20% reduction in anaerobic training volume.
RESULTS:
BM and BMI increased from T0 to T1 (5.3% and 5.2%) and stayed stable during the remaining testing sessions. BMD experienced little or no change. TFM% values decreased from T1 to T4 (3.5%). TFFM% values increased from T1 to T3 (0.9%). During T1-T2 the athlete presented a global decline from T0 in 1RMSquat, 1RMBench, MPSquat and MPBench (32.6%, 27.2%, 37.5%, 27.6%). Results of T3-T4 were also lower from T0 (23.3%, 20.6%, 23.4%, 11%). During T1-T2 the VO2max declined compared to T0 (1.8% and 6.4%), showing a small increase on T3 (+1%) and decreased again in T4 reaching the lowest decline from T0 (9%). In T1-T2 the time record of 400 m dash (8.3%) and hurdles (7.4%) increased from T0. Results showed a slight improvement at T3 (1.3% and 0.6%). Unfortunately, the T0 values were no reached.
CONCLUSION:
The results of this case report show that exercise training improved body composition, maintained BMD and TFFM, but could not reverse completely the worsening at cardiorespiratory, muscle strength and power, and running performance levels.
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OP-MH04 Physiotherapy

REDUCTION OF THE SUBACROMIAL SPACE IN SUBACROMIAL IMPINGEMENT SYNDROME AND ITS ASSOCIATION WITH THE STRENGTH OF SCAPULAR MUSCLES

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INTRODUCTION:
The reduction of the subacromial space (SAS) has traditionally been linked to subacromial impingement syndrome (SIS). Exploring the correlation between biomechanical factors and the SAS will enhance our understanding of the injury mechanism of SIS. Scapular muscles are important to control the scapular movement during arm elevation. No studies have investigated the relationship between scapular muscle strength and SAS with SIS, but such research would provide more information on the pathogenesis of SIS and preventive programmes. We hypothesized that the strength of scapular muscles in SIS is weakened, and we also hypothesized that decreased strength of scapular muscle was related to reduction of the SAS.
METHODS:
50 patients with SIS and 25 healthy people were selected as subjects for this study, healthy people were matched for age, average height and average weight with subacromial impingement syndrome. Ultrasound measurement of the acromio-humeral distance(AHD) with shoulder abduction at 0° , 30° and 60° were taken ,and the maximal isometric force in upper, middle and lower trapezius muscle , and serratus anterior muscle with manual muscle tests was assessed using a handheld dynamometer.The change in AHD during shoulder abduction from 0° to 30° , 30° to 60° and 0° to 60° were compared between groups, as well as scapular muscle strength. The relationship between scapular muscle strength and the reduction in AHD of SIS group was explored.
RESULTS:
There were no statistically significant differences in the AHD at 0, 30 and 60 degrees of shoulder abduction between the groups($p > 0.05$). However, more reduction of the AHD during 30°to 60° of shoulder abduction in SIS group(2.47±1.32mm) than healthy group(1.81±0.95mm)(p=0.016), and more reduction of the AHD during 0°to 60° of shoulder abduction in SIS group(3.9±1.21mm) than healthy group(2.93±0.97mm)(p=0.001) were found. SIS group demonstrated a significant decrease in all scapular muscles strength when compared with the healthy group($p < 0.05$). In SIS group, a lower middle and lower trapezius strength were associated with a greater reduction in AHD during 30°to 60°（r=-0.459，p=0.001 and r=-0.403，p=0.004，respectively）and 0°to 60° of shoulder abduction（r=-0.320，p=0.023 and r=-0.367，p=0.009, respectively）.
CONCLUSION:
People with SIS demonstrated more reduction in the SAS during early shoulder abduction. Decreased strength of middle and lower trapezius was related to reduction of the SAS. Future studies are needed to determine whether strengthening training for middle and lower trapezius muscle strength influence AHD in people with SIS.

RELATIONSHIPS BETWEEN PHYSICAL ACTIVITY AND LUMBOPELVIC PAIN DURING PREGNANCY: A CROSS-SECTIONAL STUDY

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INTRODUCTION:
More than half of the pregnant women are affected by lumbopelvic pain (LPP) in their daily lives [1]. Although there are many reports on the relationship between physical activity (PA) like exercise and LPP, there are few reports focusing on the relation with daily essential activity like housework, caregiving (especially childcare) and occupational activities. In particular, it is hard for the late pregnancy women to doing housework and caregiving due to the figure change and fatigue. Therefore, this study explores the relationship between the time to spend housework/caregiving and occupational, and LPP during pregnancy.
METHODS:
This study included 32 pregnant women in their third trimester who attended an obstetrics and gynecology hospital. The amount of activity of pregnant women was examined using the Japanese version of the physical activity questionnaire (PPAQ-J). The participants were divided into two groups based on the presence of LPP. The primary comparison was PPAQ score as PA, which was classified by intensity (mild, moderate, strength) and category (household/caregiving (H/C), occupational, sports/exercise (S/E)) in addition to total activities. Unpaired two-tailed t-test or Wilcoxon signed-rank test were used to compare PA between the two groups. The significance level was $p<0.05$.
RESULTS:
There were 15 participants (46.9%) with LPP and 17 participants (53.1%) with non-LPP. There were significant differences between with and without LPP in the PPAQ score of total, mild (1.5≤3.0METs), moderate (3.0-6.0METs), H/C activities (total: p=0.02; 112.3±9.1 vs 75.1±8.6, mild: p=0.01; 73.7±5.5 vs 52.4±5.2, moderate: p=0.05; 32.2±4.4 vs 17.5±4.1, H/C: p=0.002; 103.8±7.9 vs 58.7±7.4).
CONCLUSION:
The third trimester pregnant women with LPP spent a long time of total, mild, moderate and H/C activities compared with those without LPP. For many third trimester pregnant women, the key issue would be H/C activities. Standing up from a chair and tossing and turning which is expected movement during H/C activities were related to low back pain during pregnancy [2]. In addition, to do various activities becomes difficult increases the overall activity time [3]. Therefore, spending a long time on H/C activities might be interacted to LPP. Moreover, there was no significant association with S/E activities in this study; however, women without LPP tended to have longer times of S/E activities. Thus, It is suggested that pregnant women would be better to reduce the time to spend housework and childcare and

make time to perform appropriate exercises for prevention and relaxation of LPP. Furthermore, partners and family support will help with that.

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COMBINED EFFECT OF MASSAGE AND COLD WATER IMMERSION ON THE TREATMENT OF SYMPTOMS RELATED TO EXERCISE INDUCED MUSCLE DAMAGE

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INTRODUCTION:
Following an unaccustomed exercise, delayed onset muscle soreness (DOMS), swelling of the muscle, decreased range of motion (ROM) and impaired muscular strength are experienced, peaking up to 72 h post exercise and lasting up to two weeks(1). Massage has been found effective for reducing DOMS and perceived fatigue and cold water immersion (CWI) has also shown positive effect on muscle performance and soreness(2). However, results were inconclusive when these techniques were applied separately. The main objective of this study is to examine the potential benefit of combining massage and CWI as a single recovery protocol following exercise-induced muscle damage (EIMD).
METHODS:
Thirty-five healthy participants (age: 21.6 ± 0.8) performed an EIMD protocol (10 sets of 10 repetitions of drop jumps) Following the EIMD session, the legs of the participants were randomly assigned to: a) receiving a combination of a 20-minute massage and a 15-minute CWI at 12ºC, or b) acting as control. Outcome measures included pain perception (VAS), pressure point threshold (PPT), maximum voluntary isometric contraction (MVIC), counter movement jump (CMJ) and gait kinematics. All variables were assessed on day 1 and day 3 (48h), while VAS was also measured at day 2 (48h) and day 4 (72h).
RESULTS:
The intervention produced a significant increase in pain ($P < 0.001$) irrespective of the limb assessed. In the hip, knee and ankle joints, the intervention led to a significant decrease in range of motion (ROM) ($P = 0.037$; $P = 0.031$ and $P = 0.024$, respectively), in both legs at 48 hours post-intervention. No significant differences in time x intervention interaction ROM were observed in any joint ($P = 0.349$, $P = 0.448$ and $P = 0.256$). The combination of massage and CWI did not show any significant result on MVIC, CMJ or soreness in comparison with the control condition.
CONCLUSION:
A combined protocol including massage and CWI did not offer any superior benefit on soreness and other symptoms related to EIMD when compared to a control condition. Our study adds more controversy to the literature on the effectiveness of these techniques in terms of relieving soreness, accelerating recovery and maintaining muscle performance.
Key words: EIMD, recovery, cold water immersion, massage, DOMS.
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MODIFICATIONS OF THE CONTRACTILE PROPERTIES OF THE MUSCLES MEASURED WITH TENSIOMYOGRAPHY AFTER MANUAL THERAPY IN FEMALE SOCCER PLAYERS

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INTRODUCTION:
Female soccer players are at increasing risk of injury (Del Coso, 2018). It has been observed that the lesions diagnosed with the highest prevalence were in the thigh compartment (23%), followed by the knee (17%) and the ankle (17%) (Del Coso, 2018; Moreno, 2016). As a consequence, applying a preventive program and manual therapy during post-competition training reduces the number of injuries (Hagglung, 2009). Tensiomyography (TMG) is a method of muscular evaluation, an effective tool in the prevention of injuries and in the detection of muscular imbalances and asymmetries.
The purpose of this study is to determine if the application of manual therapy produces modifications in the variables of DM (muscle displacement) and TC (contraction time), measured by TMG in female soccer players.
METHODS:
We have submitted to the study two groups with 10 players each, group 1 - the experimental group and group 2 - the control group, from a womens soccer team recently promoted to the first division. The average age of the players is 21.3±3,43 years, with a weight of 55.4±5.62 kg and a height of 159.9±55,4 cm. The players train for two and a half hours, four days of the week.
We make two assessments involving both groups, the experimental group were measured before and after the manual therapy (friction, kneading, vibration, percussion) and the control group received their second measurement after twenty minutes.
TMG was used to measure the radial muscle belly displacement of the vastus medialis (VM), vastus lateralis (VL), knee extensor muscles, and of the long head of the biceps femoris (BF) flexor muscle. Each measurement involved recording the Contraction time (Tc) the time between the moment when the muscular contraction is 10% and the moment when the contraction reaches 90% out of maximum (ms), and the amplitude of muscular displacement in transverse direction, the Dm (mm) depends on the flexibility of muscular tissue. Therefore, Dm values increase when the explosive force is developed, involving high movement amplitude, and they decrease under the conditions of a high muscular tone (Rusu et al,. 2013).
RESULTS:
Summarizing the results of Student t-test, the experimental group registering better results reducing the stiffness of all the muscles than the control group. We found significant differences ($p< 0.005$) in the change percentage of the Dm in the left VL between the experimental

group (56,09%) and the control group (16%), and in the Tc of the same muscle between the experimental group (24,26%) and the control group (4%).
CONCLUSION:
We observed an increase in the Dm in all the muscles that were applied the manual therapy, which reduced the stiffness of the players in the experimental group.
No change was observed in the control group.
-The percentage of change between the pre and post values was much higher in the players of the experimental group. Although the value of the changes was high, we only found significant differences in the Dm and Tc of the left vastus lateralis

RELIABILITY OF ANKLE EVERTORS, INVERTORS AND DORSIFLEXORS ONE-REPETITION MAXIMAL (1-RM)

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INTRODUCTION:
After a Musculo-skeletal injury, monitoring rehabilitation could help partitioners to objectify improvement and to decide how to adapt their treatment. Muscle strength is one essential component of rehabilitation in general. One – Repetition Maximal (1-RM) is a reliable measure that helps practitioners to quantitatively assess muscle strength (Grgic et al., 2020). A large majority of muscles could be assessed with 1-RM, however we do not know if the assessment of ankle muscle strength could be assessed using 1-RM in reliable way. The aim of this study was to determine the level of Intrarater agreement of ankle 1-RM.
METHODS:
Twenty-four healthy young adults (10 women and 14 men) volunteered to participate in this study. One – Repetition maximal of ankle evertors, invertors and dorsiflexors were measured with participants lying supine with the calf of tested ankle on a step (knee flexed approximately to 30-40°) and a complete flexion of the other leg. The measurement were performed over one week by the same assessor on the same vertical pulley. Intrarater reliability was determined using the intra-class correlation coefficient (ICC) and the measurement error was determine using the standard errors of measurement (SEM) minimal detectable change (MDC).
RESULTS:
Intrarater reliability in healthy women for inversion, eversion and dorsiflexion 1-RM was good to excellent (ICC=0.69–0.95) with relatively low measurement errors (SEM=1.31 - 1.84 and MDC=3.62-5.10). Intrarater reliability in healthy men for inversion, eversion and dorsiflexion 1-RM was fair to excellent (ICC=0.54–0.84) with relatively low measurement errors (SEM=2.94 - 4.45 and MDC=8.14 – 12.3).
CONCLUSION:
The assessment of ankle evertors, invertors and dorsiflexors 1-RM is reliable in healthy young adults. This results has to be studied on injured adults but it is a promising method easy to use in rehabilitation after ankle injury.
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ACUTE EFFECTS OF FOAM ROLLER OR STICK MASSAGE ON INDIRECT MARKERS FROM EXERCISE-INDUCED MUSCLE DAMAGE IN HEALTHY INDIVIDUALS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION:
The foam roller and stick massage have been used as strategy to accelerate the recovery from exercise-induced muscle damage. Despite foam rolling and stick massage popularity among healthy individuals, there is no consensus as to whether this strategy is more effective than no intervention to accelerate the recovery of signs and symptoms from exercise induced muscle damage when accounted for random error. Therefore, the aim of this systematic review and meta-analysis was to examine the effects of foam roller or stick massage performed after exercise-induced muscle damage protocols on indirect markers of muscle damage compared to a non-intervention control group in healthy individuals.
METHODS:
PubMed, Scopus, Biblioteca Virtual em Saúde, Google Scholar and CENTRAL databases were searched up to December 14, 2020. Randomized and nonrandomized clinical trials involving healthy adult individuals who received foam roller or stick massage versus a non-intervention group and evaluated indirect markers of muscle damage (muscle soreness, range of motion, muscle swelling, and maximal voluntary isometric contraction) were selected. Study quality was assessed by Physiotherapy Evidence Database (PEDro scale) and risk of bias was assessed by the Cochrane Risk of Bias tools.
RESULTS:
A total of 3.058 articles were initially identified from the search. However, a total of five articles met all inclusion criteria. Three randomized and two nonrandomized clinical trials were included. The included studies presented a high methodological heterogeneity. Overall, the randomized clinical trials presented a fair quality and a high risk of bias. The nonrandomized clinical trials presented a fair quality and a moderate risk of bias. A between-groups meta-analysis showed no significant difference between massage and non-intervention control groups on muscle soreness immediately after (standardized mean difference [SMD] 0.26 [95% confidence interval (CI): -0.14; 0.65], p = 0.20), 24 hours (SMD = -0.64 [95%CI: -1.34; 0.07], p = 0.08), 48 hours (SMD = -0.35 [95%CI: -0.85; 0.15], p = 0.17), 72 hours (SMD = -0.40 [95%CI: -0.92; 0.12], p = 0.13), and 96 hours (SMD = 0.05, p = 0.82) after exercise-induced muscle damage protocol. Moreover, the results from the included studies showed that foam roller or stick massage had no significant effect on range of motion, muscle swelling, and maximal voluntary isometric contraction recovery.
CONCLUSION:
The current literature does not support the advantage of foam roller or stick massage to improve recovery of muscle damage indirect markers (e.g., muscle soreness, range of motion, muscle swelling, and maximal voluntary isometric contraction) after accounting for random error in healthy individuals.

A 10+ YEAR FOLLOW-UP STUDY OF KNOWLEDGE AND PRACTICE BEHAVIORS USED BY PHYSICAL THERAPISTS IN THE U.S. FOR THE FEMALE ATHLETE TRIAD/RELATIVE ENERGY DEFICIENCY IN SPORTS (RED-S)

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INTRODUCTION:
The Female Athlete Triad was initially described as three components occurring on a continuum: low energy availability (LEA), menstrual dysfunction (MD), and low bone mineral density (LBD).1, 2 In 2014, it was renamed Relative Energy Deficiency in Sports (RED-S) to include both men and women having one or more of the components.3, 4 Although education about the triad has been promoted for physical therapists in the U.S., it is unclear if knowledge and practice patterns have improved. The purpose of this study was to examine if knowledge and practice behaviors in U.S. physical therapists have improved in the last 10+ years or if gaps in knowledge about the triad continue to exist.5
METHODS:
A survey instrument of approximately 35 questions was administered to U.S. sports physical therapists in 2009 and in 2021 to determine whether knowledge, attitudes, and practice behaviors for the triad have changed over time. Descriptive statistics summarized demographic and general practice information about the survey participants. Likert scales ranked the likelihood of employing certain treatments and referral sources for triad. Narrative descriptions of strategies used for treatment and prevention of the triad in 2021 were compared to 2009 results.
RESULTS:
In 2021, 104 physical therapists responded to the survey, compared to 205 in 2009. In 2021, 54% of the participants were female and mostly between 25-35 years; in 2009 50% were female and mostly between 36-55 years. The majority of both groups practiced PT for 16+ years. Although 72% of the participants in both studies stated that they could accurately list the triad components, the 2021 survey respondents had a much higher percentage of accurate answers, compared to those in 2009. The most commonly practiced treatment strategies reported in 2021 were similar to those in 2009, including nutritional education, multidisciplinary consultation, and replacing cardio exercise with resistance training. The most common prevention strategies for the 2021 respondents included multidisciplinary education and pre-participation screening exams; in 2009, screening exams and observing for at-risk behaviors were top priorities. The Likert Scale indicated that the most frequent action PT's took was to first "talk to the athlete" about the condition before implementing other plans. Surprisingly, 11% of the 2021 participants still believe that absent or irregular menstruation is a normal consequence of exercise.
CONCLUSION:
This study found that overall knowledge of the FAT/RED-S for physical therapists in the U.S has improved with regard to having greater awareness and recognition of the components and a better understanding of strategies for treatment and prevention. A few misconceptions about the condition continue to exist. Improved knowledge may be attributed to having better access to health-care professionals who specialize in FAT/RED-S, and a greater emphasis on a using multidisciplinary team approach for treatment and prevention.

MIRROR THERAPY MODULATES CORTICOSPINAL EXCITABILITY TO A GREATER EXTENT THAN OTHER MOTOR SIMULATIONS IN HEALTHY SUBJECTS

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INTRODUCTION:
Motor imagery (MI) and action observation (AO) have emerged as effective training modalities for motor performance (1, 2). However, despite promising perspectives, such motor simulations are scarcely used in rehabilitation (3), contrary to mirror therapy (MT). In healthy subjects, whatever the motor simulation modality considered, corticospinal excitability has been reported to increase during each of these interventions, suggesting their ability to promote neuroplasticity (4). To optimize neurorehabilitation, it is crucial to determine how the different motor simulation strategies may influence corticospinal excitability and how their combination may lead to further increases. Therefore, we investigated in healthy subjects corticospinal excitability modulation during MI, AO or MT performed alone, as well as MI combined with either AO or MT.
METHODS:
Corticospinal excitability modulation was investigated in eigtheen healthy subjects. In each condition of motor simulation, 15 motor-evoked potentials (MEPs) and 3 maximal M-wave were elicited in the right abductor pollicis brevis (APB) either during rest (control condition), AO, MI, MT, AO+MI and MT+MI. Two-way repeated-measures ANOVAs were performed on the mean normalized MEP amplitude. Factors included in the statistical analysis were the visual condition (no visual information, AO, or MT) and the imagery (with or without MI).
RESULTS:
When compared to the control condition (i.e. no visual information and without MI), mean normalized MEP amplitude (i.e. MEP/M) increased during MI (+ 40 ± 49%, $P = .014$), MT (+ 76 ± 66 %, $P < .001$) and MT + MI (+ 60 ± 64 %, $P= .27$), the MEP modulation being of greater magnitude for MT than MI ($P = .036$) but without any difference between MT and MT + MI ($P = 1$). No MEP modulation was evidenced during AO or AO + MI.
CONCLUSION:
These results suggest that, in healthy subjects, the combination of visual feedback and unilateral movement with a mirror may be more effective compared to MI or AO alone and that further combining MT with MI may not provide greater effects.
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OP-MH05 Bone

BONE HEALTH IN ATHLETES WITH UNILATERAL LOWER LIMB AMPUTATION

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INTRODUCTION:
People with different levels of amputations are at risk of bone mineral loss in the impaired limb. Nowadays there is no data about bone health in athletes with lower limb amputation. This study has a twofold aim: first, to investigate the impact of the level of amputation and the type of sport practiced on bone mineral density (BMD) in the total hip region of the impaired lower limb (I_HIP) of athletes with unilateral lower limb amputation; second, to explore the association between BMD in the I_HIP and body composition in the impaired thigh region as well as the volume of training in this population.
METHODS:
Nineteen male athletes with unilateral lower limb amputation (above-knee amputation [AKA], n = 7; below-knee amputation [BKA], n = 12) aged 35.2 ± 8.9 years were enrolled in this study. Eight of them practiced an impact-loading sport (e.g., para triathlon) and eleven were engaged in a wheelchair-dependent sport (e.g., handbike). The average weekly volume of training was 5.2 ± 2.1 hours. Areal BMD (aBMD) in the I_HIP, and body composition in the thigh region of the impaired limb were assessed by means of dual-energy X-ray absorptiometry. Univariate analysis of variance was conducted to assess the effect of the level of amputation and the effect of the type of sport practiced on aBMD in the I_HIP. Partial correlation (r_pc) was used to measure the degree of association between aBMD in the I_HIP and body composition in the thigh region and the volume of training, accounting for the level of amputation and the type sport practiced.
RESULTS:
A statistically significant effect of both level of amputation and type of sport practiced was found on aBMD in the I_HIP ($F = 26.78$, $P < 0.001$ and $F = 5.43$, $P = 0.034$, respectively). In particular, athletes with AKA had lower (-30.2%) aBMD in the I_HIP versus athletes with BKA; moreover, athletes practicing an impact-loading sport had higher (+9.4%) aBMD in the I_HIP in comparison with those engaged in a wheelchair-dependent sport. After accounting for the level of amputation and the type of sport practiced, aBMD in the I_HIP was positively associated with the amount of lean mass in the thigh region of the impaired limb ($r_pc = 0.58$ and $P = 0.018$) as well as with the weekly volume of training ($r_pc = 0.54$ and $P = 0.031$).
CONCLUSION:
In conclusion, the level of amputation influenced aBMD in the I_HIP in athletes with amputation, with athletes with AKA having a higher risk of demineralization than those with BKA. These results also suggest that the practice of an impact-loading sport and a greater amount of weekly training seem to a have a positive impact on bone health in the I_HIP of athletes with amputation. Moreover, these results support the prescription of exercise that targets the musculature of the residual thigh for preservation of bone mass.
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DIFFERENT EFFECTS OF ENDURANCE RUNNING VERSUS INTERMITTENT HIGH INTENSITY RUNNING ON ACTIVATION OF BONE MARROW CELLS.

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INTRODUCTION:
Against degeneration of the MusculoSkeletal System (MSS), Physical Exercise (PE), hold a promising place. The intimate mechanisms by which PE induces structural MSS adaptations need to be further investigated and the mechanotransduction induced by the mechanical stress better defined
Regarding bone, PA is known to have an anabolic effect and the best osteogenic effects have been observed in sports where bone strains resulted from impacts(1). Running is consequently used and, regard to ambiguous results, effects of Intermittent High Intensity running (IHIr) need to be compare to effects of ENDururance running (ENDr) .
To explain the relationship between PA, mechano-transductive processes, and MSS adaptations, various Signalling Pathways (SP) driving the differentiation of bone marrow progenitors Mesenchymal Stem Cells (MSC) are known. It appears that the regulatory effects of an extracellular mechanical stress on SPs could be mediated by FAK and that FHL2, a multifunctional adaptor protein expressed in cells, could participates to adjustments of SPs and gene transcription(2).
Consequently, in reference to effects of running on bone marrow cells (BMC), we hypothesized that IHIR could impact differently FHL2 synthesis in BMC than ENDr.
METHODS:
18 Wiwtar male rats (7-week-old) were randomly allocated to one of the following groups: SEDentary (SED), ENDr or IHIr (n=6 per group. The running training protocol was performed on the treadmill, 45 min per day, 5 days, for 8 consecutive weeks. IHIr consisted in 7 repetitions of blocks of 3 min at 70 % Maximal Aerobic speed (MAS), followed by 2 min at 100 % MAS and 1 min of passive recovery. ENDr protocol was performed, 45 min per day at 70 % MAS. The animals were euthanized and then the radii were excised and fixed 1 day after the last training session. Bone samples were decalcified, embedded in paraffin and cut longitudinally with a microtome. FHL2 identification in BMCs was performed by immuno-histo-chemistry. Slides were observed under an optical microscope and the percentage of marked cells was calculated. Parametric tests were applied.
RESULTS:
Our data show a very significant difference of FHL2 labelled BMCs': 7.5 ± 1.6% for IHIr rats; 1.6± 0.6 % for ENDr; 0% for SED rats.
CONCLUSION:
These results suggest that mechanical impacts generated by IHIr activate a SP involving FHL2, more than ENDr. Therefore, IHIr could be proposed as a non-pharmacological strategy to induce BMCs activation. According to the effects of Dexamethasone, in vitro, on BMCs culture(3), IHIr is supposed to be also efficient to active a FHL2 transcription involved in CSM proliferation and differentiation.
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FUNCTIONAL SCORES IMPROVEMENT AFTER 6-MONTH OF AN EXERCISE PROGRAM FOR WOMEN WITH OSTEOPOROSIS: A RANDOMIZED TRIAL

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INTRODUCTION:
Osteoporosis (OP) is a systemic disease of the skeleton characterized by a reduced bone mass and deterioration of the micro-architecture accompanied by an increased risk of fracture with consequent pain, decreased physical and social functional capacity and quality of life (QoL). There is a consensus on the effectiveness of physical activity in preventing bone loss, falls and, consequently, fractures. However, there is no agreement on the optimal exercise program. The main aim of the study is to evaluate modifications of QoL measured with the Short Osteoporosis Quality of Life Questionnaire (ECOS-16) induced by the exercise program when administered as Online Group Training (OGT) or Individual Home Training (IHT). The second aims concern functional capability
METHODS:
Forty women with osteoporosis were enrolled in the randomized trial. The mean age was 67 ± 6.6 years old. The participants were divided into two groups: OGT and IHT. Both groups performed a specific exercise protocol for 6-month in 2-days/week 1-hour sessions. Moreover, all participants were requested to choose an additional third day of the week to perform brisk walking, cycling, or swimming for at least 30 min. The OGT was followed by a trainer through online supervision, while the IHT performed the protocol at home without supervision. The participants were assessed at the baseline and after 6-month of training. The assessed outcomes were: QoL measured through ECOS-16, fear of fall by short FES-I, aerobic capacity and endurance assessed by 6MWT, joints mobility by sit and reach and stick test, muscles force by handgrip and 30 seconds chair stand test.
RESULTS:
Of 40 women, 30 performed the 6-month assessment (13 OGT and 17 IHT), while 10 are not yet completed the training. Following preliminary results show the analysis of the 30 women who had completed the program. ECOS-16 showed no changes at 6-month follow-up for both groups and no difference between groups. 6MWT and 30s chair stand test showed a statistically significant improvement in both groups. The distance travelled of the 6MWT changed in the OGT, from 420±25m to 457±46m ($p<0.005$), and from 369±85m to 415±66m ($p<0.05$) in the IHT. The repetition number of the 30s chair stand test changed in the OGT from 12±3 to 15±3 ($p<0.001$) and from 12±2 to13±3 ($p<0.005$) in the IHT. Sit and reach and stick test showed not a significant improvement. FES-I, handgrip showed no changes between baseline and follow-up.
CONCLUSION:
Despite the difficulty due to the SARS Covid-2 pandemic, the study results showed that participants had maintained the same quality of life after 6-month of training. Moreover, the functional outcomes have increased after the training without differences between the groups. These results proved the efficacy of the exercise training in both settings.

DOES HIP INTERNAL ROTATION RANGE AFFECT THE CENTER OF PRESSURE DURING CROSSOVER CUTTING?

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INTRODUCTION:
A Jones fracture is common in soccer players. The more lateral position of the center of pressure (COP) increases the mechanical load on the fifth metatarsal bone during movement and is responsible for the occurrence of a Jones fracture. One risk factor for this fracture is the range limitation in hip internal rotation (HIR). However, the effect of range limitation in HIR on the mechanical load on the fifth metatarsal bone has not been clarified, and it cannot be said that improving the HIR range necessarily leads to the prevention of Jones fractures. Therefore, this study aimed to investigate the effects of the range of HIR and angle of HIR during crossover cutting, one of the directional changes in soccer on the COP, to infer the mechanical load on the fifth metatarsal bone.
METHODS:
Ten men with soccer playing experience participated in this study. The mean age, height, weight, and years of soccer experience (Mean ± SD) were 21.0 ± 0.7 years, 169.4 ± 3.0 cm, 62.8 ± 3.7 kg, and 9.4 ± 3.0 years, respectively. The HIR range of the players was measured in the supine position. For reproducibility, the HIR range of the 10 different subjects were measured in the same way, and the intrarater reliability was calculated (intraclass correlation coefficient [1, 2] = 0.991). The motion task employed was a crossover cutting movement in the 90° direction. The items to be analyzed were the maximum HIR angle during the crossover cutting movement and the COP lateral position at the time the angle was determined. The HIR angle during the movement was calculated from the marker information measured using a 3D motion analysis system, and the COP was calculated using a force plate. Statistical analysis was performed to examine the association between the HIR range and COP lateral position, the maximum HIR angle and COP lateral position, and the HIR range and maximum HIR angle using Pearson's correlation coefficient.
RESULTS:
There was no significant correlation between the HIR range measured in the supine position and COP lateral position during movement ($p = 0.11$), but there was a significant negative correlation between the maximum HIR angle during movement and COP lateral position during movement ($r = -0.747$, $p < 0.05$). There was no significant correlation between the HIR range measured in the supine position and maximum HIR angle during movement ($p = 0.24$).
CONCLUSION:
The results of this study showed that the lower the maximum HIR angle was during the crossover cutting movement, the more lateral the COP was located, and subsequently the greater was the mechanical load on the fifth metatarsal bone. We conclude that it is important to evaluate the HIR range during movement and it is necessary to examine the factors that decrease the HIR angle during the movement.

OP-MH06 Neurological Diseases

FUNCTIONAL TRAINING AND TESTING IN A YOUNG FEMALE WITH LGMDR1: A CASE STUDY

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INTRODUCTION:
Limb girdle muscular dystrophy (LGMDR1) is a neuromuscular disease related to strength and function losses. Calpain deficiency triggers weakness in the proximal muscle at the level of pelvic and/or scapular girdles already in youth, becoming degenerative and disabling at midterm (1,2). Recent research proposes supervised exercise as safe (3-5), so this study aims to further understand changes in physical function and fitness following a customized functional training program (FTP) in a 22 years LGMDR1 woman.
METHODS:
Longitudinal case study approved by the local Ethics Committee (H1057_1534342). 9 years of progressive weakness had affected both girdles. The subject (66.4 kg, 26.6 BMI) presented Vignos Scale 3; incapacity to sit/stand without support and tilting, slow gait. FTP combined global movements aiming to improve motor control, core stability, lower-limb strength, and balance, with local exercises for affected proximal muscles (often performed hidden in a complex metastability pattern; double tasking approach). Repetitions were low (4 to 10/12) and exercises varied following Differential Training statements and EFAM-Uv© guidelines (6). Volume (rep/exercises/sessions) increased along the intervention ad libitum (from 2 to 4 weekly sessions) looking for exercise joy and habituation. Cardiovascular responses were high at the beginning, so intensity was sub-maximal whatever the load. Thus, pain visual analogue scale and effort perception scale guided the session. Body composition, hand-grip strength (HG), 6-minutes walking test (6MWT), back extension (TK 5402 dynamometer), and the functional movement screen (FMS) were assessed pre-post the four months of FTP. Nutrition and life-style changes were introduced to help the intervention.
RESULTS:
Body weight decreased (66.4 vs 59.1 kg). Left HG slightly improved (24 vs 25.1 kg) whilst diminished in Right (24.3 to 22.8 kg). 6MWT enhanced (330 vs 400 m) and the back extension improved from not-done to 46.5 N. Noteworthy, the FMS showed improvements mainly in Squatting (hip-to-floor distance: 101 vs 73 cm & better shoulder mobility); Stepping (0 to 3 cm & improved balance), and Lunging (distance between feet: 26 to 34 cm left; 29 to 37 cm right).
CONCLUSION:
Walking speed reached independence levels for daily living activities. Mobilization of muscles that barely worked in the previous highly sedentary status derived in a slow but continuous improvement, fond to exercise and motor challenges, getting high rates of adherence. Deep squat, hurdle step and in-line lunge arise important exercises to assess functional improvements in LGMDR1 at early stages of an FTP. Functional training confirms to be sure and help LGMDR1 patients, improving health and quality of live with no adverse impact. REFERENCES: 1) Medicine 2019;12(76):4486-96. 2) Journal of neurology. 2020;267(1):45-56. 3) Angelini, C., & Fanin, M. GeneReviews®[Internet], (2017). 4) Acta Myologica, 2019;38(4), 207. 5) Acta Myologica, 2019;38(4): 215 6) IJERP 2020 17(16), 5984.

WHOLE BODY ELECTROMYOSTIMULATION APPLIED ON EARLY PARKINSON PATIENTS

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INTRODUCTION:
Parkinson's disease (PD) patients lead a sedentary lifestyle, being unable or unwilling to exercise conventionally, due both to physical and mental limitations. Physical activity (PA) could prevent the loss of dopaminergic neurons and improve synaptic connections, upregulating neurotrophic factor levels and consequently counteracting dyskinesia [1-2]. Whole-Body Electromyostimulation (WB-EMS) seems a promising exercise modality for this population inducing a global-body electrical myostimulation activating up to 8-10 different muscle groups synchronously, while the patient performs functional movements during the stimulation. WB-EMS are not previously applied to an exercise program for PD patients.
The aim of this study was to assess the acute effects of a single session of Whole Body Electro Myo-Stimulation (WB-EMS) on the physical performances and serum levels of neurotrophic factors in PD patients.
METHODS:
Ten subjects (aged 72.60 ± 6.82) underwent 20-minute physical activity with superimposed WB-EMS (Miha Bodytec equipment - GmbH, Augsburg, Germany) and, after four weeks, the same protocol with no WB-EMS. WB-EMS was conducted with intermittent stimulation 4s WB-EMS /4s rest, at 85Hz, 350µs. Physical fitness assessment based on the following tests: Arm tremor to evaluate the degree of Parkinsons-related tremor, Upper limb endurance and strength through Arm Curl and Handgrip strength test respectively, 8 Feet Up and Go, for dynamic balance and agility, Six minutes walking to assess cardiorespiratory fitness and Soda Pop Test, for the oculo-manual coordination. Blood samples were collected to evaluate neurotrophic factors' levels (BDNF, FGF21, proNGF, mNGF) before and after the intervention.
RESULTS:
The RM-ANOVA showed significant improvements in Sit-to-Stand ($p<0.01$), Arm Curl ($p<0.01$), Handgrip ($p<0.01$) and Soda-POP test ($p<0.01$) after WB-EMS intervention. Higher proNFG serum levels were observed in the WB-EMS condition compared to the no WB-EMS after 60 min post intervention ($p = 0.0163$).
CONCLUSION:
The positive impact of the WB-EMS protocol on physical functioning, and eye-hand coordination, makes this intervention a promising strategy to improve motor and non motor symptoms in PD patients. The effect of WB-EMS, confirmed the electrostimulation ability to modulate the proNGF quantity changing the sign of the variations recorded in the short time interval of 60 minutes.
WB-EMS may be a time-efficient solution for Parkinson's patients to improve also their adherence to PA programs considering this time-efficiency, and a feasible methodology to increase their physical condition.
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ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND NEUROPSYCHIATRIC SYMPTOMS IN OLDER ADULTS FREE OF DEMENTIA: THE MAYO CLINIC STUDY OF AGING

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INTRODUCTION:
Physical activity (PA) has numerous beneficial effects on physical and mental health across the lifespan. Here we examined the associations between PA engagement in mid- and late-life with neuropsychiatric symptoms (NPS) such as depression or anxiety in community-dwelling older adults.
METHODS:
We conducted a cross-sectional study in the setting of the population-based Mayo Clinic Study of Aging in Olmsted County, MN, USA, involving 3342 individuals (1710 males) aged ≥ 70 years (mean ± SD, 79.2 ± 5.6 years) who were either cognitively unimpaired (N = 2816) or had mild cognitive impairment (N = 526). PA (presumed predictor) in midlife (between the ages of 50-65 years) and late-life (one year prior to assessment) was assessed at three intensity levels (light, moderate and vigorous) using a self-reported, validated questionnaire. NPS (presumed outcome) were assessed using the Neuropsychiatric Inventory Questionnaire, and Beck Depression (BDI-II) and Anxiety Inventories (BAI). We conducted regression analyses adjusted for age, sex, education, Apolipoprotein E ε4 carrier status, and medical comorbidities.
RESULTS:
Logistic regression analyses revealed statistically significant inverse associations between engagement in late-life PA and presence of NPS, i.e. light intensity PA was associated with lower odds of having agitation [odds ratio (95% CI), 0.88 (0.77, 0.99), p=0.039], apathy [0.86 (0.78, 0.94), p=0.001], sleep/ nighttime disturbance [0.91 (0.84, 1.00, p=0.040], depression [0.90 (0.84, 0.96), p=0.002], irritability [0.92 (0.85, 1.00), p=0.047] and clinically-relevant depression [0.87 (0.79, 0.94), p=0.001]. Moderate intensity PA in late-life was associated with lower odds of having irritability [0.88 (0.80, 0.96), p=0.007], clinically-relevant depression [0.90 (0.81, 0.99), p=0.037] and clinically-relevant anxiety [0.83 (0.75, 0.92), p=0.001]. Linear regression analyses showed that light intensity PA in midlife was associated with less depressive and anxiety symptoms as indicated by lower BDI-II [estimates (95% CI), -0.034 (-0.054, -0.013), p=0.001] and BAI total scores [-0.033 (-0.054, -0.012), p=0.002]. With regard to late-life, both light and moderate intensity PA were associated with lower scores on BDI-II [light PA: -0.054 (-0.072, -0.036), p<0.001; moderate PA: -0.038 (-0.057, -0.018), p<0.001] and BAI [light PA: -0.036 (-0.055, -0.017), p<0.001; moderate PA: -0.024 (-0.044, -0.004), p=0.021]. There were no significant effects for vigorous intensity PA.
CONCLUSION:
Engagement in late-life PA, particularly at light and moderate intensities, is associated with decreased odds of having NPS in community-dwelling older adults free of dementia. This suggests that staying physically active in late-life regardless of midlife PA is associated with better emotional health. These findings need to be confirmed by a prospective cohort study. Also, objective assessment of PA using body-worn sensors should be considered to overcome risk of bias from self-reports.

SMALL STEPS IN FITNESS TRANSLATE TO MAJOR LEAPS IN HEALTH FOR ADULTS WITH INTELLECTUAL DISABILITIES

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ERASMUS MC

INTRODUCTION:
For the general population, cut-off values are available for the minimum physical fitness levels required to generate health benefits, such as decreased morbidity and longer survival. However, for extremely unfit populations, such as older adults with intellectual disabilities (ID), these cut-off values may be impossible to reach. Our novel hypothesis is that even among very unfit, older adults with ID, small changes in fitness translate to major leaps in health. The aim is to check whether our data collected within the Healthy Ageing and Intellectual Disabilities (HA-ID) study can support this hypothesis.
METHODS:
Physical fitness (cardiorespiratory fitness, gait speed, grip strength) was measured in 900 older adults with ID (50 years and older). Mortality was collected 5 years after baseline. The relationships between fitness and survival were analysed with multiple linear regression models and Cox proportional hazard models.
RESULTS:
Looking at cardiorespiratory fitness, 100% of the older adults with ID scored below the average reference range of the general population. For gait speed this was 43% of the men and 54% of the women, and for grip strength 77% of the men and 67% of the women scored below the average reference range of the general population. Within these extremely low fitness levels, better baseline fitness was still associated with better survival (cardiorespiratory fitness HR = 0.997 [0.995–0.999], comfortable gait speed HR = 0.65 [0.54–0.78], grip strength HR = 0.97 [0.94–0.99]).
CONCLUSION:
Our study is the first to support our novel hypothesis that even small differences at the lower end of the physical fitness spectrum are associated with health benefits. Improving physical fitness is therefore important for better health outcomes even in extremely unfit populations scoring well under the cut-off values for the general population. This supports a stronger focus on improving fitness amongst these unfit adults with ID.

OP-MH07 Obesity / Diabetes

IS ACUTE HIGH INTENSITY INTERVAL EXERCISE MORE EFFECTIVE THAN THE MATCHED MODERATE INTENSITY CONTINUOUS EXERCISE ON PLASMA GLUCOSE CONTROL IN MEN WITH TYPE 2 DIABETES? A RANDOMIZED CONTROLLED TRIAL.

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INTRODUCTION:
With the enhanced prevalence and the early onset of the type 2 diabetes (T2D), more effective exercise strategy is compelling to deliver the greater glycemic benefits, especially for the young and middle-aged patients. High intensity interval exercise (HIIE) has been proposed as a promising intervention for T2D. While it has yet to be clear how differently a single bout of HIIE, when compared with matched moderate intensity continuous exercise (MICE), can influence the meal-induced glucose control and FFA profile. This study aimed to compare the acute effects of HIIE versus MICE on the dynamic changes of postprandial glucose, insulin and FFA levels in men aged 30-50 years with T2D. We hypothesized acute HIIE might be more effective on improvements in glycemic control and FFA profile.
METHODS:
T2D patients (13 men aged 30-50 years) underwent a randomized three crossover intervention: HIIE (7 × 1 min at 90% of maximal oxygen uptake (VO2max) + 7 × 2 min at 30% VO2max + 4 min of warm-up and 5 min cool-down) with cycling; time and energy expenditure matched MICE (cycling at 50% VO2max); and a sedentary control (CON). All the interventions were conducted one hour after the breakfast. Glucose, insulin and free fatty acids (FFA) levels were measured at pre-exercise, post-exercise, 1 h post-exercise, pre-lunch and 1 h post-lunch, respectively. Responses of areas under the curve (AUC) during 4 h from pre-exercise to 1 h post-lunch were also calculated.
RESULTS:
Significant intervention × time interaction effects were identified for plasma glucose (P = 0.001) and insulin (P = 0.006) values evolution. Lower glucose levels were observed immediately after exercise between HIIE and CON (P ＜ 0.001), MICE and CON (P = 0.001), and between HIIE and MICE (6.28 ± 2.19 vs. 7.27 ± 3.13 mmol/l, P = 0.033), while no significant differences were observed between three trials in other time points except for the post-exercise. Lower insulin levels were observed immediately after exercise between HIIE and CON (P = 0.006), and between MICE and CON (P = 0.016). No difference was found between HIIE and MICE at any time points. FFA was unchanged throughout the three experimental interventions(P＞0.05). When compared to CON, AUCs for glucose and insulin were reduced in HIIE (glucose 29.3 ± 10.3 vs. 35.1 ± 10.0 mmol/l·4 h, P = 0.047; insulin 114.8 ± 47.4 vs. 173.3 ± 84.0 μU/ml·4 h, P = 0.024,) and MICE (glucose: 30.2 ± 11.1 vs. 35.1 ± 10.0 mmol/l·4 h, P = 0.036; insulin: 121.5 ± 53.3 vs. 173.3 ± 84.0 μU/ml·4 h, P = 0.015), whereas no differences were observed between HIIE and MICE. FFA AUC remained unchanged between three interventions.
CONCLUSION:
Acute HIIE and the matched MICE improve glucose control in the same magnitude in type 2 diabetic men aged 30-50 years. Accordingly, either HIIE, or MICE can be adopted as an effective exercise strategy in glucose control for diabetic men in this age. Furthermore, both acute HIIE and MICE may not be enough to elicit notable FFA response.

MANAGING EXERCISE-RELATED INJURIES AND ADVERSE EVENTS IN A WALKING FOOTBALL PROGRAM FOR MIDDLE-AGED AND OLDER MEN WITH TYPE 2 DIABETES

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1 - EPIUNIT – ISPUP; 2 - LABORATÓRIO ITR; 3 - PORTUGUESE FOOTBALL FEDERATION; 4 - CIFI2D; 5 - CIDESD; 6 - CIAFEL; 7 - NORTHERN REGION HEALTH ADMINISTRATION

INTRODUCTION:
Given the global burden of type 2 diabetes (T2D) worldwide and the low adherence to exercise programs, the development of effective strategies is necessary to improve the control of this chronic disease. Considering individuals with T2D have an increased risk of injuries and adverse events associated with exercise training, efforts across safety appear to be fundamental in the long-term adherence to exercise programs. This study aimed to describe the exercise-related injuries and adverse events of a community-based walking football program in middle-aged and older men with T2D.
METHODS:
This study enrolled 31 male participants with T2D recruited from primary health care units of Porto (Portugal), with 50–70 years old, major diabetes complications controlled, and without contraindications to exercise. Participants engaged in a 12-week walking football program (three sessions per week of 60 minutes, consisting of strength and conditioning exercises, technical skills drills, and small-sided walking football games). Sessions were conducted in a sports hall by a football coach and supervised by an exercise physiologist and a nurse. Exercise-related injuries and adverse events were recorded and managed in all sessions.
RESULTS:
This walking football program was completed by 29 participants (64.5±4.5 years old). Falls (n=25) and musculoskeletal injuries (n=8) were the most frequent adverse events, followed by episodes of seizures (n=1), myalgias (n=1), and malaise (n=1). 30.6% (n=11) of the adverse events interfered with exercise participation. Of these, 19.4% (n=7) interfered with the exercise session of the event, 2.8% (n=1) also interfered with the following exercise session, and 8.3% (n=3) interfered with more than one exercise session. No acute metabolic or hemodynamic adverse events were observed, and no harm has resulted from these events.
CONCLUSION:
A community-based walking football program for patients with T2D revealed injuries and adverse events as expected for this clinical population and activity. Walking football seems to be a safe exercise strategy and, therefore, may have the potential for large-scale implementation by local communities with the involvement of football clubs and primary health care centers, targeting T2D control.
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ClinicalTrials.gov Identifier: NCT03810846
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Portugal; 6 - Research Centre in Physical Activity, Health and Leisure (CIAFEL), Faculdade de Desporto, Universidade do Porto, Porto, Portugal; 7 - Northern Region Health Administration, Porto, Portugal

ASSOCIATION OF OBESITY WITH INFLAMMATION IN WOMEN WITH SYSTEMIC LUPUS ERYTHEMATOSUS: FITNESS AS AN EFFECT MODIFIER

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INTRODUCTION:
Systemic lupus erythematosus (SLE) is an autoimmune disease characterized by a chronic low-grade inflammation state that is independent of the disease activity. Obesity is an independent contributor to inflammation in SLE [1] and physical fitness is a strong modifiable health marker both in the general population [2] and in patients with some rheumatic autoimmune diseases, such as SLE. As low physical fitness seems to be associated with a worse cardiovascular profile in patients with rheumatic conditions [3], this cross-sectional study assessed the potential role of physical fitness as an effect modifier of the association of obesity with inflammatory markers in women with SLE.
METHODS:
We recruited 77 women with SLE. Relevant markers of obesity were measured including body mass index (BMI), waist-to-height ratio (WHtR), and body fat percentage (BF%). Inflammation was assessed through plasma levels of high sensitivity C-reactive protein (hsCRP), interleukin 6 (IL-6), and leptin. Cardiorespiratory fitness (CRF) was assessed through the 6-minute walk test, range of motion (ROM) through the back-scratch test, and muscular strength through the handgrip strength test.
RESULTS:
CRF attenuated the association of BMI with IL-6 and the association of BF% with IL-6 (both, $P<0.05$), and tended to attenuate the association of WHtR with IL-6 ($P=0.078$). For example, participants who were able to walk 380 meters in the 6-minute walk test presented an increase of 1.13 pg/mL in IL-6 for 1 incremental BMI unit, while those who were able to walk 560 meters presented an increase of 0.12 pg/mL in IL-6 for 1 incremental BMI unit. ROM attenuated the association of BMI with IL-6 ($P<0.05$), the association of BF% with hsCRP ($P<0.05$), and the association of BMI with hsCRP ($P=0.056$). These interactions revealed that higher CRF and flexibility were associated with a lower increase in inflammation per unit increase in the obesity-related parameter. Muscular strength attenuated the association of BF% with IL-6 ($P=0.057$), but potentiated the association of BF% with leptin ($P<0.05$).
CONCLUSION:
The results suggest that higher CRF and ROM attenuated the impact of obesity-related parameters with inflammation in women with SLE. These findings open a window to understand the potential of fitness to counteract the effect of obesity on inflammation in SLE, although this needs to be corroborated in future prospective research.
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FEATURES OF CHANGE IN VASCULAR FUNCTION AFTER ACUTE HIIE AND MICE IN RECESSIVE OBESE WOMEN

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INTRODUCTION:
According to recent survey and supervision of health condition, at present the physical constitution of young people in our country came down, proportion of overweight and obesity increased significantly, especially in females. So it's time to strengthen physical fitness and health of young women. This paper probes into effect of acute high-intensity interval exercise (HIIE) and moderate-intensity continuous exercise (MICE) at the same amount on vascular function of recessive obese women, to guide them to do exercise scientifically and prevent cardiovascular disease.
METHODS:
Thirty recessive obese women (20.1±2.3yrs) participated in the study that was approved by IRB at Beijing Sport University. They were randomly divided into HIIE (HIE) group, MICE (MIE) group and control (CON) group. There were 10 women in each group. The HIIT intervention was 4 × 4 min of interval running (4 min of running at 85%-95% HRmax followed by 3 min of rest). The MICE intervention did equal amount of exercise with HIIE. The intensity of MICE was 65%-75%HRmax. The control group did not perform any kind of exercise. The exercise began after two hours of the meal. The brachial ankle pulse wave velocity (BaPWV) and ankle brachial index (ABI) were measured before exercise, immediately after exercise, then every 5 min till 40 min.
RESULTS:
1) There were no significant differences among the participants of three groups in age, weight, height, body mass index, BaPWV or ABI at baseline. 2) Immediately after the exercise, the MIE group demonstrated significantly decreased level of BaPWV (9.31±0.22 vs 9.81±0.35m/s, $P<0.05$). 25 min after the exercise, BaPWV level in MIE group returned to the baseline. 3) Immediately after the exercise, participants in HIE group had a significant reduction in the BaPWV level (8.1%, $P<0.01$). During recovery period, from 5 to 25 min, the level of BaPWV in HIE group decreased significantly compared with baseline level ($P<0.01$). 30 min after the exercise, BaPWV level in HIE group returned to the baseline. 4) During recovery period, compared with CON group, participants in MIE group had a significant lower BaPWV level at 5 min (9.05±0.44 vs 9.72±0.37m/s, $P<0.05$), and participants in HIE group had a significant reduced BaPWV level from 5 to 15 min ($P<0.01$). And the level of BaPWV in HIE group significantly lower than MIE group at 10 min (8.42±0.31 vs 9.14±0.43, $P<0.05$).
CONCLUSION:
Both acute HIIE and MICE could ameliorate arterial stiffness and improve vascular elasticity of recessive obese women, which were beneficial to prevent arteriosclerosis and cardiovascular disease in early life. It was suggested that acute high-intensity interval exercise had a stronger and sustained effect on the vascular function of recessive obese women than moderate-intensity continuous exercise.

OP-MH08 Aging and Elderly

EFFECTS OF HIGH VELOCITY VS. LOW VELOCITY ISO-POWER TRAINING MODELS ON THE PEAK POWER OF OLDER PEOPLE.

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INTRODUCTION:
It has been observed that the loss of muscular performance with ageing, in particular the ability to generate strength and power, occurs earlier and at a higher rate than the loss of muscle mass (1). Given that the power is the result of the product of force and velocity, the influence of the velocity and force at which the maximum power is reached on functionality has been recently analysed (2).
The inverse force-velocity relationship (FV) implicitly implies a parabolic relationship between power and velocity and therefore the existence of a peak value of power with an optimal velocity, which in turn it´s equivalent to a value of force in the FV. This parabolic profile of the power-velocity relationship means that there are iso-power points, specifically, equal power magnitude that can be reached at different velocities (2).
Considering the relevance of the preservation of power for the maintenance of functionality, the aim of this study was to contrast the effect of two resistance training programmes performed at the same relative power but with different loads and therefore at different velocities (i.e., iso-power training), on the maximum power performed in different exercises by community dwelling elderly people. Given the relevance of the optimum velocity on the power performance of older people, we hypothesized a greater improvement of power by a training with lower load and at a higher velocity.
METHODS:
Forty-four active adults, older than sixty years were randomized (high velocity, HV; low velocity, LV; and control, CON) to obtain the one repetition maximum (Egym, Germany) the load-power ratio (% 1RM-W) through a progressive load test (seated row, SR; chest press, CP; leg press, LgP), before and after a power training intervention (5 weeks; 2 sessions per week). The power training was developed at 98% of individual maximum power and at maximum intended velocity but at a higher or lower velocity than the optimum one (I.e., lower or higher load than that associated with maximum power). The total volume and recovery were equated between experimental groups.
RESULTS:
Peak power increased after training for SR in both HV ($p<0,001$; Hedge´s g: 0,989) and LV ($p<0,001$; Hedge´s g:0,653). Similar results were observed for LgP in HV ($p=0,005$; Hedge´s g:0,933) and LV ($p<0,001$; Hedge´s g:0,983). HV ($p=0,224$; Hedge´s g:0,386) but not LV ($p=0,012$; Hedge´s g: 0,790) significantly incremented their peak power in CP.
CONCLUSION:
Power training with older adults is a god method for increase the peak power. For a similar power performance, the effects were similar for high load-low velocity and low load-high velocity protocols.
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EFFECTS OF COMBINED INTERVENTION OF PHYSICAL ACTIVITY AND COGNITIVE STIMULATION IN PREVENTION OF COGNITIVE DECLINE FOR PATIENTS WITH MILD COGNITIVE IMPAIRMENT

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INTRODUCTION:
Older people experience a progressive loss of cognitive and physiological functions, comprehending cognitive impairments and loss of functional motricity. It is estimated that by 2050 the number of people with dementia will reach 131.5 million worldwide.
Mild cognitive impairment is a state of declined cognitive function present in the preclinical stage of other types of dementia, characterized by retained capacity to perform daily functional activities. Early intervention at the mild cognitive impairment stage can prevent the decline of cognitive function (Park et al., 2019; Varela et al., 2012).
This study aimed to investigate the effects of a dual-task (exercise + cognitive stimulation) intervention program on cognitive function.
METHODS:
Thirty-seven individual (aged 64-97y; 73% female, 27% male) resident in care homes for elderly people, were included in the study and divided into an intervention (IG, n=25; aged 65-91y) and a control (CG, n= 12; aged 64-97y) group.
The mild cognitive impairment diagnosis was based on medical evaluations conducted by a neurologist. Cognitive assessments were performed by psychologists, according to standardized method Mini Mental State Examination (MMSE) at baseline and after six-month, individually tailored exercise program.
The intervention program included aerobic and strength exercises, combined with cognitive tasks (dual tasks).
RESULTS:
After completion of the dual-task programme, IE MMSE scores improved from 18.20 (sd 2.59) to 19.80 (sd 3.20), while MMSE scores of CG decreased from 15.00 (sd 4.39) to 13.80 (sd 3.91).
Analysis of the subjects for group-time interaction revealed that the exercise group exhibited a significantly improved MMSE score.
CONCLUSION:
A six-month intervention combining exercise and cognitive stimulation not only maintained, but improved cognitive function in patients with mild cognitive impairment, whereas patients not submitted to the intervention decreased cognitive function.
Supervised, dual-task interventions should be considered as complementary, non-pharmacologic, and effective therapies to individual who presents mild cognitive impairment, since they present potentialities to prevent cognitive decline.

THE ASSOCIATION BETWEEN WALKING SPEED TO VARIOUS PHYSICAL FUNCTIONAL AND COGNITIVE PARAMETERS IN OLDER ADULTS

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INTRODUCTION:
Walking speed (WS) has become an important health indicator among older adults due to its association with a wide range of adverse health outcomes and increased mortality risk [1,2]. However, previous studies have assessed WS using two different approaches: usual or fast speed. This study examined potential differences in the association among these two walking speeds to various physical functional and cognitive parameters in a sample of older adults.
METHODS:
One hundred older adults participated in this study (Mean±SD; age: 84.7±6.3 years; BMI: 27.9 kg/m2; 70% women). Usual WS was assessed through the gait speed test section (4-meter course) of the Short Physical Performance Battery (SPPB) and fast WS was assessed using the Timed 25-foot Walking Test (25FWT). WS for both tests were expressed in meters/second (m/s). Physical functional assessments included the 2-minute step test (2MST), the SPPB balance assessment (balance), the 30-second Chair Stand Test (30CST), handgrip strength, and number of falls in the last 12 months. Cognitive assessments included the Symbol Digit Modalities Test (SDMT), the California Verbal Learning Test (CVLT), and the Brief Visuospatial Memory Test (BVMT). Data were analyzed using partial correlation (r) analysis controlling for age, sex, body mass index (BMI), and physical activity (PA) level. Significance was set at $p < .05$.
RESULTS:
Partial correlation (r) analysis controlling for age, sex, BMI and PA level demonstrated that usual WS was associated with scores observed in the 2MST ($r = .34$; $p = .001$), balance ($r = .43$; $p < .001$); 30CST ($r = .59$; $p < .001$), number of falls in the last 12 months ($r = -.24$; $p = .020$) and; SDMT ($r = .30$; $p = .004$). Fast WS was associated with 2MST ($r = .43$; $p < .001$); balance ($r = .39$; $p < .001$), 30CST ($r = .68$; $p < .001$), handgrip strength ($r = .29$; $p = .004$); SDMT ($r = .29$; $p = .005$) and; BVMT ($r = .24$; $p = .020$).
CONCLUSION:
The results suggest that after controlling for age, sex, BMI and PA levels, both usual and fast WS were associated with both physical functional and cognitive parameters among older adults; and that the strength of the associations ranged from small-to-large in magnitude based on the correlation coefficients observed. Our findings reinforce the importance of WS as an important health-related physical parameter among older adults and as a potential assessment to be included in comprehensive geriatric care.

THE ACUTE EFFECT OF PHYSICAL EXERCISE ON COGNITIVE PERFORMANCE IN A VIRTUAL SUPERMARKET SERIOUS GAME FOR OLDER ADULTS

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INTRODUCTION:
Recent studies have shown a strong link between regular physical exercise and maintenance of cognitive function/performance. However, knowledge on the acute effects of exercise on older adults is relatively scarce. The virtual supermarket (VSM) serious game application is a clinically valid and enjoyable tool for assessing performance of multiple cognitive domains (attention, memory, orientation, and perception) [1]. This study aimed to investigate whether a physical-exercise (EXE) session alters older adults' cognitive performance in the VSM game.
METHODS:
Twenty-one older adults (8 men, 13 women) aged 65-85 years and without any neuromuscular disabilities participated in this study. Participants underwent a familiarization session with the VSM the day before testing, to suppress learning effects that could affect our experimental outcomes. The next day, they performed two sessions of 3 successive VSM trials, one before the physical-exercise session (pre-EXE), and one immediately after (post-EXE). The EXE comprised consecutive sets of a 5 times-sit-to-stand trial followed by 45sec of static vigorous walk. The trial was discontinued if the participant's perceived exertion exceeded "really hard" (8/10 on Borg scale). Heart rate was monitored. After completing the 3rd VSM trial in each session, participants completed the NASA-TLX to assess perceived workload. Cognitive performance was evaluated by the time required to complete the VSM game [1]. For each participant, the average duration (time for VSM game completion) and the corresponding standard deviation (SD) of the three successive trials was calculated for each session. The SD was used to evaluate trial variability. The Wilcoxon signed-rank test was used to compare pre- vs post-EXE performance.
RESULTS:
The EXE session resulted in a heart rate rise ($p<0.05$) of 32.4±10.7%. The time for the VSM game completion was reduced following the EXE session (8.06±4.97min vs 7.17±5.31min ($p=0.014$), pre- and post-EXE, respectively). The SD was also reduced following the EXE session (2.55±1.73min vs. 1.66±1.47min ($p=0.001$), pre- and post-EXE, respectively). No differences in NASA-TLX rating pre- and post-EXE were found ($p>0.05$).
CONCLUSION:
Physical-exercise improved older adults' cognitive performance, as assessed by a virtual game task, without altering the perceived workload. A potential mechanism for the beneficial effect of physical-exercise on this cognitive performance could be attributed to the increase in cerebral blood flow and oxygenation during the exercise session.
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IS THE ISOMETRIC KNEE EXTENSION TEST A REPEATABLE AND SUITABLE TOOL FOR LOWER-LIMB SCREENING AMONG INSTITUTIONALIZED OLDER ADULTS?

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INTRODUCTION:
To date, the handgrip test represents the most common evaluation used to measure muscle strength in older adults, due to its high portability, simplicity and test-retest repeatability [1]. Nevertheless, this test is restricted to the upper limb, specifically to the arms, so it lacks information from lower limb. Between the different assessments used by the scientific literature as a complement to the handgrip is the isometric knee extension (IKE) test, which informs about the neural and muscular capability of knee extensor elements [2]. On this matter, a high intra- and inter-session repeatability has been found in the IKE test conducted by healthy adults, using a strain gauge [3]. However, to the best of our knowledge, no study to date has analyzed the intra- and inter-session repeatability of this methodology (IKE test + strain gauge) among institutionalized older adults. Thus, this study aimed to analyse the field-based IKE test in terms of: i) intra- and inter-session repeatability, and ii) relationship with functional and body composition factors of sarcopenia among institutionalized older adults.
METHODS:
The present analysis is part of an ongoing multicentre, randomized controlled trial (NCTXXXXXXXX). Thirteen institutionalized older adults (age 87 ± 10.9 years, height 160.0 ± 7.9 cm, body mass 73.1 ± 10.9 kg, muscle mass 42.9 ± 5,9kg) were recruited from a nursing home. Participants completed four testing sessions. In session 1, participants completed a medical screening, followed by a battery of functional evaluations, including the Handgrip, 6-m Gait Speed, Time Up and Go (TUG), and Sit-to-stand tests. In session 2, they underwent a body composition scan by dual-energy X-ray absorptiometry. Finally, in sessions 3 and 4 (separated by 5 days of full rest), participants performed three trials of 3 s of the IKE test at a comfortable knee angle of 110-120° with a rest of 60 s using a portable strain gauge attached to a resistant padded anklet.
RESULTS:
A high to very high intra-session repeatability was found for both the dominant and non-dominant legs (CV ≤ 6.0 %, ICC ≥ 0.989). This intra-session repeatability increased on the second session, especially for the dominant leg (CV = 3.6 %, SEM = 0.09 N·kg-1). Similarly, both legs showed a high inter-session repeatability (SEM ≤ 0.26 N·kg-1, ICC ≥ 0.959). On the other hand, significant associations were found between Dominant and Non-dominant IKE/BM and 6-m Gait Speed (r = 0.77, p = 0.002; r = 0.58 p = 0.039), ALM/BMI (r = 0.62, p = 0.023; r = 0.58 p = 0.039), and Non-dominant Handgrip/BM (r = 0.6, p = 0.031; r= 0.68 p = 0.011). In addition, a significant correlation was found between Dominant IKE/BM and TUG (r = -0.74, p = 0.006), as well as between Non-dominant IKE/BM and Dominant Handgrip/BM (r= 0.67, p = 0.012).
CONCLUSION:
The IKE test is a repeatable and suitable tool for lower-limb screening among institutionalized older adults.
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ESTIMATING THE RELATIVE LOAD FROM MOVEMENT VELOCITY DURING THE SEATED CHEST-PRESS EXERCISE IN OLDER WOMEN AND MEN

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INTRODUCTION:
The measurement of movement velocity during resistance exercises is an effective way to estimate the relative load (i.e., % of one-repetition maximum [1RM]) due to the well-known load-velocity relationship (1). Although this method is commonly used in athletic settings, its accuracy in geriatric contexts is poorly studied. To our best knowledge, only one study proposed load-velocity regression equations in the free-weight bench-press and 45º inclined leg-press exercises with strength-trained older women (2). However, studies that analyzed the load-velocity profile in resistance machine exercises with older women and men without training background are unknown. Therefore, in this study, we analyzed the predictive ability of the load-velocity relationship in the seated chest-press exercise in older women and men.
METHODS:
Seventeen women and fifteen men (79.6±7.7 years; 71.5±14.5 kg; 1.57±0.11 m) living in community-dwelling centers participated in this study. All participants performed a progressive loading test up to 1RM in the seated chest-press exercise. The fastest peak velocity (PV) and mean velocity (MV) attained with each weight were collected through a linear velocity transducer. Quadratic regression equations were developed for women and men. We analyzed the regression models effectiveness by checking the assumptions of normality, independence, and homoscedasticity of the residuals. The regression equations were cross validated, considering the holdout method, to test if there was no overfitting. Independent samples t-test analyzed the differences between sexes in the estimated PV and MV for each relative load.
RESULTS:
The data demonstrated a very strong quadratic load-velocity relationship in the seated chest-press in women (PV: r2=0.97, standard error of the estimate (SEE)=4.5%1RM; MV: r2=0.96, SEE=5.3%1RM) and men (PV: r2=0.98, SEE=3.8%1RM; MV: r2=0.98, SEE=3.8%1RM). The results suggested no overfitting in both models since the correlation coefficients were positive and high (r=0.98-0.99) and did not present a big difference between both subsets. Men presented significantly higher ($p<0.001$) estimated PV and MV values than women against almost all relative loads, except with 95 and 100% of 1RM ($p>0.05$).
CONCLUSION:
Our findings suggest that movement velocity can accurately estimate the relative load during the seated chest-press exercise in older women and men. Clinicians and researchers can use the proposed sex-specific regression equations to implement velocity-monitored resistance training programs with older adults.
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PHYSICAL FITNESS CORRELATED WITH LOCOMOTOR REHABILITATION INDEX TO ANALYZE THE GAIT PERFORMANCE IN OLDER BRAZILIAN WOMEN

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INTRODUCTION:
Older adults self-select a reduced walking speed caused by the aging process. In turn, the self-selected walking speed (SSWS) is gradually reduced compared to optimal walking speed (OWS, speed where the metabolic cost is minimal). Therefore, closer values between SSWS and OWS represent a more economical walk. The locomotor rehabilitation index (LRI) is a parameter capable of evaluating how much the mechanics and energetics are close to optimal conditions. Our study aimed to assess the correlation of LRI with variables related to physical fitness in older Brazilian women.
METHODS:
We conducted a community-based, cross-sectional study among 192 women from 60 to 90 years old (72.42±7.36 years old; body mass index: 28.43 ±4.80 kg/m²) from Southern Brazil. We measured SSWS by 10-meter walking test; LRI was defined as percentage ratio between SSWS and OWS (LRI = 100 × SSWS/OWS); muscle strength by 30-sec sit-to-stand test; flexibility (FL) by chair sit-and-reach test; cardiorespiratory endurance (CE) by two-minute stepping; functional mobility (FM) by timed up and go test. Statistical analysis included descriptive variables, and Pearson correlations (α =0.05), using IBM SPSS® software.
RESULTS:
LRI was 89.7±15.2%, SSWS was 1.29±0.22 m/s, muscle strength was 16.0±4.5 repetitions, FL was -3.40±10.67 centimeters, CE was 86.92±16.56 repetitions and FM 5.74±1.13 seconds. There were significant positive correlations of LRI with SSWS (r=.987; p<.001), muscle strength (r=.181; p=.012), FL (r=.289; p<.001), and CE (r=.160; p=.027); negative correlations with age (r=-.262; p<.001) and FM (r=-.344; p<.001).
CONCLUSION:
SSWS, age and variables related to physical fitness were associated with LRI. A high score in physical fitness and SSWS improved the likelihood of the older women having an LRI close to ideal. LRI showed an inverse correlation with age indicating that the younger older adult´s score is higher, and the older adult´s score is lower. Therefore, a higher score means that walking requires lower energy expenditure and a low score more energy expenditure. Furthermore, LRI showed a positive correlation with all physical fitness variables (MS, FL, CE, and FM) and SSWS, indicating a convergent relationship with gait performance. Thus, investigating the LRI is useful in detect gait performance, as it allows an indirect inference on the energy cost of walking in older adults. It is worth noting that the LRI is an easy instrument with high applicability in observational and clinical trials to assess the effects of physical exercise programs on gait. Future predictive models will help improve the understanding of the association between conditioning capacities and functional mobility applying the LRI.

EFFECTS OF REALLOCATION OF TIME SPENT IN PHYSICAL ACTIVITY ON SARCOPENIA RISK IN OLDER ADULTS: DOES TYPE OF PHYSICAL ACTIVITY MATTER?

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INTRODUCTION:
Reallocating time spent in sedentary behaviours for physical activity (PA) of different intensities may have a beneficial effect on sarcopenia risk in older adults. However, the optimal PA intensity threshold associated with lower sarcopenia risk (SRS) in older adults remains elusive. Whether the type of PA (muscle strengthening activities, MSA) has an influence on the relationship between time spent in PA of different intensities SRS remains to be determined. The aim of the present cross-sectional study was to investigate the relationship between objectively assed PA behaviours and sarcopenia risk in older adults by using an isotemporal approach and taking in account engagement in MSA.
METHODS:
A total of 235 community-dwelling older men and women (65–70 years) were included in the study. A continuous sex-specific clustered sarcopenia risk score (SRS) was created based on (a) muscle mass, assessed by using bioelectrical impedance analysis, (b) five times sit-to-stand (5-STS) and (c) handgrip strength, assessed using Jamar dynamometer. Times spent in sedentary, light intensity PA (LPA) and moderate-to-vigorous intensity PA (MVPA) were objectively assessed by the Actigraph GT3x accelerometer and adherence to guidelines on MSA (two sessions per week) was retrieved based on the EPAQ2 questionnaire. All analyses were adjusted by the following covariates: adherence to guidelines for protein intake, waist circumference, medication and tobacco use.
RESULTS:
Replacing 10-minute periods of daily sedentary time by either LPA or MVPA was significantly related to a lower SRS and its components. Similarly, beneficial impacts on SRS were observed when replacing 10-minute periods of LPA with MVPA. These findings were evident after further adjustment by covariates. Interestingly, after stratification by adherence to guidelines on MSA, displacement of time spent in different PA intensities was beneficial for SRS and its components only in participants who failed to reach the MSA guideline.
CONCLUSION:
The effect of displacing sedentary time bouts for higher intensity PA on SRS and its components in older adults is moderated by the type of PA performed. This supports current guidelines on PA for adults highlighting the importance of MSA alongside reducing sedentariness in favour of increased time in MVPA.

OP-PN01 Physiology Endurance

PLACEBO EFFECTS ON ENDURANCE PERFORMANCE – A CROSSOVER STUDY

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INTRODUCTION:
Placebo effects (i.e., effects attributable to person's expectations to a treatment or substance [1]) can influence sports performance [2]. Large effect sizes connected to placebo were reported, when substances with a high perceived ergogenic effect (e.g., anabolic steroids,

erythropoietin) were used [3]. In a pilot study, we found large video-clip-induced placebo effects on endurance performance when using a non-ergogenic substance (water) [4]. However, the pilot study contained a between-subject design, observers were not blinded, and no control video clip was used potentially introducing interindividual differences and observer bias. Therefore, the aim of the present study was to study placebo effects connected to water intake on endurance performance overcoming the limitations of the pilot study.
METHODS:
Using a within-subject crossover design with randomized starting order, 48 healthy, moderately trained students (age: 22.6±2.9 years, female: 56.3%) were exposed to an expectancy modification condition (EC) and a control condition (CC). Maximal oxygen uptake was assessed in a baseline spiroergometry (females: 40.1±5.0, males: 49.5±5.9 ml/kg/min). Endurance performance was tested on the two conditions each using a time trial to exhaustion with 110% of baseline performance. EC consisted of a one-minute expectancy modification video clip affirming that the following water intake (2x200ml) will support the participants in showing their best performance. The belief to show the best performance was assessed by questionnaire. A neutral one-minute video clip was shown in the CC. Observers were blinded regarding the video clips. A 2 x 2 mixed ANOVA was used to analyze sequence group differences (EC-CC, CC-EC) over time (1st, 2nd test).
RESULTS:
No significant time-by-sequence group interaction emerged for time to exhaustion, $F(1, 46) = 2.07$, $p = .157$, $d = 0.42$. For the first test, time to exhaustion was not significantly different between EC (59.2±18.2 s) compared to CC (52.2±14.5 s), $t(46) = 1.46$, $p = .152$, $d = 0.43$. No significant time-by-sequence group interaction was found for the belief to show the best performance, $F(1, 46) = 1.70$, $p = .199$, $d = 0.39$. No significant sex differences were observed.
CONCLUSION:
The present findings contrast with our previous findings [4] and suggest that placebo effects might partially be attributed to interindividual differences, observer bias, and/or the lack of a control video clip. Although the non-significant effect size at the first test is in the range of previous findings [3], we furthermore cautiously conclude that the different wording in the otherwise identical short video clips did not create enough contrast between conditions to generate sufficiently large placebo effects in endurance performance or belief to show the best performance.
1. Turner et al. (1984) 2. Hurst et al. (2019) 3. Hurst et al. (2020) 4. Niedermeier et al. (2020)

EFFECTS OF THE MENSTRUAL CYCLE ON SERUM IRON MARKERS IN ENDURANCE-TRAINED WOMEN

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INTRODUCTION:
Higher iron intake is recommended due to the erythropoietic drive caused by regular exercise and iron loss through menstrual bleeding [1]. Consequently, athletes´ iron status should be frequently monitored in order to address any disturbance and properly addressed in case of deficiency [2]. In non-athletic premenopausal women, significant variations in serum iron markers have been found throughout the menstrual cycle, which may confound de interpretation of these markers [3]. However, data are scarce in athletic population. Thus, the aim of this study was to compare serum iron-related parameters throughout the menstrual cycle in a cohort of endurance-trained women.
METHODS:
Thirty-six endurance-trained eumenorrheic women (33.5±5.4 yrs; 57.84±7.3 kg; 163.4±6.1 cm;
VO2max: 49.4±4.2 ml/kg/min) were analyzed. Resting blood samples were taken to analyze serum iron markers (iron, transferrin, transferrin saturation (TS) and ferritin) in three different menstrual cycle phases: early follicular phase (EFP), mid-late follicular phase (MLFP) and mid-luteal phase (MLP). Sex hormones verification was carried out to confirm menstrual cycle phase. ANOVA for repeated measures was conducted to explore differences among menstrual cycle phases.
RESULTS:
Lower values of TS were observed during the EFP (13.50±1.18 %) compared to the MLFP (19.81±1.60 %; $p<0.001$) and the MLP (19.13±1.84 %; $p=0.014$). Likewise, serum iron was lower during the EFP (53.86±4.57 µg/dl) compared to the MLFP (78.22±5.92 µg/dl; $p=0.001$) and the MLP (76.25±7.20 µg/dl; $p=0.016$). Nevertheless, ferritin (EFP=30.71±3.12 ng/ml; MLFP=34.67±3.86 ng/ml; MLP=32.87±3.84 ng/ml) and transferrin (EFP=288.94±5.78 mg/ml; MLFP=287.69±6.07 mg/ml; MLP=288.67±6.11 mg/ml) showed no differences throughout the menstrual cycle ($p>0.05$).
CONCLUSION:
The menstrual cycle disturbs TS and plasma iron availability, which may confound the diagnosis of iron disorders, such as iron deficiency, in endurance-trained eumenorrheic women. Specifically, the large drop in both variables during the EFP could compromise the adequate iron supply for the heightened erythropoietic activity usually exhibited by athletic population. Finally, the diagnosis of iron stores measured by serum ferritin appears to be stable throughout the menstrual cycle.
Funding: DEP2016-75387-P
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EFFECTS OF HIGH-INTENSITY TRAINING ON VO2MAX OF ELITE ATHLETES. A META-ANALYSIS ON RANDOMIZED CONTROLLED TRIALS.

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INTRODUCTION:
High-intensity interval training (HIT) is one of the most effective means to improve maximum oxygen uptake (VO2max) (Helgerud et al. 2007), which is deemed the main success factor in aerobic endurance sports (Saltin 1990). However, a meta-regression on non-athletic males has indicated that adaptive effects of HIT on VO2max favor the less fit (Weston et al. 2014), and we hypothesized, even more, dete-

riorated HIT responses in highly endurance-trained athletes. Here, we synthesized research within this cohort to get a summary effect and the dispersion of HIT on VO2max. Such insights are vital for practitioners, coaches, and athletes.
METHODS:
The study was submitted to PROSPERO for pre-registration and followed the PRISMA guidelines. PubMed, Scopus, SPORTDiscus, Web of Science, and references of original research were scanned for relevant peer-reviewed studies. Inclusion criteria involved randomized controlled trials of classical endurance-trained or elite athletes with a baseline VO2max value ≥60 ml·min−1·kg−1 for men and ≥ 55 ml·min−1·kg−1 for women. Training interventions had to last at least 1 week, with ≥5 sessions and ≥1 session per week. Aerobic or anaerobic HIT was was classified with intensities of ≥90% of the individual maximum heart rate and VO2max, or maximal to supramaximal intervals of 2-90 s. We used a random-effects model on the standardized mean differences (Hedges' g). The dispersion was valued via Q statistics, I^2 statistics, and the prediction interval. Effect sizes were set small for g>0.2, medium for g>0.5, and large for g>0.8 (Cohen, 1988).
RESULTS:
Ten articles with a study design of 6 to 16 HIT sessions met the inclusion criteria. HIT resulted in a large increase in VO2max when compared with the control conditions (p<.001, g=0.88, 95% confidence intervals ±0.37). Interestingly, the effects of the HIT interventions were similar across studies (Q=9.27, df=9, p=.412), and variations were mainly attributed to random sampling error rather than true differences in the effect sizes (I^2=2.99%). The 95% prediction interval was 0.52 to 1.25, meaning that the impact of the HIT is expected to be moderate in roughly 40% and large in roughly 60% of the elite athletes.
CONCLUSION:
Contrary to our hypothesis, highly endurance-trained or elite level athletes with notably high VO2max benefited similarly from HIT sessions than non-athletes or sedentary adult females and males (e.g., Westen et al. 2014; Sloth et al. 2013).
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OP-PN02 Cardiovascular

CHANGES OF CARDIAC BIOMARKERS AND IMPACT FACTORS AFTER REPEATED ENDURANCE EXERCISES IN MARATHON RUNNERS

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INTRODUCTION:
Endurance athletes often engage in repeated endurance trainings or competitions within one to two weeks. The changes of cardiac biomarkers after repeated endurance exercises, related impact factors, and clinical significance remained unclear. This study aimed to observe the changes of cardiac biomarkers and impact factors, blood volume (BV), renal and inflammation biomarkers before and after two acute endurance exercises to explore potential clinical significance.
METHODS:
Ten marathon runners (age: 27.5±4.7 y, height: 171.0±5.7 cm, weight: 62.1±7.3 kg, VO2max: 59.8± 8.0 ml /kg/min, training years: 9.4±5.3 y) completed two endurance exercises separated one week (exe1, exe2; 95% individual ventilation threshold; running velocity, 13.2±1.6 km/h; duration, 90 min; distance, 19.8±2.4 km). There was no significant difference in heart rate (exe1, exe2:156.4±16.2, 156.4±7.7 beat/min, P=0.99) between the two exercises. BV was measured and venous blood was collected before, 4 and 28 h after exercises, respectively. High-sensitive cardiac troponin I (hs-cTnI), high-sensitive cardiac troponin T (hs-cTnT), Galactin-3, Suppression of Tumorigenicity 2 (sST-2), kidney injury molecule 1 (KIM-1), neutropil gelatinase associated lipocalin (NGAL), Cystatin C (Cys C), high-sensitive C-reactive Protein (hs-CRP) and interleukin-6 (IL-6) were measured.
RESULTS:
Serum hs-cTnI level was significantly increased 4 h after exe1, and returned to baseline 28 h after (pre, post-4 h, post-28 h: 2.9±3.3, 10.3±9.3, 4.7±8.3 ng/L, P<0.01). as well as after exe2 (3.8±3.2, 6.0±4.8, 3.0±3.1 ng/L, P<0.01). There was no between-group effect at the corresponding time points of exe1 and exe2. Serum hs-cTnT level was significantly increased 4 h after acute endurance exercise, and returned to quiet level 28 h after acute endurance exercise (6.4±4.9, 17.2±12.4, 6.1±3.0 ng/L, P<0.01). It was significantly increased at 4 h after exe2 (8.9±9.3, 13.5±9.1, 5.8±2.7 ng/L, P<0.01). There was no inter-group effect at the corresponding time points of exe1 and exe2.
Cardiac fibrosis biomarkers: serum galectin-3 level was significantly increased 4 h after exe1, and returned baseline 28 h after (8.2±2.3, 10.0±2.4, 8.0±2.2 ng/mL, P<0.05). There was no significant change after exe2. There was no between-group effect at the corresponding time points of exe1 and exe2. Serum sST-2 level was significantly increased 4 h after exe1, but did not return to baseline at 28 h (20.3±7.6, 26.5±7.7, 22.5±6.9 ng/mL, P<0.01). It was significantly increased at 4 h after exe2, and returned to the baseline at 28 h (22.8±9.3, 28.4±9.7, 24.0±7.2 ng/mL, P<0.05). There was no between-group effect at the corresponding time points of exe1 and exe2.
There was no significant difference in BV between exe1 and exe 2.
Renal function biomarkers: Serum NGAL level was significantly decreased 28 h after exe1 (pre, post-28 h: 89.6±38.0, 70.8±27.5 ng/mL, P<0.05). There was no between-group effect at the corresponding time points of exe1 and exe2.
Inflammatory biomarkers: serum hs-CRP level was significantly decreased 28 h after exe1 (pre, post-28 h: 0.1±1.2, 1.6±1.8 mg/L, P<0.01). There was no between-group effect at the corresponding time points of exe1 and exe2. Serum IL-6 level was significantly decreased at 4 h and 28 h after acute endurance exercise (pre, post-4 h, post-28 h: 11.4±16.7, 1.4±1.5, 0.8±0.8 ng/L, P<0.05). The changes were similar after exe2 (46.9±87.1, 3.0±4.1, 8.1±14.5 ng/L, P<0.01). There was no between-group effect at the corresponding time points of exe1 and exe 2.
CONCLUSION:

No differences between repeated endurance exercises in cardiac biomarkers; changes of BV, renal function and inflammatory status were not found to affect the changes of cardiac biomarkers.

EFFECT OF INCREASED CALF VENOUS COMPLIANCE WITH WEARING GRADUATED COMPRESSION STOCKING ON VENOUS RETURN FROM CALF AND STROKE VOLUME DURING EXERCISE

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INTRODUCTION:
Exercise training causes the increased calf venous compliance. However, it is unknown whether the increased venous compliance effects on the circulatory responses to exercise. Venous return from the calf to the heart during exercise is increased by muscle pump, which depends on the force of muscular contraction and the amount of blood within venous vessels (Barendsen and van dem Berg. 1984; Folkow et al. 1970). Based on this, we hypothesized that the increased venous compliance could cause the increase in venous return from calf during exercise, and secondary could enhance stroke volume (SV). Because exercise training causes not only adaptation of venous compliance but also various cardiovascular systems (e.g. the heart and artery circulation), it is too difficult to clarify the effect of increased venous compliance per se on circulatory responses to exercise in the experimental model using exercise training. On the other hand, it is reported that wearing graduated compression stocking (GCS) caused only the increased calf venous compliance (Hayata et al. 2006). Thus, in order to test our hypothesis, we investigated the effect of increased calf venous compliance with wearing GCS on the venous return from the calf and SV during exercise.
METHODS:
Eleven healthy young volunteers (8 men, 3 women; age, 23 ± 1 years; height, 168.2 ± 7.8 cm; weigh, 62.4 ± 11.5 kg) participated in this study. First, we confirmed that wearing GCS increased the calf venous compliance. Next, under condition of wearing GCS or no stocking (CON), subjects rested in supine position, and then stood up and performed tiptoe exercise. Change in volume in the calf by using strain-gauge-plethysmography and SV were measured through this protocol. From the change in volume in the calf, the amount of venous volume (VV) during standing position from supine and the ejection volume (EV) during tiptoe exercise were calculated (Stewart et al. 2004). EV was used the index of venous return from the calf.
RESULTS:
Calf venous compliance was greater in GCS than CON ($P < 0.05$). VV was also higher in GCS than CON ($P < 0.05$), but EV did not differ between GCS and CON. In addition, the change in SV during tiptoe exercise was similar between GCS and CON.
CONCLUSION:
These results suggested that the increased venous compliance with wearing GCS could not influence on the venous return from the calf and SV during tiptoe exercise in healthy young adults.
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LIMITS OF LINEAR KINETICS MODELS FOR HEART RATE AND OXYGEN UPTAKE

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INTRODUCTION:
Heart rate (HR) and respiratory oxygen uptake (V'O2) kinetics are typically described by dynamical linear models. By pseudo-random binary sequences (PRBS) of work rate (WR) changes a description without explicit models, such as exponential models, is possible. The aim of this study was to investigate the limits to predict steady states and incremental WR responses from PRBS testing.
METHODS:
13 subjects performed a complex exercise protocol which comprises a section with 5 min constant WR at 30 W and 80 W, 10 min PRBS WR changes between 30 W and 8 0W and an incremental WR increase (INC, 25 W per min). From the PRBS part HR and V'O2 dynamic characteristics as impulse response, slope and offset were determined via time-series analysis. By mathematical convolution, a prediction for HR and V'O2 were calculated for the complete exercise protocol. The predictions for steady states at 30 W and 80 W and the individual correlations for the PRBS interval and the incremental part from 80 W to 175 W were calculated. Residuals between measured and predicted data were determined.
RESULTS:
An average correlation coefficient between measured HR and V'O2 and the respective prediction were 0.64±0.12 (HR) / 0.62±0.09 (V'O2) for the PRBS and 0.91±0.09 / 0.82±0.07 for INC. Measured and predicted steady states for HR at 30 W (91±11 bpm versus 95±13 bpm; +4% difference) and at 80 W (120±16 bpm; 115±15 bpm; -4%) differed significantly. Similar but not significant differences were found for V'O2 (30 W: 0.71±0.07 L min-1, 0.73±0.07 L min-1; 4% / 80 W: 1.18±0.08 L min-1, 1.17±0.09 L min-1; 1%). Residuals showed relatively constant deviations for HR but increasing differences (= measured - prediction) with increasing V'O2.
CONCLUSION:
Although indications for deviations from dynamic linearity were found, it is possible to predict steady states from PRBS data within a range of ±4%. The predictability for HR was better than for V'O2. This study showed that PRBS testing allows a characterization of HR and V'O2 kinetics and a limited prediction beyond the PRBS range. In the next step this idea should be tested in field situations to optimize endurance training.

WOMEN WITH HYPERTENSION WHO ARE ENGAGED IN NON-MANUAL OCCUPATIONS BENEFIT MORE FROM EXERCISE THERAPY: A LONGITUDINAL STUDY

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INTRODUCTION:
Hypertension is an important chronic metabolic disorder that is proven to have a strong association with obesity. At present, some guidelines recommend exercise therapy in addition to pharmacological treatment to address this non-communicable disease. Women are more affected by age and obesity-related factors than are men, thus there is a greater need for acquired interventions and precise exercise instruction for the former. Herein, 40–59-year-old women with essential hypertension were studied to investigate and analyze the differences in the effects of exercise in patients with different occupations.
METHODS:
Middle-aged and elderly women aged 40-59 years with hypertension from five communities in Jinan and Yantai, Shandong Province, were randomly selected and divided into a manual labor group (ML group, n = 89) and a non-manual labor group (NML group, n = 175) according to whether their occupations required physical labor. Following a 12-month exercise intervention (brisk walking, running, ball games, etc.), their body weight, chest, waist, and abdomen circumferences, and thickness of the skin folds of the upper arms, abdomen, and scapula were measured.
Analysis of the data set was performed using SPSS 26.0 statistical software, and α values of 0.1 and 0.05 indicated moderately significant and significant differences respectively.
RESULTS:
There were no significant differences in body weight and circumference in the ML group ($p = 0.33$ and 0.73). There was a slight reduction in the mean values of the upper arm and scapular skinfold thickness, but it was not statistically significant. Compared to the baseline value, there was a reduction in the mean abdominal skinfold thickness by 2.51 mm after the intervention, which was statistically significant ($p = 0.02$).
Weight, body circumference, and skinfold thickness decreased in the NML group; statistically significant differences were seen in weight and abdominal skinfold thickness before and after the intervention ($p < 0.1$). Statistically significant differences in chest circumference and upper arm skinfold thickness ($p < 0.05$) were also observed, with a mean reduction of 1.76 cm in chest circumference and 0.86 mm in upper arm skinfold thickness after the intervention, compared to the before intervention values.
CONCLUSION:
Among middle-aged and elderly women with hypertension in the community, those in the NML group had better exercise intervention results than did those in the ML group. The NML group showed varying degrees of benefit in terms of weight, body circumference, and skinfold thickness, whereas the ML group showed a greater reduction in abdominal fat. The rewards and benefits of exercise therapy were more cost-effective for middle-aged and elderly women with hypertension who were engaged in non-manual work than for those who were involved in manual work.

AEROBIC EXERCISE IMPROVE THE CEREBRAL ARTERIAL FUNCTION VIA PKCA/LTCC PATHWAY IN HYPERTENSIVE RATS

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INTRODUCTION:
The enhancement of protein kinase Cα (PKCα)/L-type voltage-gated Ca2+ channels (LTCC) pathway is the main cause of vascular dysfunction in hypertension. A-kinase anchoring protein AKAP150, facilitating transduction events by binding PKCα to specific cellular microdomains, plays a central role in ion channel remodeling in vascular during hypertension. Aerobic exercise is an effective nonpharmacological therapy for preventing and controlling hypertension, but the underlying mechanism is unclear. Therefore, this study aimed to explore the role of PKCα/LTCC pathway in aerobic exercise-induced improvement of cerebral arterial function in hypertension.
METHODS:
Twelve-week-old male spontaneously hypertensive rats (SHR) and Wistar-Kyoto (WKY) rats were randomly assigned to sedentary (WKY-C, SHR-C) and exercise training (WKY-E, SHR-E) groups. Exercise groups were performed a moderate-intensity treadmill running for 12 weeks (exercise protocol: 18~20 m/min, ~55-65% VO2max, 60 min/d, 5 d/week, 0 grade). After the intervention, artery contraction myography, patch-clamp electrophysiology and immunofluorescence were used to detect the cerebral vascular tone, LTCC currents, the colocalization of AKAP150, PKCα and α1C subunit in cerebral arterial myocytes.
RESULTS:
The sensitivity of cerebral arteries to LTCC inhibitor nifedipine was significantly up-regulated in SHR-C, while down-regulated in SHR-E (pIC50: 8.58±0.13 vs. 7.07±0.04, $P<0.05$). The current density of LTCC was significantly lower in SHR-E than those in SHR-C (-13.2±1.7 vs. -9.6±1.5 pA/pF, $P<0.05$). The opening probability (nPo) of LTCC was significantly up-regulated in SHR-C, while down-regulated in SHR-E (0.121±0.012 vs. 0.077 ±0.008, $P<0.05$). PKCα specific inhibitor G?6976 effectively inhibited the whole cell current of LTCC, the inhibitory rate in SHR-E (~38%) was significantly lower than those in SHR-C (~48%), $P<0.05$. PKCα agonist PDBu significantly increased the LTCC single-channel current ($P<0.05$), the increase multiples on WKY-C, SHR-C and SHR-E groups are 1.5 times, 3.8 times and 1.8 times. The plasma membrane-localized AKAP150 and sarcolemma PKCα translocation were significantly reduced in SHR-E compared with SHR-C. The colocalization rate of PKCα and α1C subunit in cerebral arterial myocytes from SHR-C was up-regulated (~22%); however, it was down-regulated in SHR-E (~10%), $P<0.05$. The sarcolemma colocalization rate of AKAP150 and PKCα in cerebral arterial myocytes from SHR-C was enhanced; while reduced from SHR-E (20.1±1.1% vs. 30.0±1.6%; $P<0.05$).
CONCLUSION:
Aerobic exercise can improve the cerebral arterial function by inhibiting the upregulation of PKCα/LTCC pathway on the vascular smooth muscle of cerebral artery during hypertension. In this process, AKAP150 may play an important role.
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EXERCISE-BASED CARDIAC REHABILITATION: SECONDARY DATA ANALYSES OF 54,163 CHD PATIENTS ON MORTALITY AND WORKING CAPACITY 2010-2017

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INTRODUCTION:
Coronary heart disease (CHD) or ischemic heart disease is the second leading cause of DALYs worldwide [1]. In Germany, CHD shows a lifetime prevalence of 6.4% in women and 12.3% in men [2]. In 2019 CHD led to 838,000 hospital admissions in Germany. Further, CHD leads to higher morbidity, reduced physical capacity, and premature mortality. Physical activity, exercise and sports therapy are core components of cardiac rehabilitation and recommended in national and international rehabilitation guidelines [3]. The aim of this study is to evaluate the effectiveness of outpatient exercise-based rehabilitation in rehabilitation phase III on mortality and working capacity in CHD patients.
METHODS:
The analyses used claims data of the German pension fund from 2010-2017. Overall, 54,163 patients with coronary heart disease (I20.-I25.) were included in the analyses and followed up for outpatient exercise-based cardiac rehabilitation (phase III). Patients were categorized according to participation duration (long: >90 days, short: <90 days, non-participation). Effectiveness of exercise-based rehabilitation was analyzed by calculating adjusted hazard ratios for mortality and reduced working capacity related to program participation.
RESULTS:
Of all CHD patients, 57.6% received a medical recommendation for exercise-based rehabilitation phase III, and 16.8% actually participated. 1776 (3.3%) persons died during the study period and 3050 (5.5%) received reduced earning capacity pension. Mortality risk was higher for non-participation in exercise-based cardiac rehabilitation compared to long participation HR 1.97 (95% CI, 1.60-2.43). Risk for reduction in working capacity was higher for non-participation compared to short participation HR 1.24 (95% CI, 1.00-1.54).
CONCLUSION:
Exercise-based cardiac rehabilitation phase III may reduce mortality and maintain working capacity. Analyses of claims data are a promising approach to evaluate existing programs and to improve exercise-based interventions in health care service.
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VALIDITY AND RELIABILITY OF A NOVEL NON-EXERCISE METHOD FOR ASSESSMENT OF MAXIMAL OXYGEN CONSUMPTION USING SEISMOCARDIOGRAPHY

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INTRODUCTION:
Maximal oxygen consumption (V̇O2max) is a fundamental parameter to evaluate training and performance and is very strongly related to metabolic health and longevity. The golden standard method for determining V̇O2max is an incremental exercise test performed to voluntary exhaustion with indirect calorimetry measurements. However, this methodology is physically demanding, time consuming and requires expensive equipment. A novel non-exercise method based on seismocardiography (SCG) has been shown to correlate with V̇O2max ($r=0.80$, $p<0.001$). However, the validity and reliability of this method remain to be examined. Therefore, the aim was to investigate the accuracy and precision of the non-exercise method of V̇O2max assessment using SCG.
METHODS:
On three separate days within 14 days healthy men (n=10) and women (n=10) with varying age (22-72 years) and training status underwent two tests for determination of V̇O2max in the following order; a non-exercise test using SCG (SCG V̇O2max) and a graded exercise test to voluntary exhaustion on a cycle ergometer using indirect calorimetry (IC V̇O2max). These tests were performed to examine the day-to-day reliability and the validity of SCG V̇O2max. Furthermore, SCG V̇O2max was assessed twice on each test day to investigate test-retest reliability. The SCG V̇O2max was performed in the prone position following a short resting period by placement of the SCG recording device on the lower part of sternum with double adhesive tape. V̇O2max was assessed during a 5-minute recording of the sternal movement using SCG in combination with demographic data of the participants. In addition, body composition was measured and a resting blood sample collected each test day.
RESULTS:
On average SCG V̇O2max was 3.3 ± 2.4 ml/min/kg (mean ± 95% CI) lower than IC V̇O2max (Two-way ANOVA RM: $p=0.013$, SCG V̇O2max: 36.6 ± 3.3 ml/min/kg, IC V̇O2max: 39.9 ± 3.0 ml/min/kg). A positive correlation was found between SCG V̇O2max and IC V̇O2max (Pearson, $r=0.72$, $p<0.001$). Both SCG V̇O2max and IC V̇O2max was similar between test days ($p=0.972$) and the intra-individual coefficient of variation (CV) was 4.5 ± 2.9% and 4.0 ± 2.5%, respectively. CV was 0.6 ± 0.1% for weight and 2.3 ± 0.7% for haemoglobin between test days. Within each test day no difference was observed between SCG V̇O2max tests ($p=0.993$) and mean values of the tests were highly correlated ($r=0.99$, $p<0.0001$).
CONCLUSION:
The accuracy of the non-exercise method of V̇O2max assessment using SCG is not optimal, as V̇O2max was systematically lower than the golden standard measurement with indirect calorimetry. Despite the difference, SCG V̇O2max and IC V̇O2max were highly correlated and the precision of SCG V̇O2max was very high as both day-to-day and test-retest reliability were high. Further optimization of the SCG V̇O2max method is needed together with studies assessing sensitivity to longitudinal changes in training status to improve applicability and accuracy of the SCG method for determination of V̇O2max.

ASSOCIATIONS OF FEMALE SEX HORMONES AND HORMONAL STATUS WITH ARTERIAL STIFFNESS IN FEMALE SAMPLE FROM REPRODUCTIVE YEARS TO MENOPAUSE

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INTRODUCTION:
The role of female sex hormones in arterial stiffening is unclear. We investigated associations of estradiol (E2), progesterone (P4), and follicle-stimulating hormone (FSH) with arterial stiffness in 19–58-years-old healthy women. We also studied associations of menstrual cycle, combined oral contraceptive (COC) cycle and menopausal status with arterial stiffness.
METHODS:
Data is from Endogenous and exogenous hormones and performance in women (MEndEx) and Estrogen and microRNAs as modulators of women's metabolism (EsmiRs) studies. MEndEx included 26 healthy 19–37-yrs-old women, of which 16 had natural menstrual cycle (NAT) and 10 were COC-users. EsmiRs included 39 healthy 52–58-yrs-old women (MENO), of which 5 were perimenopausal and 26 postmenopausal non-hormone therapy (HT)-users and 8 were postmenopausal HT-users. Measurements were done at 4 menstrual/pill cycle timepoints for NAT and COC groups, and at 2 lab-visits for MENO group. Aortic pulse wave velocity (PWVao, m/s) and augmentation index (AIx, %) were assessed from upper arm using Arteriograph (TensioMed Ltd) in the supine position after 10 min rest. Body composition was assessed by InBodyTM720. In MEndEx peak oxygen uptake (V̇O2PEAK) was determined using a standard treadmill test, while EsmiRs used an incremental bicycle ergometer test. Serum E2, P4 and FSH levels were determined with IMMULITE 2000 XPi (Siemens). Generalized estimating equation models were constructed to investigate associations of hormones among all participants, and menstrual cycle (NAT), pill cycle (COC) or menopausal status (MENO) within each group, with PWVao and AIx. Results from models adjusted for relative fitness level (VO2PEAK/fat free mass), body size (height, fat mass) and age are reported.
RESULTS:
Age, but not E2, P4 or FSH, was associated with PWVao (in E2 and P4 models B=0.09, p<0.001, in FSH model: B=0.05, p=0.2) and AIx (in E2 and P4 models: B=0.85, p<0.001; in FSH model: B=0.72, p<0.001). Menstrual cycle was associated with AIx and pill cycle with PWVao. AIx was higher during late follicular (B=2.68, p=0.023), ovulation (B=5.51, p<0.001) and luteal (B=3.22, p=0.043) stages compared to early follicular stage (menstruation). PWVao was lower during first (B=-0.78, p=0.002) and second (B=-0.28, p=0.046) week of active pill compared to the withdrawal bleeding days with placebo pill. Menopausal status was not associated with arterial stiffness.
CONCLUSION:
Age-related differences in arterial stiffness attributes are not explained by differences in female sex hormones. Menopausal women's arterial stiffness was not affected by HT use or lack thereof compared to perimenopausal non-users. In contrast, both menstrual and COC-pill cycle differentially associated with arterial stiffness, which may be indicative of menstrual hormone surges affecting arterial elasticity. However, we did not find sex hormones to be directly associated with arterial stiffness among all participants. Thus understanding the role of sex hormones needs further studies.

PERFORMING A VERIFICATION-PHASE TEST AFTER AN INCREMENTAL RAMP TEST HAS LIMITED ADDITIONAL VALUE

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INTRODUCTION:
VO2max is the gross criterion for cardiorespiratory fitness and achieved when a distinct plateau of VO2 uptake to work rate relationship is present at the termination of the test. Despite performing the test with maximum effort, about half of the participants do not show a VO2-plateau. Hence, performing a subsequent verification test (VER-T) at a higher intensity than the peak power output (PPO) reached during the incremental test is discussed as a method to verify VO2max. The aims of this study were: 1) to investigate the reliability (i.e. day-to-day variation) of VER-T, 2) to quantify the robustness to diurnal variations of VER, and 3) to determine the additional value of performing VER-T as compared to only determining VO2-plateaus.
METHODS:
Eighteen (11 males) exercise trained adults performed cardiorespiratory fitness tests at 7:00, 10:00, 13:00, 16:00, 19:00, and 21:00 in a randomized sequence and separated by at least 27 hours to assess the diurnal variation. To assess the day-to-day variation a seventh test was performed 24 hours after the sixth test. Each test consisted of an incremental phase with an increase of 25/20 W/min (males/females) followed by a 10-minute regeneration phase, 2-min at 50% of PPO, 1-min at 70% PPO, and 105% of PPO until exhaustion (i.e. VER-T). VO2-plateau was accepted if delta-VO2 between the oxygen uptake in the last 25 W and the second-to-last 25 W of the incremental phase was < 125 mL. Gwet's agreement coefficient (AC1) was used to quantify the reliability.
RESULTS:
Participants mean age and VO2peak were 28 ± 5 years and 56 ± 8 mL/kg/min, respectively. The VO2-plateau method showed Gwet's AC1 values (95% confidence intervals) for the day-to-day and diurnal variations of 0.64 (0.22, 1.00) and 0.71 (0.42, 0.99). The respective values for VER-T were 0.69 (0.31, 1.00) and 0.07 (−0.38, 0.52), respectively. In 66% of the tests, performing VER-T added no value, because either a VO2-plateau was already present during the incremental phase or VO2 reached during the verification phase was considerably lower (3%) as compared to the VO2 during the incremental phase. In 32% the VER-T added uncertain value and in only 2% it added certain value. Certain added value was defined as no VO2-plateau present and verification-VO2 > 103% indicating that the verification-phase was able to disprove low VO2max.
CONCLUSION:
VO2-plateau and verification tests both show acceptable reliability between days. However, verification tests show low robustness against diurnal variations. This is a disadvantage because exercise tests are frequently carried out at different times of the day. In addition, the fact that in only 2% of cases performing a verification test adds certain value suggests that the use of the applied protocol of the present study should be omitted considering the low cost-benefit ratio.

ACCOUNTING FOR INDIVIDUAL CHARACTERISTICS MAKES THE %HRR-%V̇O2R RELATIONSHIP NEITHER 1:1 NOR MORE ACCURATE

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INTRODUCTION:
The actual association, during incremental exercise, between the percentages of heart rate reserve (HRR) and oxygen uptake reserve (V̇O2R), and how several factors may affect that association are under debate (1). The aim of this study was to assess if considering individual characteristics can make the relationship between %HRR and %V̇O2R either 1:1 or more accurate.
METHODS:
Cycle ergometer data of the maximal incremental exercise tests performed by 450 healthy and sedentary participants (17 to 66 years) of the HERITAGE Family Study (2), grouped for sex, ethnicity, age, body fat, resting HR, and V̇O2max, were used to calculate the individual linear regressions (ILR) between %HRR and %V̇O2R. The mean slope and intercept of the ILRs of each group were compared with 1 and 0 (i.e., identity line), respectively, using Hotelling tests followed by post-hoc one-sample t-tests. Two multiple linear regressions (MLR) were also performed, using either the slopes or intercepts of the ILRs as dependent variables, and gender, age, resting heart rate, and maximal oxygen uptake as independent variables. α was set to 0.05 and was adjusted using the false discovered rate procedure.
RESULTS:
The mean %HRR-%V̇O2R relationships of all groups differed from the identity line. Moreover, ILR intercepts (8.872±16.036) and slopes (0.971±0.190) changed ($p<0.001$) after 20 weeks of aerobic training (13.076±11.090 and 0.891±0.122, respectively). The MLRs were able to significantly predict ILRs' intercepts ($F=5.82$, $p<0.001$) but not slopes ($F=1.89$, $p=0.131$). However, the MLRs could explain only 3.8% and 1.3% of the variance in the intercepts and slopes whose variability remained high (standard error of estimate = 15.784 and 0.189, respectively).
CONCLUSION:
The %HRR-%V̇O2R relationship differs from the identity line and due to the high interindividual variability, the use of a single equation for the whole population does not appear to be suitable for representing the %HRR-%V̇O2R relationship of a given subject, even when several individual characteristics are accounted for. Therefore, using individual relationships may be preferable when prescribing the intensity of aerobic exercise. Moreover, since aerobic training also affects the association between %HRR and %V̇O2R, this study highlights the need of assessing individuals' %HRR-%V̇O2R relationships periodically.
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A TWO-HOUR NIGHTTIME NAP SUPPRESSES SLEEP DEPRIVATION-INCREASED BLOOD PRESSURE DURING PASSIVE AND VOLUNTARY ELBOW EXTENSION-FLEXION EXERCISES

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INTRODUCTION:
Evidence indicates that shift work-induced sleep deprivation (SD) is associated with an increased risk of adverse cardiovascular events. An exaggerated blood pressure (BP) response to physical activity is known to increase the risk for adverse cardiovascular events. However, evidence supporting the association between SD and BP response to exercise has remained sparse and inconclusive. In addition, it has been shown that nighttime naps attenuated the blunted BP-dipping evoked by nighttime shift work. Thus, we investigated whether SD increases BP responses to an elbow extension-flexion exercise. We also aimed to determine the effects of a nighttime nap on SD-induced changes in BP during rest and the elbow extension-flexion exercise.
METHODS:
Study participants included six healthy men (21.0 ± 1.5 years, 170.7 ± 5.4 cm, 67.0 ± 8.8 kg). All participants provided written consent after being informed of the experimental protocol and possible risks in this study. The ethical approval for the present study was provided by the Ethical Committee of Chubu University (Approval No. 20200063-2). Measurements were performed three times; after normal sleep (control trial), after 24-h SD with a nap for 2 h at 2:00-4:00 AM (SD+NAP trial), and after 24-h SD without a nap (SD trial). After a 10-min baseline rest, a passive elbow extension-flexion movement (PEX) followed by a voluntary elbow extension-flexion exercise (VEE) was conducted. The duration and frequency of both exercises were 1 min and 1 Hz, respectively. The PEX was designed to isolate the effect of the muscle mechanoreflex, while the VEE was performed with minimal effort. We continuously measured systolic and diastolic BP (SBP and DBP) during rest, PEX, and VEE, using a servo-controlled finger photoplethysmography. We also recorded the rate of perceived exertion (RPE) using the Borg scale to evaluate the volitional effort.
RESULTS:
SBP measurements during rest, PEX, and VEE in the SD trial were significantly higher than SBP measurements in the control trial (rest, 115.9 ± 6.7 vs 129.5 ± 9.4 mmHg; PEX, 128.3 ± 5.2 vs 142.1 ± 10.3 mmHg; VEE, 131.4 ± 4.6 vs 144.8 ± 13.0 mmHg; $P < 0.05$ for all three comparisons). DBP response to PEX was significantly augmented in the SD trial when compared to the control trial (Δ7.8 ± 3.4 vs Δ11.8 ± 3.5 mmHg, $P < 0.05$). Importantly, these significant increases in absolute BP levels during PEX and VEE and BP response to PEX were not observed in the SD+NAP trial ($P > 0.44$). RPE was not significantly different between any trials (control vs SD vs SD+NAP, 9.8 ± 2.6 vs 9.0 ± 2.8 vs 9.2 ± 2.6, respectively, $P = 0.37$).
CONCLUSION:
The present study demonstrated that 24-h SD up-regulated BP levels during PEX and VEE and augmented BP response to PEX, but that a 2-h nighttime nap suppressed the augmentation. The data suggests that naps during night work may be beneficial for reducing SD-evoked potentiation of cardiovascular risk during physical activity.

PATTERN OF THE HEART RATE PERFORMANCE CURVE IN SUBJECTS WITH BETA-BLOCKER TREATMENT AND AGE MATCHED HEALTHY INDIVIDUALS

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INTRODUCTION:
The heart rate performance curve (HRPC) in incremental cycle ergometer exercise was shown to have a diverse pattern such as a regular downward deflection, a linear or even inverted time course. These diverse patterns cause over- or underestimation of exercise intensity when prescribed as a fixed percentage of maximum heart rate (HRmax) (1). The variations in the pattern of the HRPC were prescribed to be mediated by β-adrenergic receptor sensitivity (2). As ß-blocker administration causes a competitive inhibition of these receptors, changes of the pattern are suggested in individuals receiving a ß-blocker. Therefore, the aim of the study was to investigate differences in the HRPC deflection patterns between adults with ß-blocker treatment and age-matched healthy controls.
METHODS:
Cycle ergometer exercise tests from 535 (102 female) individuals treated with ß-blocker (BB) were matched in a 1:1 fashion (C) (male 59±11yrs, female 61±11yrs). We detected a first and a second HR threshold (Th1 / Th2) by performing multiple linear regression analyses within two regions of interest (Th1: start to 66% Pmax; Th2: 40% Pmax to Pmax). HRPC´s were categorized based on the degree of the deflection (kHR) into regular (downward deflection, kHR>0.1) and non-regular (upward deflection or linear time course kHR<0.1) curves. Data are shown according to their distribution as mean ± standard deviation (SD) or median (interquartile range (IQR)).
RESULTS:
The number of non-regular HRPC´s was significantly higher in BB compared to C (m: 378 vs. 299, p<0.0001; f: 90 vs. 50, p<0.0001) and logistic regression analysis revealed a 2.8 times higher odds ratio to present a non-regular curve in BB compared to C. The number of non-regular HRPC was constantly high in BB but increased with increasing age in C. Maximal as well as absolute and relative submaximal performance and HR variables were significantly lower in BB (p<0.05). %HRmax values varied considerably between groups and were found in BB and C at Th1 at 62.1 (9.2; 41.5)% and 63.4 (8.5; 37.6)% respectively at 66.8±7.0% and 68.9±5.0% and at Th2 at 77.2±7.3% and 80.8±5.0% respectively at 79.2±5.1% and 84.2 (6.5;19.7)% for male and female individuals respectively. Interestingly %Pmax values at Th1 and Th2 were rather consistent in all groups and ranged between 37.5 - 42.1% at Th1 and 69.8 - 70.8% at Th2 independent from age, sex, and medication.
CONCLUSION:
The HRPC pattern in incremental cycle ergometer exercise is different between individuals with BB compared to C, were individuals receiving a β-blocker presented a consistent high number of non-regular HRPC´s. Relative HR values at thresholds are not constant and comparable but vary substantially with BB and intensity prescription by %HRmax is inaccurate. Contrary, our data support %Pmax as a more stable and independent indicator for exercise intensity prescription compared to %HRmax.
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2) Hofmann et al., Med Sci Sports Exerc 2005.

OP-PN03 Energy Expediture / Muscle pH

MECHANISMS OF MUSCLE PH REGULATION IN SICKLE CELL DISEASE

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INTRODUCTION:
Sickle cell disease (SCD) is a genetic disease emerging as a major public health problem with approximately 5 million people affected worldwide (Piel, Steinberg and Rees, 2017). SCD is due to the synthesis of abnormal haemoglobin S (HbS). The mode of transmission and according to the parents genes, the descents can be either healthy subjects (AA), or so-called asymptomatic sickle cell trait carriers (AS), or symptomatic patients (SS) (Piel et al., 2013; Ware et al., 2017). In patients, SCD causes among others painful vaso-occlusive crises and severe chronic anaemia. These clinical manifestations disrupt oxygenation of tissues (Setty et al., 2003), including the skeletal muscle (Waltz et al., 2012). From that point of view, muscle pH regulation mechanisms (MPRM) could be altered. Lactate and H+ transport (via MCT1, MCT2 and MCT4) is an important contributor of MPRM (Juel, 2000). Several other mechanisms modulate and/or complete the action of lactate and H+ transport (Na+/H+ exchanger NHE1, Na+/bicarbonate co-transporter NBC and carbonic anhydrases CAII, CAIII and CAIV) (Juel, 2000; Kristensen and al, 2004). Besides, because women are more anaemic than men, a sexes difference in MPRM might be suspected. The aim of the present study was to investigate some parameters of MPRM in AA, AS and SS. We hypothesised that 1) SS might have developed higher MPRM than AA and AS, and 2) that in SS, women had developed higher MPRM than men.
METHODS:
Vastus lateralis muscle biopsies of fifty-eight SCD patients were analysed (20 AA, 20 AS and 18 SS). Muscle content of MCT1, MCT2, MCT4, NHE1, NBC, CAII, CAIII and CAIV was studied by Western Blot. ANOVA and Tukeys post-hoc tests were used to compare data of AA, AS, and SS. Significance was accepted when p≤ 0.05.
RESULTS:
Muscle content of MCT4 was higher in AS than AA (p = 0.012) and that of CAII was higher in AS than AA and SS (p = 0.008 and p = 0.010). No difference was observed between AA and SS. No significant difference was observed among groups for MCT1, MCT2, NHE1 and NBC. No significant difference was observed between SS men and women.
CONCLUSION:
The present study is the first to evaluate muscle content of proteins involved in pH regulation between AA, AS and SS, and to compare SS men and women. Contrary to our hypothesis, SS do not display higher mechanisms of muscle pH regulation than AA. On the other hand, AS showed higher MCT4 and CAII muscle content than AA. Still contrary to our hypothesis, women did not develop higher muscle pH regulatory mechanisms than men. These results suggest that 1) AS may be subjected to muscle pH challenges and that consequently they developed compensatory mechanisms, 2) the lack of specific adaptation of the studied muscle pH regulatory mechanisms in SS may be a way to protect patients against sicking since the studied mechanisms may favour the release of lactate and H+ from the muscle to the blood, while H+ in blood triggers sickling and 3) women do not seem to have developed specific adaptation.

IS POLE WALKING CONVENIENT FOR OPTIMIZE THE MAXIMAL UPHILL PERFORMANCE?

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INTRODUCTION:
Recently, we reported that the use of poles (PW) during walking on steep uphill treadmill is energetically advantageous compared to walking without poles (W) [1]. However, a few criticisms may be made to this study since the laboratory conditions might not reflect the real-life outdoor situation (e.g., uneven terrain, exercise duration and intensity). Nonetheless, only a few studies have been conducted in outdoor environment about the use of poles [2-4] and none of them has examined the maximal performance. Thus, the aim of this study was to compare PW and W on a steep uphill mountain path at maximum intensity.
METHODS:
Fifteen trail running male athletes (maximal oxygen uptake ($\dot{V}O_2max$): 67.6±8.0 ml/kg/min) participated in the study. They performed one test in the laboratory to determine the maximal parameters, respiratory compensation point (RCP) and gas exchange threshold. Then, in randomized order, they completed two uphill tests at maximal intensity with (PWmax) or without poles (Wmax) on a mountain path (length: 1.3 km, elevation gain: 433 m, average incline: 19.5°). During every test we measured $\dot{V}O_2$ and carbon dioxide production ($\dot{V}CO_2$) using a portable metabolic unit. Then, we calculated metabolic power and vertical cost of transport. Also, we recorded heart rate (HR). As well, at the end of each test we measured the blood lactate concentration (BLC) and rate of perceived exertion (RPE). We compared PWmax and Wmax with a paired t-test, two tails. Then, we calculated the effect size (ES). Also, we compared the results obtained during PWmax and Wmax with those of the incremental test by using a repeated measures one-way ANOVA analysis, with the Geisser-Greenhouse correction. Significance was set at $p<0.05$.
RESULTS:
Exercise time with poles was shorter than without poles (18:51±03:12 vs. 19:19±03:01 in min:sec, p=0.013, ES=0.08, small). Consequently, the vertical velocity (vvert) during PWmax was higher (1409.5±210.3 vs. 1375.5±212.3 m/h, p=0.014, ES= 0.08, small). Twelve out of the 15 participants improved their performance when used poles. All the other parameters were not different between PWmax and Wmax. The $\dot{V}O_2$ and HR measured during PWmax and Wmax were not different from the ones corresponding to the RCP identified during the incremental test ($p>0.05$) whereas the vvert was slower (-6.7±5.4% and -9.0±4.8% for PWmax and Wmax, respectively, $p<0.001$).
CONCLUSION:
This is the first study in which the maximal uphill performance is compared between PW and W. Overall, the use of poles is advantageous during a maximal uphill effort even though high-level athletes (in our study with more than 77 ml/kg/min of $\dot{V}O_2max$) and less experienced pole users do not obtain an advantage in using them. Also, the intensity maintained during a ~20 minutes uphill effort is similar to the RCP intensity and this information may be of interest of coaches and athletes.
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BURNING CALORIES; CAN INTENSIVE STRENGTH TRAINING MATCH UP TO RUNNING?

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INTRODUCTION:
In today´s fitness world, burning calories to help manage body composition plays a large role in training programs. Claims that strength training can be as effective as running is often stated in the field, if sessions are time equated and rest periods are kept short between strength training sets. Could this be true?
METHODS:
Eight students (five females), age 23 to 29 yr participated. In random order, participants performed a running or a strength training workout, separated by 7 days. The running session consisted of a warm-up period of 15 min, followed by a 30 min interval session. The intervals were performed as a series of thirty 45 second on /15 seconds off intervals, at a self-selected pace on a treadmill with 1.5% inclination. Subjects were encouraged to do an “all out” effort with the help of the Borg RPE scale. The strength session consisted of a 15 min warm-up period, followed by 5 compound and one isolation exercise, focusing on the large muscle groups of the back, chest and legs. Four exercises were done in straight sets of 4 x 8-10 reps, 3 exercises were performed as drop-sets (4 drops). Participants were instructed to lift to near muscular failure (approx. 1-2 Repetitions In Reserve). Interset rest-periods were kept short (60 seconds). During both sessions, oxygen uptake and carbon dioxide production was continuously recorded using a Cosmed K5 metabolic system, as well as heart rate. Energy expenditure was calculated by the Weir-formula (Weir, 1949).
RESULTS:
The cumulative oxygen uptake during running was significantly larger than in the strength session, and thus also the energy expenditure, 451 (83) vs. 266 (54) kcal, $p<0.01$. The Respiratory Exchange Ratio was significantly higher during the strength training session, 0.91 (0.09) vs. 1.00 (0.14), $p<0.01$. Heart Rate was significantly higher in the running session, 163 (27) vs. 150 (22) bpm, $p>0.01$. The compound exercises that recruited the largest muscle mass (e.g. squats and deadlift), had an energy consumption equal to high intensity running, whereas exercises involving smaller muscles or muscle groups had much lower energy consumption.
CONCLUSION:
When high intensity running, and high intensity strength training sessions are time-equated, high intensity running is superior in regard to burning calories. However, compound strength exercises involving large muscle mass, such as squats and deadlift, show energy expenditure equal to high intensity running. Training only using these types of large muscle compound movements, are however not sustainable over time. Thus, high intensity running should be the preferred strategy.
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EFFECTS OF AEROBIC EXERCISE ON OXIDATIVE PHOSPHORYLATION OF MITOCHONDRIA IN THE CORTEX AND HIPPOCAMPUS OF APP/PS1 MICE

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INTRODUCTION:
To investigate the effects of aerobic exercise on the oxidative phosphorylation of mitochondria in the cortex and hippocampus of APP/PS1 mice. So as to provide theoretical basis for conforming that aerobic exercise can prevent alzheimers disease.
METHODS:
APP/PS1 male mice were randomly divided into control group (T-CG) and exercise group (T-EG). Wild-type C57BL/6J male mice were also randomly divided into control group (W-CG) and exercise group (W-EG). The mice in the T-EG and W-EG group underwent an 8-week treadmill training. Morris water maze experiment was performed in the 9th week to test the cognitive function of the mice. After morris water maze experiment, all mice cerebral cortex and hippocampus were isolated. The content of ATP, the relative enzyme activity of mitochondrial respiratory chain complex I - V and the mitochondrial membrane potential in the cortex and hippocampus were detected by the kit. And the protein levels of Cox5a, Cox2, Nd1 and Sdhc were assayed by Western blot.
RESULTS:
Compared with W-CG group, in the T-CG group the content of ATP, the relative enzyme activity of mitochondrial respiratory chain complexes Ⅰ-Ⅴ, the mitochondrial membrane potential and the protein levels of Cox5a, Cox2, Nd1 and Sdhc in the cerebral cortex and hippocampus were significantly decreased. In the morris water maze both escape time and distance were significantly increased. After 8 weeks of treadmill exercise, compared with T-CG group, in the T-EG group the content of ATP in the cortex and hippocampus was significantly increased. In the cortex, the relative enzyme activity of mitochondrial respiratory chain complexes I, III, IV and V was significantly increased. While in the hippocampus, the relative enzyme activity of mitochondrial respiratory chain complexes Ⅰ - Ⅴ was significantly increased. The mitochondrial membrane potential was increased significantly. Moreover, the protein levels of Cox5a, Cox2, Nd1 and Sdhc in mitochondrial were increased significantly. In the morris water maze both escape time and distance were significantly decreased. Furthermore, Compared with W-CG group, in the W-EG group the content of ATP, the relative enzyme activity of mitochondrial respiratory chain complexes Ⅰ-Ⅴ, the mitochondrial membrane potential and the protein levels of Cox5a, Cox2, Nd1 and Sdhc in the cerebral cortex and hippocampus were significantly increased. In the morris water maze the escape time was significantly decreased.
CONCLUSION:
Aerobic exercise can significantly improve the content of ATP, the enzyme activity of mitochondrial respiratory chain complex and the mitochondrial membrane potential in the cortex and hippocampus of APP/PS1 mice. And aerobic exercise can significantly enhance the mitochondrial oxidative phosphorylation levels and improve cognitive function by increasing the expression of mitochondrial oxidative phosphorylation regulatory proteins.

ENERGETIC DEMANDS IN THE MENS EUROPEAN HANDBALL CHAMPIONSHIP 2020

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INTRODUCTION:
Handball is characterized as highly intermittent with fast transitions between offensive and defensive phases. Recent research shows that there are differences in the movement characteristics between playing positions in handball, but for the classification of intensity and match load it is necessary to include acceleration and deceleration in the analysis. In this observational study, we aimed to confirm differences in volume/load and intensity among playing positions and decreasing intensity in the course of a game according to findings in the literature.
METHODS:
Position data were collected from 414 players (192.4±6.7cm, 94.3±10.5kg, 28.1±4.8y) in 65 matches of the European Handball Championship 2020 with a local positioning system (LPS, 16,66 Hz). Players were categorized into six positional groups: Left Wing (LW), Left Back (LB), Centre Back (CB), Right Back (RB), Right Wing (RW), Pivot (P); goalkeepers were excluded. We analyzed net played time only with durations above 1 min, resulting in 1591 observations. Total energy expenditure and high metabolic energy [kJ*kg-1] were calculated to estimate the overall load. Average Metabolic Power [kJ*kg-1*s-1] was calculated to estimate the intensity. We used a hierarchical model with players in teams as nested, random effect and time played and playing position as fixed effect to model intensity. Volume parameters were modeled with position as fixed effect only.
RESULTS:
Centre Backs spent most energy relative to time and bodyweight (7.9 kJ*kg-1*s-1, 95% CI [7.7, 8.0]), higher than Wings (- 4.5 %), higher than Backs (- 9 %), higher than pivots (- 13.8 %). Our linear model predicts a decrease in intensity of 0.2 kJ*kg-1*s-1 (95 % CI [0.17, 0.23], ~ 2.5 %) per 10 minutes played. Wings spent most time on the court and spent most energy overall and in high energy domains.
CONCLUSION:
Our study confirms, that wings are highly demanded by longer exposure in the game and high intensity bouts (eg, sprinting) in energetic terms. However, centre backs showed the highest energetic demands per played time; this could be due to their movement being highly intermittent. Pivots spent less energy per time; this could be due to not implementing the additional energetic load from events like tackling, passes and shots. Further, we can confirm decreasing intensity over the time course of a match. Using the Metabolic Power approach, we reveal high-intensity demands of the centre backs, which might be underestimated by conventional approaches so far.

CHANGES IN BODY COMPOSITION, RESTING METABOLIC RATE AND CENTRAL BLOOD MARKERS DURING A SHORT-TERM TRAINING CAMP AT ALTITUDE IN ELITE ALPINE SKIERS

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INTRODUCTION:
Training and competing in extreme conditions including high altitude and cold temperatures often lead to a negative energy balance and unfavorable changes in body composition (BC), which may negatively affect performance and increase injury risk. Currently, there is no literature on energy balance in elite alpine skiers during sport-specific glacier training (3-4 hrs of daily training at 3000-4000 m above sea

level). The present study investigated the impact of a short-term training camp at altitude on energy balance, including changes in BC and central blood markers in elite alpine ski athletes.
METHODS:
In a prospective observational study, active male (n= 9, 27±2.9 yrs) and female (n=10, 25±3.0 yrs) international alpine skiers, competing in either speed (SPEED, downhill, super-G; n=11) or technical (TEC, slalom, giant slalom, n=9) disciplines, completed a 7- to 15-day training camp at altitude (base: 1800m, glacier: 3500m). BC (displacement plethysmography and bioelectrical impedance) and resting metabolic rate (RMR; indirect calorimetry) were assessed 2-3 months before (BL), directly before (PRE) and after (POST) the training camp. Throughout the training camp, body mass and capillary blood for analysis of leptin (LEP) and triiodothyronine (T3) were collected.
RESULTS:
BC changed during training at altitude, as indicated by an overall increase in body mass (BM) (+0.9±1.4 kg, p=0.011), fat mass (FM) (+0.9±1.0 kg, p<0.001) and body fat percentage (F%) (+1.0±1.1 %, p=0.001), whereas fat free mass (FFM) was unchanged. Increases in FM and F% were prominent in men (p<0.001) and SPEED (p=0.002, p=0.003, respectively), but not in women or TEC. No changes were observed in RMR, respiratory quotient (RQ) or central blood markers between time points. However, changes in LEP were significantly correlated with changes in FM (p=0.049) and F% (p=0.026). Changes in T3 were correlated with FFM (p=0.040) and BM (p=0.070) in SPEED, but not in TEC. Moreover, changes in BM (p=0.017) and F% (p=0.049) were significantly correlated with T3 in men.
CONCLUSION:
The findings show that elite skiers are able to meet and to some degree even exceed the high energy demands of on-snow training at altitude over the course of a 1-2 week period. Increases in BM and FM indicative of a positive energy balance were observed predominantly in male athletes and in the speed group and are supported by changes in blood markers. Further research is needed to determine whether more intensive training and competing in extreme environments have adverse effects on BC over the course of a competitive season.

OP-PN04 Nutrition / Supplements

EXERCISE PLUS PRE-SLEEP PROTEIN INGESTION INCREASES OVERNIGHT MUSCLE CONNECTIVE TISSUE PROTEIN SYNTHESIS RATES IN HEALTHY OLDER MEN

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INTRODUCTION:
Aging is associated with the maladaptation of muscle collagenous tissue (i.e., connective tissue), which transfers force from contracting muscle fibers to tendons and bones. Protein ingestion and exercise stimulate myofibrillar protein synthesis rates. When combined, exercise further increases the post-prandial rise in myofibrillar protein synthesis rates. However, it remains unclear whether protein ingestion with or without exercise also stimulates muscle connective tissue protein synthesis rates. We assessed the impact of pre-sleep protein ingestion on overnight muscle connective tissue protein synthesis rates at rest and during recovery from resistance-type exercise in older men.
METHODS:
Thirty-six healthy, older men were randomly assigned to ingest 40 g intrinsically L-[1-13C]-phenylalanine and L-[1-13C]-leucine-labeled casein protein (PRO, n=12) or a non-protein placebo (PLA, n=12) before going to sleep. A third group performed a single bout of resistance-type exercise in the evening before ingesting 40 g intrinsically-labeled casein protein prior to sleep (EX+PRO, n=12). Continuous intravenous infusions of L-[ring-2H5]-phenylalanine and L-[1-13C]-leucine were applied with blood and muscle tissue samples collected throughout overnight sleep.
RESULTS:
Pre-sleep protein ingestion did not result in higher muscle connective tissue protein synthesis rates when compared to placebo ingestion (0.049±0.013 vs 0.060±0.024 %/h in PLA and PRO, respectively; P=0.73). Exercise plus protein ingestion resulted in higher overnight muscle connective tissue protein synthesis rates (0.095±0.022 %/h) when compared to placebo and protein ingestion at rest (P<0.01). Exercise increased the incorporation of dietary protein-derived amino acids into muscle connective tissue protein (0.054±0.009 vs 0.036±0.013 MPE, respectively; P<0.01).
CONCLUSION:
Resistance-type exercise plus pre-sleep protein ingestion increases overnight muscle connective tissue protein synthesis rates in older men. Exercise enhances the utilization of dietary protein-derived amino acids as precursors for de novo muscle connective tissue protein synthesis during overnight sleep.

INTERVENTION CONCEPTS COMBINING INDIVIDUALIZED TRAINING AND ADMINISTRATION OF CARBOHYDRATES AND PROTEIN BY FOODSTUFFS TO MAINTAIN MUSCLE MASS, STRENGTH AND METABOLIC ACTIVITY IN AGING FEMALES AND MAN

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INTRODUCTION:
Aging is related to a decrease of muscle mass, strength and metabolic rate. At the age of 60, strength is reduced by 1-1.5% per year increasing to 3% per year. In previous studies we could demonstrate that that individualized training concepts combining strength and endurance training, effect body compositing and increase strength and metabolic activity in postmenopausal woman. Moreover, we could demonstrate in health young individuals that ingestion of proteins and carbohydrates by foodstuff after exercise results in an enhancement of regeneration and physical performance after endurance and resistance training. Therefore, in the described study we investigated comminatory effects of training and protein carbohydrate administration by foodstuff in postmenopausal woman and elderly man.
METHODS:

In part 1 of the study 31 subjects (25 female and 6 males, age: 65.9 ± 4.9) conducted three times a week sling training (30 minutes each for 12 weeks). In part 2 of the Study 60 postmenopausal woman in the age between 50 and 65 conducted one time a week a 60min whole-body resistance training and two times a week a 60min endurance training for 12 weeks.
In both parts of the study immediately after training the intervention group received a meal consisting of 110 g sour milk cheese with two slices of whole meal toast. The nutritional values of these meal consisting of 38.95 g protein, 23.2 g carbohydrates and 2.9 grams of fat (= 1190 kJ / 278.5 kcal). In part 1 of the study strength and body composition was monitored. In part two of the study in addition, bone metabolism, fat metabolism and carbohydrate metabolism were analyzed by spirometry, Isotope ratio mass spectroscopy and analysis of biomarkers in the blood. In addition, quality of sleep and physical activity profiles were investigated by wearables and by using questionnaires. All participants perform a strength test and an endurance test on the treadmill.
RESULTS:
In part 1 of the study sling training resulted in the control group and in the intervention group in a significant increase of strength. Average strength increases between 20 to 30% for leg and chest strength up to 40% to 130% for trunk strength (ventral, dorsal and lateral). For all kinds of trunk strength nutritive protein carbohydrate uptake results in an additive training effect which was significant for the left lateral trunk strength. Interestingly all volunteers like to have a common meal after training.
In part two of the study the intervention is ongoing. Results will be expected in July 2021.
CONCLUSION:
Our results indicate that a combination of sling and nutritive protein and carbohydrate uptake by food may be a suitable strategy to counteract age related loss of strength and muscle mass and improve the quality of life in the elderly. Whether such a concept is also suitable to effect body composition strength and metabolic activity in postmenopausal woman is under investigation.

SPIRULINA SUPPLEMENTATION EFFECTS ON ELITE RUGBY PLAYERS' PHYSICAL RECOVERY AND BIOLOGICAL MARKERS IN RESPONSE TO EXHAUSTIVE EXERCISE

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INTRODUCTION:
Spirulina is a blue-green microalga, well-known for its high protein, vitamin/mineral content which exhibits antioxidant (AO) and anti-inflammatory properties and has beneficial effects on body composition. In recent years, Spirulina is widely used by athletes for these health benefit effects in the belief it will increase performance and accelerate recovery especially by limiting oxidative stress (OS), inflammation and skeletal muscle damage (SMD).
This study aimed to examine the effects of spirulina supplementation on physical recovery and on pro/antioxidant status, inflammation, and SMD markers immediately and 24h after exhaustive exercise in elite rugby players.
METHODS:
Seventeen elite male Rugby Union players were randomly assigned to a Spirulina (SPI: n=9), or a placebo group (PLA: n=8) in a double-blind design. Subjects were supplemented with Spirulina platensis (5.7 g/d) or placebo (isoproteic and caloric) for 7 weeks. At baseline (W0) and after seven weeks of supplementation (W7), blood samples were obtained before (T0), immediately after (T1), and 24h after (T2) exhaustive exercise. The Yoyo Intermittent Recovery Test Level 2 was used as an exhaustive exercise to induce OS, inflammation, skeletal muscle damage and physical fatigue. The studied parameters included pro/antioxidant status markers (blood SOD, GPX, GSH/GSSG ratio, plasma ox-LDL, and F2-Isop), inflammation markers (plasma MPO and CRP), and skeletal muscle damage markers (plasma LDH and CK). Physical recovery was evaluated by comparing physical performance (knee extensors and flexors peak torque, vertical jump height [SJ and CMJ]) between T0 and T2.
RESULTS:
Our results showed that F2-Isop, CRP, and CK levels significantly increased at T1 only in PLA group with no change in SPI group which reflects the effect of spirulina to prevent lipid peroxidation, inflammation, and SMD induced by exhaustive exercise. Moreover, spirulina supplementation accelerated the return to baseline values given that F2-Isop, CRP, and CK levels at T2 were significantly lower than at T0 in SPI group. No significant interaction effect was found for physical recovery parameters.
CONCLUSION:
Seven weeks of Spirulina supplementation could effectively reduce exercise-induced lipid peroxidation, inflammation, and SMD in high-level rugby players. Based on our findings, we recommend spirulina supplementation especially for athletes who do not achieved the recommended AO dietary intake and who perform a high volume of training in order to reduce the magnitude of OS, inflammation, and SMD which could help to reduce performance losses and accelerate recovery after training/competitions throughout the season.
ACKNOWLEDGMENTS: This study was supported by the Brittany Region and the competitiveness pole "Valorial, osons l'aliment plus intelligent." Spirulina was provided by the society "Algae Green Value."

IMPACT OF TWELVE WEEKS OF HIIT AND/OR LINSEED OIL SUPPLEMENTATION ON OBESITY-INDUCED OXIDATIVE STRESS IN HIGH FAT DIET-FED RATS.

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INTRODUCTION:
Obesity is a complex disease involving an excessive amount of body fat leading to impaired health and increased mortality rate (Abdelaal et al., 2017). Unhealthy dietary habits (i.e. increased intake of energy-dense foods high in fat and sugars and low in vitamins, minerals and other healthy micronutrients/bioactive compounds) (Perez-Escamilla et al., 2012) and sedentary lifestyle/physical inactivity (Jebb and Moore, 1999) are the leading factors associated with the development of obesity. The adipose tissue expansion during the progression of obesity increases reactive oxygen species (ROS) production through different mechanisms and subsequently promotes systemic oxidative stress (OS) (Manna and Jain, 2015, Hu et al., 2007). Linseed oil [LO] supplementation (Tamtaji et al., 2020) and high-intensity interval training [HIIT] (Groussard et al., 2019) are effective strategies known for reducing obesity-induced OS. The objective of this study was to deter-

mine whether the HIIT-LO combination might potentiate their effects to prevent obesity-induced OS in a rat model of obesity (high fat diet rats).
METHODS:
Eight-week-old male Wistar rats received a low fat diet (LFD; n = 12; 11.5% fat, 19.8% proteins and 68.7% carbohydrates) or high fat diet (HFD: n = 48; 43.3% fat to induce obesity including 4% of sunflower oil, 17.3% proteins and 39.4% carbohydrates) for 16 weeks to induce obesity. Then, animals in the HFD group were subdivided in four groups: HFD (control), LO, HIIT, and HIIT+LO. LO supplementation consisted in replacing 2% of sunflower oil in the HFD with 2% of LO. For HIIT, rats ran on a treadmill (0° slope), 4 days/week for 12 weeks (6 sets of 3 min at 10m.min-1 followed by 4 min at 18 m.min-1). Epididymal (visceral) and subcutaneous adipose tissue, gastrocnemius muscle, liver, and plasma samples were collected to measure OS stress markers (advanced oxidation protein products [AOPP], oxidized low-density lipoprotein [oxLDL]), antioxidant system markers (superoxide dismutase [SOD], catalase, glutathione peroxidase [GPx] activities), and pro-oxidant enzymes (NADPH oxidase [NOx] and xanthine oxidase [XO]) activities.
RESULTS:
Compared with the LFD, the HFD altered the pro/antioxidant status in the various studied tissues, excepted for muscle (significant increase in plasma AOPP, oxLDL, SOD and CAT activities, significant increase in SOD activity in liver and decrease in epididymal tissue). LO supplementation induced beneficial effects in liver by upregulating the activity of the antioxidant CAT and by decreasing the activity of the prooxidant NOx. HIIT alleviated the HFD negative effects in liver by reducing SOD and NOx activity. In addition, the HIIT+LO combination potentiated their actions by up-regulating SOD activity in subcutaneous tissue.
CONCLUSION:
HIIT and LO supplementation have independent beneficial effects on the pro/antioxidant balance. Additionally, their association promotes SOD activity in subcutaneous tissue.

HIGH-INTENSITY INTERVAL TRAINING AND A-LINOLENIC ACID SUPPLEMENTATION IMPROVE DHA CONVERSION AND INCREASE THE ABUNDANCE OF GUT MUCOSA-ASSOCIATED OSCILLOSPIRA BACTERIA

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INTRODUCTION:
Physical activity is an effective strategy to counteract obesity. High-intensity interval training (HIIT) is a time-efficient modality for decreasing fat mass (FM), especially visceral adiposity, which is strongly related to cardiovascular diseases. N-3 polyunsaturated fatty acids (PUFAs n-3) can also be beneficial in obesity by limiting fat mass accumulation and decreasing low-grade inflammation. Our aim was to determine whether HIIT and/or α-linolenic acid supplementation (to equilibrate the n-6/n-3 PUFA ratio) might prevent obesity disorders, particularly by modulating the mucosa-associated microbiota.
METHODS:
Male Wistar rats (n=60, aged 8 weeks) were evenly divided into CONT (normal diet, n=12) and HFD-ind (high fat diet-induction, n=48) groups for a 16-week period to induce obesity. At the end of this period, the HFD-ind group was divided into 4 groups of 12 matched for body weight (BW) and total FM: HFD; HFD with LO supplementation included in the diet (LO); HFD with a HIIT program (HIIT); and HFD with LO supplementation and a HIIT program (HIIT+LO). Trained animals ran on a treadmill (0° slope), 4 days/week for 12 weeks (3min at 10m.min-1 followed by 4min at 18m.min-1 for 42min). The diet difference between HFD and HFD+LO was only n-6/n-3 PUFAs ratio (30.2 and 2.93, respectively). Body composition was analyzed by EchoMRI. Erythrocyte n-3 PUFAs content, body composition, inflammation, and intestinal mucosa-associated microbiota composition were assessed after 12 weeks.
RESULTS:
After the obesity induction period, BW and FM were higher in the HFD-ind group than in the CONT group ($p<0.05$). Net area under the curve (AUCnet) obtained from the oral glucose tolerance test showed higher values for the HFD-ind group vs. the CONT group meaning that HFD was effective in altering body composition and metabolic profile. The 12-week intervention (HIIT and/or LO supplementation) showed that training promoted lower weight gain and FM accumulation than in the groups without training, despite similar food intakes. LO supplementation alone was not able to induce the same effect. Erythrocytes n-3 PUFAs content increased in the LO and HIIT+LO groups. In the HIIT+LO group, the percentage of DHA from total n-3 PUFAs was significantly higher than in the other groups. Plasma MPO is reduced in groups with LO supplementation. HIIT had the main effect on mucosa-associated microbiota β-diversity, but the HIIT+LO association significantly increased Oscillospira relative abundance.
CONCLUSION:
HIIT had a major effect on limiting weight and FM gain, whereas LO reduced systemic inflammation. Our study showed that HIIT associated with LO improved ALA conversion to DHA and increased the abundance of Oscillospira bacteria in the microbiota. Thus, the combination of HIIT and α-linolenic acid seems favorable and could be proposed in the management of metabolic diseases such as obesity.

EFFECT OF 12-WEEK INTAKE OF NICOTINAMIDE MONONUCLEOTIDE ON PHYSICAL PERFORMANCE, FATIGUE FEELING AND SLEEP QUALITY IN OLDER JAPANESE ADULTS: A RANDOMIZED DOUBLE-BLIND PLACEBO CONTROLLED-STUDY

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INTRODUCTION:
It has been reported that Nicotinamide mononucleotide (NMN) intake can effectively improve age-related physiological functions (energy metabolism, mitochondrial oxidation metabolism, etc.) in mice (Mills et al., 2016, cell Metabolism). Therefore, we conducted a randomized double-blind placebo control study to clarify the effect of NMN intake on physical performance, fatigue feeling and sleep quality of Japanese older adults.
METHODS:
Different intake time zones (AM: ante meridian; after waking up - 12:00 or PM: post meridian; 18:00 - before bedtime) were set to compare the effects of NMN. 108 participants (72.6 ± 4.6 years) were divided into 4 groups (NMN_AM, NMN_PM, Placebo_AM, Placebo_PM) through stratification and permuted block randomization. All groups took in 6 tablets of supplements (1200 mg) for 12 weeks daily: 282 mg NMN (purity 90% = 253.8 mg), 768 mg maltitol, 120 mg crystalline cellulose, 6 mg silicon dioxide, and 24 mg magnesium stearate for NMN group, and 1050 mg maltitol, 120 mg crystalline cellulose, 6 mg silicon dioxide and 24 mg magnesium stearate for Placebo group. Meas-

urements of physical performance include grip strength, 5-times sit to stand (5-STS), timed up and go (TUG), 5-m habitual walk. Fatigue feeling scale was evaluated on variables including drowsiness, instability, uneasiness, local pain or dullness and eyestrain by a questionnaire. Subjective sleep quality was evaluated by the Pittsburgh Sleep Quality Index (PSQI) and sleep diary. A repeated-measures analysis of variance was then used to determine interactions between groups and among 3 periods (pre-test, mid-test, and post-test), and we conducted post hoc analyses with Bonferroni correction. In addition, we evaluated effect sizes of all variables by Cohens d value.
RESULTS:
Significant interactions were observed in 5-STS (P = 0.04) and drowsiness (P = 0.02). Through within-group analysis, 5-STS of all groups in post-test and drowsiness of NMN_PM and Placebo_PM groups in mid- and post-test showed significant improvement than those of pre-test. The largest effect size was in 5-STS (0.40, 0.72, 0.41, and 0.30 for NMN_AM, NMN_PM, Placebo_AM, and Placebo_PM respectively) and drowsiness (0.08, 0.64, 0.37, and 0.50 for NMN_AM, NMN_PM, Placebo_AM, and Placebo_PM respectively) of NMN_PM group after intervention. In addition, significant interactions (P < 0.01) were also shown in sleep latency evaluated by sleep diary. The within-group analysis showed significant improvement in NMN_AM and Placebo_AM in the mid- and post-test compared to the pre-test.
CONCLUSION:
Although that sleep latency was improved significantly in NMN_AM and Placebo_AM, our findings suggested that intake of NMN during afternoon was effective to improve lower-limb strength and reduce drowsiness of older adults, which may further benefit their physical and mental health.

THE RELATION BETWEEN GUANIDINO COMPOUNDS, CREATININE, NITRATE, AND NITRITE DURING AND AFTER SPRINT EXERCISE.

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INTRODUCTION:
On the one hand, guanidino-related compounds play a role in the synthesis of creatine, and on the other hand, they are related to nitric oxide metabolism. To investigate whether there may be an interaction between both is the aim of this study.
METHODS:
17 healthy male volunteers participated in this study (mean±SD, age: 26.7±4.2 years, height: 182.7±7.4 cm, body mass: 77.9±9.8 kg). All subjects performed an incremental test (IT) and a double Wingate-test (WT) on 2 separate days. As a warm-up a 10-min period at 50%Wmax was used. During WT cubital venous blood was taken several times at defined time points to measure pH, sO2, and markers for fluid shifts. Creatinine (CRN), nitrate (NO3-), nitrite (NO2-), Methemoglobin (MetHb), and amino acid concentrations in heparinized plasma were measured by gas chromatography-mass spectrometry (GC-MS) (1). Repeated measures ANOVAs were performed to investigate changes in plasma concentrations throughout the exercise. Pearson correlation coefficient was calculated to indicate possible connections between variables.
RESULTS:
There is a significant increase of NO3- ($p=0.032$) and CRN ($p=0.002$) as well as a decrease of NO2- ($p<0.001$) and MetHb ($p<0.001$) during exercise. No significant changes in GAA, hArg, and AMDA could be shown ($p>0.163$), while Gly is reduced due to exercise ($p<0.001$). Significant main effects for Lys and Arg were observed ($p=0.005$, $p<0.001$). Post hoc tests revealed a decrease of both during recovery phase after the 2nd Wingate test.
Over all measuring points NO3- is correlated with NO2- ($r=0.34$, $p<0.001$), MetHb ($r=-0.19$, $p=0.013$) and CRN ($r=0.30$, $p<0.001$). CRN itself correlates negatively with Gly ($r=-0.17$, $p=0.035$) and Arg ($r=-0.30$, $p<0.001$) but not with GAA ($r=-0.09$, $p=0.245$). Furthermore, Arg is correlated with GAA ($r=0.57$, $p<0.001$), hArg ($r=0.29$, $p<0.001$) and ADMA ($r=0.39$, $p<0.001$). NO2- as a physiological storage for NO was connected with GAA, Lys, Arg, hArg and ADMA ($|r|>0.18$, $p<0.020$). Finally, NO2- and MetHb also tend to correlate negatively with one another ($r=-0.15$, $p=0.062$).
CONCLUSION:
The increase of NO3- during high-intensive exercise matches with earlier studies (2). The correlation between NO3- with NO2- and CRN might in part be due to the nitrate/nitrite reductase activity of xanthine oxidase (3). Additionally, the reductase activity of Hb might add to the decrease in NO2- (4). The resulting NO should be leading to an increase of NO3-. But since the coefficient of determinations of the relation between NO3- und MetHb is low, other ways to form NO3- should be concidered. Whether the decrease in Lys, Gly, and Arg during the early recovery adds to a fast replenishment of Cr remains to be clarified.
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DIETARY NITRATE SUPPLEMENTATION COMBINED WITH INTERMITTENT HYPOXIC TRAINING: EFFECTS ON ENDURANCE PERFORMANCE AT ALTITUDE

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INTRODUCTION:
Although most sport events are held at sea level, athletes may be required to compete in hypoxic environments (1). For logistically purposes, intermittent normobaric hypoxic training (living low-training high) may represent a reliable alternative to pre-acclimatize and prepare for competition at altitude (2). Given that several key components of this training program need to be adjusted (e.g., training intensity and nutrition), this study investigates if performance at altitude is improved to a larger extent when high-intensity interval-training is performed in normobaric hypoxia and if this is potentiated when combined with chronic dietary nitrate (NO3-) supplementation.
METHODS:

Thirty endurance trained male participants were allocated to one of three groups: hypoxia (13% FiO2) + NO3- (HNO; n=10); hypoxia + placebo (HPL; n=10); normoxia (20.9% FiO2) + placebo (CON; n=10). All performed 12 cycling sessions (8 sessions of 2*6x1 min at severe intensity with 1 min recovery and 4 sessions of 4*6*10 s all-out with 20 s recovery) during a 4-weeks period (3 sessions/ week) in hypoxia (HNO and HPL) or normoxia (CON). All were supplemented 3-2.5 h before each session with 150 ml of beetroot juice (HNO: Sabeet, Sabinsa Corporation) or a placebo drink (HPL and CON). Before and after training intervention, participants performed an incremental exhaustion test (INC), a severe intensity exercise bout to exhaustion (80%Δ: Tlim) and a 3 min all-out test (3AOT), all in hypoxia conditions (FiO2=13%). Pulmonary oxygen uptake (V O2) and V O2 kinetics were assessed using a portable gas analyser (K5, Cosmed, Italy). Vastus lateralis changes in local oxygen saturation (SmO2) were also measured (Moxy monitor, Fortiori Design, Minnesota, USA). Comparisons between moments (Repeated measures T-Test) and groups (Independent T-Test) were done ($p \leq .05$).
RESULTS:
In all tests, performance improvement (pre vs. post) in INC, Tlim and 3AOT was similar in hypoxia groups compared to normoxia (HNO+HPL vs. CON), with the exception of SmO2 after Tlim (p=0.04, d=0.82) and 3AOT (p=0.03, d=1.43) which were lower in both HNO and HPL compared to CON. Dietary NO3- supplementation did not bring any additional benefits in any performance tests.
CONCLUSION:
Performance at altitude was not improved to a larger extent when 4-weeks of high-intensity interval-training was held in hypoxia conditions, when compared with the condition where the training design was held in normoxic. Moreover, and as previously suggested (3), this study failed to show that dietary supplementation with NO3- would further improve performance in hypoxia than with a placebo.
ACKNOWLEDGMENTS
Portuguese Foundation for Science and Technology (SFRH/BPD/114670/2016 and UID/04045/2020).
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L-MENTHOL ADMINISTRATION MITIGATES THE SENSATION OF DYSPNOEA AND IMPROVES ENDURANCE CAPACITY

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INTRODUCTION:
Dyspnoea during high intensity exercise is one of the determinants of athletic capacity [1.2]. Administration of L-menthol has been reported to improve endurance capacity [3]. Since L-menthol is an agonist of TRPM8 [4.5], it is possible that TRPM8 channel activation may mediate the improvement of endurance capacity. Although TRPM8 channel is widely distributed at the larynx [4.5], L-menthol solution may reach the larynx when ingested but not by mouth rinsing. Therefore we tested our hypothesis that ingestion of L-menthol solution may better improve dyspnoea during endurance running, and thus the endurance capacity as compared to water without menthol ingestion or to mouth rinsing with L-menthol solution. In addition, we compared the level of sensation of dyspnoea exerting airway resistance before and after running and the endurance capacity among three conditions.
METHODS:
Thirteen healthy male runners (age 35.8±7.8 years, VO_2max 62.7±6.8 ml•kg-1•min-1) performed a treadmill running at an exercise intensity of individual's anaerobic threshold to exhaustion. All the runners underwent 3 trials of running with either ingesting 25ml of water (W-IG), ingesting 25ml of 0.01% L-menthol solution (M-IG), or mouth rinsing with 25ml of 0.01% L-menthol solution (M-MR) every 5 minutes during running in a random order. The level of subjective dyspnoea was measured immediately after the fluid intake each time. The sensation of dyspnoea induced by exerting airway resistance was examined before and after the running test. The levels of subjective dyspnoea measured after the first fluid intake and at 2 last intakes during the running test, and the level of sensation of dyspnoea using airway resistance before and after the running test were compared by a two-way repeated measures ANOVA (condition*time). The time to exhaustion was analysed by one-way repeated measures ANOVA.
RESULTS:
For the changes of levels of subjective dyspnoea at the first and the last 2 measurements, there was no statistically significant interaction between condition and time (p=0.31), and the main effect of time (p=0.33) and condition (p=0.09). However, at the last 2 measurements before exhaustion, the levels of subjective dyspnoea was mitigated under M-IG condition as compared with W-IG condition ($P< 0.001$). The level of sensation of dyspnoea deteriorated after the running test, but the deterioration was the mildest under M-IG condition (p for interaction < 0.001). The endurance time was longer at M-IG condition as compared to W-IG (p=0.01).
CONCLUSION:
Although L-menthol ingestion nor mouth rinsing did not mitigate the levels of subjective dyspnoea during high intensity endurance running, L-menthol ingestion reduced the level of sensation of dyspnoea induced by airway resistance and improved the endurance capacity.
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OP-PN05 Metabolism / -Omics

ROLE OF UNCOUPLING PROTEIN 1-3826 A/G POLYMORPHISM ON THE EFFECTS OF ACUTE AND CHRONIC ANAEROBIC EXERCISES ON SERUM LIPIDS AND LIPOPROTEINS LEVELS

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INTRODUCTION:

Dyslipidemia characterized by high serum Low Density Lipoprotein Cholesterol (LDL-C) and Triglyceride (TG) and low serum High Density Lipoprotein Cholesterol (HDL-C) levels is associated with elevated risk of coronary heart disease. However, exercise has beneficial effects on lipid and lipoprotein metabolism. While regular low-intensity aerobic exercise is sufficient to increase HDL-C levels, high intensity exercises are recommended to reduce LDL-C and TG levels [1]. On the other hand, the effects of exercise on metabolic disorders may vary individually and the main reason of this difference is assumed to be inherited. Besides, genetic predisposition to dyslipidemia may play a role on its etiology along with environmental factors. In this context, the literature showed that UCP-1 A-3826G polymorphism (UCP1P) is associated with lipid/lipoprotein-related diseases [2]. However, no study about the role of UCP1P on the effects of exercises on serum lipids and lipoproteins levels was conducted in the literature. Therefore, this study investigated the role of UCP1P on the effects of acute maximal exercise (AME) and chronic anaerobic training (CAT) on serum lipids and lipoproteins levels in healthy young men.
METHODS:
YO-YO intermittent recovery test level 1 was applied to anaerobic team sports players (SG, n=43, age: 20.65±2.46 years) and sedentary participants (CG, n=43, age: 22.49±3.51 years). From pre-and post-test postprandial venous blood samples, hemogram, serum Total Cholesterol (TC), HDL-C, LDL-C, non-HDL cholesterol and TG levels were measured. UCP1P was determined by restriction fragment length polymorphism analysis. Participants were grouped as G-carriers and AA genotypes. Three-way ANOVA test was used to determine the effects of AME, CAT, UCP1P and their interactions on parameters.
RESULTS:
AME increased serum TC, HDL-C, LDL-C and Non-HDL-C ($p<0.05$), while it decreased serum TG ($p<0.05$). CAT decreased serum LDL-C and Non-HDL-C levels ($p<0.05$). UCP1P and its interactions with AME and/or CAT had no significant effects on parameters ($p>0.05$).
CONCLUSION:
In conclusion, as expected AME and CAT have beneficial effects on lipid and lipoprotein metabolism. However, the hereditary factor in terms of UCP1P does not play a role in these effects. Hence, a similar study involving another obesity-related polymorphism along with UCP1P may be conducted in the future to clarify the role of hereditary on the effects of exercises on lipid and lipoprotein metabolism.
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THE EFFECT OF A HYPERTROPHY-ORIENTED RESISTANCE TRAINING SESSION AT ACUTE MODERATE ALTITUDE ON THE RELATIONSHIP BETWEEN MIR-378 AND METABOLIC STRESS.

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INTRODUCTION:
Resistance training (RT) in hypoxia has been shown to potentially increase muscle strength and hypertrophy compared to the equivalent training under normoxic conditions [1]. One of the responses to exercise in hypoxia is an increase in the metabolic stress [2]. Exercise-induced metabolite accumulation (H+, Ca2+ or Pi, among others) is proposed to promote the recruitment of additional high-threshold motor units, cell swelling, and elevated systemic hormonal production [3]. GH release also seems to be mediated by blood lactate and H+ levels [4], which may indirectly activate some muscle protein signaling pathways like mTOR. Moreover, miR-378 release increases the transcriptional activity of the myogenic differentiation factor (MyoD) [5], regulating processes that lead to muscle hypertrophy (mTOR pathway). In fact, miR-378 overexpression has been linked to protein synthesis regulation after a RT period [5]. The present study aimed to analyze the influence of acute exposure to moderate altitude on the hypertrophic RT response in regard to its potential relationship between miR-378 and metabolic stress-related variables.
METHODS:
13 males completed 2 counterbalanced hypertrophic RT sessions (3set x10RM, 2min rest) under moderate altitude (H;2320m asl) and normoxic conditions (N;<700m asl) with 72h rest between sessions. Venous blood samples were taken before and throughout the initial 30 min post-exercise period for determination of lactate [Lac], calcium [Ca2+], liquid carbon dioxide [CO2L] and miR-378.
RESULTS:
Correlation analysis did not display a statistically significant association between miR-378 and any of the studied metabolites in N or H (r coefficient ranged from -0.465 to 0.231; $p>0.05$). The ascent to altitude did not affect the strength of these associations (Fishers F distribution < 2,69; $p>0.05$). However, the Cohen's Q inference analysis displayed a large effect of the environment on the relationship with miR-378 and CO2L (Q=0.739) and a small effect with Ca2+ (Q=0.115).
CONCLUSION:
Our results suggest that the metabolic stress variables studied after a RT session do not seem to be related to miR-378 both in N and H. However, the influence of the environment with the association between miR-378 and CO2L could reflect the acid-base modulation response induced by the ventilatory compensation in acute H, improving the buffering response. Previous research displays a relationship between miR-378 and GH, sensitive to the change in altitude [6]. However, despite the large influence of the blood pH status on GH, the changes in blood bicarbonate concentration are not sufficient to detect the muscular signaling pathway activation. Further research is required for longer periods.
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"FUEL FOR THE DAMAGE INDUCED": AN UNTARGETED METABOLOMICS INVESTIGATION OF ACUTE CHANGES AND THE TIME COURSE OF RECOVERY AFTER ELITE RUGBY UNION MATCH PLAY.

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INTRODUCTION:
Our understanding of the metabolic perturbations caused by competitive rugby are not well characterised. The use of metabolomics as an unbiased, systems approach to investigate the complex nature of the responses may fill critical gaps in our understanding. Our aim is to develop appropriate interventions, based on the metabolic fluctuations that occur in response to elite rugby.
METHODS:
Seven members of an English Premiership squad consented to fasted blood, urine and saliva samples, each morning, over a competitive week. The gameday (GD) samples were collected immediately post-match. The physical demands and dietary intake were recorded daily. Sample collection, processing and statistical analysis were performed in accordance with best practice set out by the metabolomics standards initiative employing 700MHz NMR spectroscopy. Univariate analyses were performed on normalised spectra using false-discovery rate (FDR) adjusted one-way ANOVA with Tukey's post-hoc analysis. Multivariate analysis via Partial least squares discriminant analysis (PLS-DA) were evaluated using the receiver operator characteristic (ROC) scores. Metabolites within each model were only used for further analyses if the Variable Importance in Projection (VIP) scores were above 1.00 and ROC scores = 0.75.
RESULTS:
Univariate analyses of serum revealed significant increases in alanine (FDR adjusted $p<0.0001$) and citrate ($p=0.032$) immediately post-match. Pathway enrichment analysis of serum and saliva revealed further acute changes in glycolysis, glucose-alanine cycle, amino acid, and ketone body metabolism pathways. Tryptophan metabolism changed acutely and throughout recovery in the urinary metabolome. At GD+2 serum alanine was significantly higher ($p=0.019$) compared with pre-match. Saliva and serum show the glucose-alanine cycle and gluconeogenesis to be upregulated during recovery. Markers of collagen degradation, myofibrillar protein breakdown and adipogenesis were detectable in urine and saliva in the recovery period. Finally, the serum profile of the lipoproteins HDL and VLDL shifts at GD+2 unfavourably. Dietary analysis revealed no significant changes across the week in protein ($p=0.3743$), or fat ($p=0.3666$) intakes. Carbohydrate intake did vary ($p<0.0001$) in a periodised manner, with significantly higher intakes on GD-1 and GD and below the mean intake for the week on GD+1.
CONCLUSION:
We provide novel metabolic insight into the acute demands upon energy systems in elite rugby union match-play. A potential reduction in fatty acid oxidation coupled with upregulation of gluconeogenesis leads us to propose the effective recovery from muscle damaging collisions is dependent upon glucose availability. Adjusting the periodisation of carbohydrate to increase GD+1 provision may prevent the oxidation of amino acids which could crucially allay markers of structural tissue degradation. Should we expand the 'Fuel the work required' paradigm in collision-based team sports to include 'Fuel the damage induced?

FIBRE-TYPE-SPECIFIC PROTEOMICS IDENTIFIES ALTERATIONS IN THE MITOCHONDRIA OF TYPE I FIBRES WITH MODERATE-INTENSITY CONTINUOUS TRAINING BUT NOT SPRINT INTERVAL TRAINING

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INTRODUCTION:
Mitochondria are involved in many essential cell functions, including the production of energy and cellular metabolism. Methods for studying mitochondrial adaptations in skeletal muscle have mostly used whole-muscle samples, where results may be confounded by the presence of a mixture of type I and II fibres. Mass spectrometry (MS) allows for the quantification of thousands of proteins in small biological samples, providing the ability to analyse changes in mitochondrial proteins in single muscle fibres. We aimed to integrate mass spectrometry results to provide insights into mitochondrial adaptations and divergent regulation of type I and II fibres with two different types of training; moderate-intensity continuous training (MICT) and sprint-interval training (SIT).
METHODS:
Single muscle fibres from muscle biopsies were collected at rest and after training and pooled for analysis (~6 fibres). A subsequent proteomic workflow was applied permitting a three-tiered comparison and identification of mitochondrial protein content from different fibre types by MS. Our protocol includes tandem mass tag labelling for increased identification of low-abundant proteins. An 8-week training intervention was undertaken by 23 men (27 ± 6 y, 23.6 ± 2.5 BMI, VO2max 52 ± 7 mL/kg/min) who performed either MICT or SIT. These two types of training were chosen as they should require very different skeletal muscle fibre recruitment, with the MICT group's training volume ~5-fold higher than the SIT group and the intensity ~5-fold higher in SIT.
RESULTS:
We quantified the levels of 536 known mitochondrial proteins, representing more than 45% of the total mitochondrial proteins in pooled single muscle fibres. When comparing type I to type II fibres, 89 mitochondrial proteins were differentially expressed following MICT and 20 following SIT. Further analysis indicated that these proteins were associated with known cellular pathways within the mitochondria including oxidative phosphorylation, the TCA cycle, fatty acid oxidation, and mitochondrial dynamics. There were distinct trends of fibre-type-specific protein responses to different types of exercise training. Following MICT these processes were upregulated mostly in type I fibres, without analogous changes observed following SIT.
CONCLUSION:
Our research utilised proteomic technologies to better understand how fibre-type-specific mitochondrial proteins were altered in response to the stress of exercise training. Overall, greater upregulation of mitochondrial proteins was observed following MICT; this upregulation was predominantly seen in type I fibres, suggesting volume provides a powerful stimulus in the adaptation of mitochondrial pathways.

PROTEOGLYCAN GENES ACAN, BGN AND DCN AND RISK OF ACHILLES TENDON INJURIES: A CASE-CONTROL GENETIC ASSOCIATION STUDY IN A SOUTH AFRICAN AND BRITISH COHORT.

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INTRODUCTION:
Several intrinsic, including several genetic loci, and extrinsic factors have been implicated in the development of Achilles tendon injuries (ATI). Interestingly, previous studies have implicated polymorphisms within proteoglycan genes in risk susceptibility to injuries such as anterior cruciate ligament rupture and carpal tunnel syndrome. These heavily glycosylated proteins are critical components of the extracellular matrix where they perform structural and signaling functions to maintain tendon homeostasis. This study aimed to further the evidence for a role for proteoglycans in susceptibility to ATI by investigating an a priori hypothesis that polymorphisms in ACAN, BGN and DCN are associated with altered risk to ATI using previously recruited SA and UK ATI cohorts.
METHODS:
Polymorphisms within ACAN (rs2351491 C>T, rs1042631 T>C and rs1516797 T>G), BGN (rs1126499 C>T and rs1042103 G>A) and DCN rs516115 C>T, were investigated in SA (CON:119; ATI:112), UK (CON:129; ATI:134) and SA+UK participants. Participants were genotyped using DNA extracted from venous blood and saliva samples for SA and UK cohorts respectively. Fluorescence-based Taqman® polymerase chain reaction assays were used. Inferred haplotype analyses were performed.
RESULTS:
ACAN rs1516797 G/T genotype was independently associated with the risk of ATI in SA and UK cohorts separately, where it was associated with increased risk (p=0.029, OR: 0.47, 95% CI:0.26-0.85) and reduced risk (p=0.005; OR:1.89, 95% CI:1.14-3.12), respectively. Sex-dependent associations were noted where rs2351491 C/C genotype associated with increased risk in male participants (p=0.017, OR:4.39, 95% CI:1.18-16.30) and the T allele associated with increased risk in females (p=0.004; OR: 0.41, 95% CI:0.22-0.74) for the UK cohort. The rs1042631 T/T genotype was associated with reduced risk in the male SA (p=0.038, OR: 0.13, 95% CI:0.61-1.25) and similar results were observed in females. The (C–C–G) ACAN rs2351491–rs1042631–rs1516797 haplotype was associated with increased risk to ATI when all participants of the SA and combined (SA + UK) cohorts were investigated (p=0.015 and 0.043, respectively). The BGN rs1126499 T allele was significantly associated with reduced susceptibility to ATI in all the female cohorts (SA, UK and SA+UK) (p=0.005, OR: 0.51, 95% CI:0.32-0.82). The (T–G) BGN rs1126499–rs1042103 haplotype was significantly associated with reduced risk to ATI in all the female cohorts (SA, UK, and SA+UK) while the C–G haplotype was associated with increased risk in the female SA and combined SA+UK cohorts. No associations were noted for DCN.
CONCLUSION:
The study showed that proteoglycans within ACAN and BGN are implicated in the risk modulation of ATI in the SA and UK and combined study groups. Differences in the direction of association as well as sex-dependent associations were noted. Further investigation is necessary to fully characterize these genetic signatures across populations and injuries.

OP-PN06 Physiology Thermoregulation

EFFECT OF THE DEPTH OF COLD WATER IMMERSION ON SLEEP ARCHITECTURE AND RECOVERY AMONG WELL-TRAINED MALE ENDURANCE RUNNERS

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INTRODUCTION:
The aim of the present study was to investigate the effect of the depth of cold water immersion (CWI) (whole-body with head immersed and partial-body CWI) after high-intensity, intermittent running exercise on sleep architecture and recovery kinetics among well-trained runners.
METHODS:
In a randomized, counterbalanced order, 12 well-trained male endurance runners (VO2max = 66.0 ± 3.9 ml·min−1·kg−1) performed a simulated trail (≈18:00) on a motorized treadmill followed by CWI (13.3 ± 0.2°C) for 10 min: whole-body immersion including the head (WHOLE; n = 12), partial-body immersion up to the iliac crest (PARTIAL; n = 12), and, finally, an out-of-water control condition (CONT; n = 10). Markers of fatigue and muscle damage—maximal voluntary isometric contraction (MVIC), countermovement jump (CMJ), plasma creatine kinase [CK], and subjective ratings—were recorded until 48 h after the simulated trail. After each condition, nocturnal core body temperature (Tcore) was measured, whereas sleep and heart rate variability were assessed using polysomnography.
RESULTS:
There was a lower Tcore induced by WHOLE than CONT from the end of immersion to 80 min after the start of immersion ($p < 0.05$). Slow-wave sleep (SWS) proportion was higher ($p < 0.05$) during the first 180 min of the night in WHOLE compared with PARTIAL. WHOLE and PARTIAL induced a significant ($p < 0.05$) decrease in arousal for the duration of the night compared with CONT, while only WHOLE decreased limb movements compared with CONT ($p < 0.01$) for the duration of the night. Heart rate variability analysis showed a significant reduction ($p < 0.05$) in RMSSD, low frequency (LF), and high frequency (HF) in WHOLE compared with both PARTIAL and CONT during the first sequence of SWS. No differences between conditions were observed for any markers of fatigue and muscle damage ($p > 0.05$) throughout the 48-h recovery period.
CONCLUSION:
WHOLE reduced arousal and limb movement and enhanced SWS proportion during the first part of the night, which may be particularly useful in the athlete's recovery process after exercise. Future studies are, however, required to assess whether such positive sleep outcomes may result in overall recovery optimization.

PHYSIOLOGICAL, PERCEPTUAL AND MOOD RESPONSES TO WEARING RESTRICTIVE HEAT LOSS ATTIRE DURING AND FOLLOWING A HIGH INTENSITY INTERVAL TRAINING SESSION

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INTRODUCTION:
The COVID-19 pandemic restricted athletes' access to training facilities and necessitated home-based training routines. This study aimed to optimise home-based training by imposing added heat stress via restrictive heat loss attire (RHLA) to increase the physiological load during a high intensity interval training (HIIT) session, as well as assess how RHLA influenced perceptual and mood responses to HIIT.
METHODS:
Five healthy participants (2 female; age 22 ± 2 years) performed a 20-min HIIT session (functional bodyweight exercises; 30-s work (rating of perceived exertion >17), 30-s rest) followed by 30-min recovery with permissive dehydration in temperate conditions (18-21°C), on two separate days. One session was completed in compression garments, thick dense fabrics and waterproof layers (RHLA), and one in shorts and t-shirt (CON). Participants remained in their session attire during recovery. Continuous heart rate (HR; 30-s averages), core temperature (TCore; 30-s intervals via telemetry pill) and skin temperature (TSkin; 5-min intervals) were recorded to calculate area under the curve (AUC). Sweat rate was estimated via changes in nude-body mass. Thermal comfort (TC) and sensation (TS) were rated via 10- and 13-point scales, respectively. Mood was rated via 8-items on affect and physical feeling states using a 5-point scale ("not at all" to "extremely") immediately before (Pre), after (Post) and 30-min post-exercise (Post30). Data are presented as mean ± SD. Statistical analyses: paired t-tests (physiological measures), Wilcoxon signed-rank tests (TC; TS) and 3x2 repeated-measures ANOVAs (mood). Significance accepted at $p<.05$.
RESULTS:
Following HIIT, peak TCore (38.41 ± 0.37 vs. 38.31 ± 0.33°C), peak mean TSkin (35.99 ± 0.84 vs. 33.94 ± 1.36°C) plus peak TC (8 ± 1 vs. 5 ± 1) and TS (12 ± 0 vs. 10 ± 0) were all greater in RHLA vs. CON, respectively (p's<.05). Peak HR was similar in RHLA vs. CON (158 ± 10 vs. 167 ± 14 bpm; p=.12). Compared to CON, AUC analysis for TSkin was greater during the HIIT bout and in recovery in RHLA (p's<.01), while HR was elevated during recovery only (p=.02). TCore AUC was not different between trials during HIIT (p=.66) or recovery (p=.14). Sweat rate across the session was higher in RHLA vs. CON (1.2 ± 0.5 vs. 0.3 ± 0.2 L/hr; p=.02). Compared to Pre, energetic mood was lower Post and Post30 in RHLA (p's<.01), but only lower Post in CON (p=.03), and tense/anxious was higher Pre RHLA (p=.03), compared to CON (all condition*time interactions). Calm/relaxed was also lower throughout RHLA (condition main effect; p=.03).
CONCLUSION:
These findings indicate that wearing RHLA during HIIT increased the thermal and perceptual exercise load. A further 30-min recovery period in RHLA maintained an elevated TSkin and HR, but not TCore. Thus, wearing RHLA may be an alternative strategy athletes can use to increase their training load at home. Further research could explore if RHLA worn during HIIT may be a useful heat acclimation alternative.

COMPARISON OF SWEAT RATE, THERMAL RESPONSES AND PERFORMANCE CHARACTERISTICS BETWEEN TWO OFFICIAL WHEELCHAIR BASKETBALL GAMES IN HOT AND TEMPERATE CONDITIONS

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INTRODUCTION:
The regulation of body core temperature (Tc) is impaired among individuals with a spinal cord injury (SCI) dependent on the lesion level and heat loss through sweating is limited, especially in hot conditions. Data from able-bodied individuals show that hot environmental conditions reduce performance and modulate activity patterns in team sports. The limited sweating capacity in individuals with SCI might further increase the risk for heat-related illness and decreased performance, especially during hot environmental temperature. Thus, the purpose of the study was to investigate the differences in thermal and thermoregulatory responses, fluid balance and performance parameters between two wheelchair basketball (WCB) games, in hot and temperate conditions.
METHODS:
Eleven male WCB athletes with a traumatic SCI (median, IQR; age: 39.8, 11.3 y; body mass: 82.8, 20.2 kg) participated on different days in two competitive WCB games with a duration of 4 x 10 minutes (effective). The environmental conditions were 31.0 °C, 50 % rh for game 1 (HOT) and 21.0 °C, 50 % rh for game 2 (TMP). A pill was ingested to measure intestinal Tc, fluid intake and sweat rate (SR) were assessed using a balance. An indoor tracking system was used to monitor mean velocity (Vmean, m/s), peak velocity (Vpeak, m/s) and percentage of time spent in six different speed zones (Z1: 0.0-0.49 m/s, Z2: 0.5-0.99 m/s, Z3: 1.0-1.49 m/s, Z4: 1.5-1.99 m/s, Z5: 2.0-2.49 m/s, Z6: > 2.5 m/s).
RESULTS:
A significantly higher SR was found in HOT (0.93 L/h, p=0.02) compared to TMP (0.48 L/h). Loss of body mass was higher in HOT (1.39 %, p=0.03) compared to TMP (1.06 %). The increase in Tc was significantly higher in TMP (1.05 °C, p=0.01) compared to HOT (0.8 °C). Fluid intake (HOT: 1.08 L TMP: 1.08 L p=0.94), Vmean (HOT: 1.12 m/s, TMP: 1.07 m/s, p=0.54), Vpeak (HOT: 4.15 m/s, TMP: 4.12 m/s, p=0.69) did not differ between the games. Descriptive statistics did not reveal obvious differences between players with a lesion level above and below T6 but Vmean seems to depend on the classification (R=0.97, p=0.005). Over both games, the players spent ~80% of the playing time in low-intensity Z1 and Z2
CONCLUSION:
This study demonstrated that a competitive WCB in a hot condition leads to a significantly higher SR and therefore a higher loss in body mass in WCB players compared to a temperate condition. Interestingly, the increase in Tc was higher in the TMP. Performance parameters did not reveal any differences between the games. Data showed a high percentage of low-intensity exercise during the games. Thus, we speculate that the produced metabolic heat was too low, consequently, the athletes had a sufficient heat loss (i.e. higher SR) which enabled them to prevent a decrease in performance during HOT. Due to the variability in game characteristics between "real" games, further research is needed to develop a field test mimicking the requirements of a WCB game.

THE EFFECTS OF HIGH INTENSITY INTERVAL TRAINING COMBINED WITH CRYO-STIMULATION ON ANAEROBIC METABOLISM AND BROWN ADIPOSE TISSUE

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INTRODUCTION:
Cryo-stimulation and high intensity interval training both could activate PGC-1a and induce adipose browning. However, the period of exposing to cold or exercising in the past research were too long. Consequently, the aim of this study was to investigate the effects of high intensity interval training combined with cryo-stimulation on body surface temperature, energy metabolism and heart rate.
METHODS:
10 adults (age: 28±4.6 years, height: 171±7.7 cm, weight: 70.2±14 kg) with exercise habit participated in the 3 tests in crossover order: 1) High intensity interval training (2x6x60 s, V6) combined with cryo-stimulation (-120±10°C) (HIITC); 2) High intensity interval training (HIIT); 3) Cryo-stimulation only (CS). The lactate concentration (La), heart rate (HR), and ammonia (NH3) were collected before exercise, during exercise and during the recovery period in all 3 tests. Additionally, the reaction of brown adipose tissue was observed using a thermographic camera. All data was analyzed with SPSS 20.0. Two-way ANOVA (repeated measures) was used to analyze the change on the biological parameters from different stimulation methods and time sequence. Graphs were created through SigmaPlot 12.5. All data are presented in mean ± standard deviation. The significance level was set at $\alpha = .05$.
RESULTS:
The average temperatures of the supraclavicular epidermis and the jugular epidermis were 35.5±1.0°C in HIITC, 35.5±0.8°C in HIIT and 36.5±1.3°C in CS at Set-1. At Set-2, the temperatures were 34.7±0.9°C (HIITC), 35.4±0.9°C (HIIT) and 36.0±0.6°C (CS). The difference in temperature between Set-1 and Set-2 was 0.8°C in HIITC, 0.2°C in HIIT and 0.5°C in CS. The lactate concentrations at Set-1 were 5.6±1.4 mmol/l (HIITC), 6.1±1,1mmol/l (HIIT), and 1.5±0.6 mmol/l (CS). The average heart rate was 154±19 min-1 (Set-1) and 156±20 min-1 (Set-2) in HIITC, and was 160±15 min-1 (Set-1) and 165±18 min-1 (Set-2) in HIIT. The average heart rate in HIIT was significantly higher than HIITC at Set-2.
CONCLUSION:
CS showed higher body surface temperature. The phenomenon indicated that the supraclavicular epidermis and the jugular epidermis would be febrile in order to sustain constant temperature in the body. The temperature of HIITC and HIIT was similar, suggesting that both lose heat through the same mechanism. Another finding was that the heart rate, lactate and NH3 concentration were lower in HIITC than in HIIT. We thought that cryo-stimulation helped reducing the physiological pressure from high intensity exercise.

OP-SH01 Coaching / Mentoring

MULTIDIMENSIONAL ASSESSMENT OF PROFESSIONAL PADEL PLAYERS. A REAL CASE STUDY.

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INTRODUCTION:
Physical testing through laboratory and on-court tests seems to be basic in monitoring racket sport players development [1]. Nonetheless, to our knowledge only two studies to date have established an integral assessment protocol in professional padel players [2,3], existing no data about force-velocity profile in professional padel players and no studies have been found joining physical with psychosocial data. Linking different dimensions in the player assessment contributes a greater value to the performance context compared with the traditional laboratory tests, becoming a practical tool for physical trainers.
Thus, the aim of the present study is to develop a real context approach for a comprehensive assessment of the main professional padel players physical abilities, such as changing of direction (COD) at maximum speed in few meters [2], cardiorrespiratory fitness [2], upper-limbs strength [3], force-velocity profile [4]. In addition, psychosocial dimension was measured through self-concept and the profile of Mood States (POMS) test [5]
METHODS:
2 professional padel players were measured by specific padel agility test using video analysis [2]; Wingate Test (Skillbike Technogym S.p.A., Italy) [6]; Handgrip strength test using a digital dynamometer (TKK '5101 Grip-D; Takey, Tokyo, Japan) [8]; Force-velocity squat profile using a linear power transducer (SmartCoachTM, SmartCoach Europe AB, Stockholm, Sweden) [8]; Physical Self-Concept Questionnaire (PSC-Q) [9] and profile of Mood States (POMS) Questionnaire [10].
RESULTS:
Results show substantial differences between players in some dimensions (i.e. psychosocial dimension or fitness and strength profile), which would represent the need to carry out a multidimensional evaluation, because, as shown in the present study, the players are configured by different factors, which leads us to the need to, firstly, carry out evaluations that allow us to know indicators of each of these dimensions (multidimensional), and secondly, the need for individual planning, in order to meet the specific requirements of each player.
CONCLUSION:
Professional padel players have to be assessed through specific COD (i.e. Modified Agility T-test), anaerobic power and capacity (i.e. Wingate test), upper-limbs strength (i.e. handgrip strength test) force-velocity (i.e. squat exercise) tests and psychosocial dimension (i.e. self concept and mood state test).
The real value of this work has been to design a real tool taking into account the different dimensions that affect the performance of a padel player, bridging the gap between laboratory and field assessment, proposing a valid tool for physical trainers.

DISCOVERY VS. RULE-DIRECTED LEARNING IN SCUBA DIVING EDUCATION

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INTRODUCTION:
Time efficiency is a crucial factor when teaching SCUBA diving underwater, where limited access, limited air supply, and cold reduce the amount of practice time. Still, safety skills must be learned with sufficient quality and still be mastered even after long breaks. This is espe-

cially true for beginners who learn to dive in their home country but apply their skills only later on vacation. Based on prior research, we suspected rule-directed learning (RL) to facilitate explicit knowledge and working memory, resulting in good initial results but less stability over time. Discovery learning (DL), on the other hand, tends to be more robust to stress and fatigue and shows greater stability over time. We hypothesized to observe a similar pattern when teaching the deployment of a surface marker buoy (SMB) as a safety skill to diving beginners. We expected the DL group to produce the skill with a higher quality in a retention test compared to RL.
METHODS:
28 beginners with pool experience (age: 22.5 ± 2.6; 6 females, 22 males) were randomly assigned to the RL- (N=14) or DL- group (N=14) and familiarized with the concept and necessity of deploying an SMB in recreational diving. In the PRE-test, both groups received the same criteria for successful deployment of an SMB underwater (i.e., stable positioning and trim, time, and safety). Only the RL-group watched an additional video with visual presentation and explicit instructions about how to perform the skill successfully. After 10 min of underwater familiarization (at 4 m depth, in a 5 m pool) and six practice trials, three evaluation trials were performed. The latter were video-recorded and independently evaluated by three licensed SCUBA dive instructors on the basis of various sub-criteria to water position/trim, time, and safety. A retention test was performed after 45 (± 5) days without any further practice or information.
RESULTS:
The PRE-test showed no significant differences between groups (all P>0.05). DL scored overall higher in water positioning / trim (P=0.566; d=0.793) and safety (P=0.869; d=0.822), while scores for time were about equal (P=0.697; d=23.341) with 75.5s (±20) for DL and 79.0s (± 26.1) for RL. After the test, DL reported to have focused more on criteria relevant for safety than RL and felt more satisfied with their performance (P=0.028; d=0.885). Analysis of retention-test data is still pending but will be available for presentation at ECSS 2021.
CONCLUSION:
The two educational concepts did not evoke any differences in the quality of performing the safety skills after the initial acquisition. We assume that the special and challenging underwater environment might claim cognitive resources to the detriment of performing such skills. In this case, and especially for inexperienced beginners, the suspected higher amount of implicit knowledge gained in the DL-group might benefit a reproduction of the skill in the retention test.

THE EFFECT OF AUGMENTED FEEDBACK ON PERFORMANCE IN CRICKET: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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INTRODUCTION:
Cricket is a global sport played by two teams, competing using the specialised and dynamic tasks of batting, bowling, and fielding. To help improve skills and performance outcomes, coaches often provide augmented feedback. Appropriately structured feedback has multifaceted impacts on perceptual-motor learning and performance of sporting skills [1]. When viewed through an ecological dynamics perspective, feedback may facilitate the exploration of the learner's perceptual-motor workspace, allowing identification of key information sources within performance environments to couple functional movements to [2]. Further, technological developments have aided the contexts feedback can be presented and used [3]. However, current understanding of the role of augmented feedback within the context of skilled cricket performance is limited. Therefore, this systematic review with meta-analysis assessed the role and effectiveness of augmented feedback interventions on skill-based performance outcomes in cricket.
METHODS:
Six electronic databases were searched (SPORTDiscus, CINAHL, MEDLINE, Scopus, Web of Science, PSYCHInfo) from the earliest date to 17 December 2020. Full text studies where augmented feedback was provided to the participant, with a focus on improving skill-based cricket performance were included. A modified Downs and Black checklist was used to assess quality and risk of bias. Meta-analyses were conducted for perception (anticipation accuracy) and action (performance success) attributes using a random-effects model in R.
RESULTS:
Ten studies (n=169 cricketers) met the inclusion criteria; five (n=119 cricketers) were included in the meta-analyses. Meta-analysis results demonstrated improvements in favour of the intervention groups that experienced augmented feedback, with a large effect size for improvements to anticipation accuracy (g=1.21, 95%CIs [-0.37, 2.78]) and a medium effect size for overall performance success (g=0.55, 95%CIs [-0.39, 1.50]). The majority (n=9) of studies used video-based technology to deliver feedback, primarily (n=4) following an occluded trial. Importantly, most studies were limited in terms of representative design (n=7), which negatively impacts on opportunities for augmented feedback to facilitate movement exploration; critical components within an ecological dynamics framework.
CONCLUSION:
Interventions featuring augmented feedback improved perception (anticipation accuracy) and action (performance success) outcomes in representative and non-representative batting and fielding tasks in cricket. However, given the small number of studies available, and lack of research isolating the provision of feedback, further research within an ecological dynamics framework is warranted to fully elucidate the role of augmented feedback, and potential role technology may play within representative learning design to promote exploration in cricket.
1. Lauber & Keller 2002; 2. Correia et al. 2019; 3. Libermann et al. 2002

THE EFFECTS OF GAME SPECIFIC TASK CONSTRAINTS ON THE BASKETBALL PLAYERS PERFORMANCE

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During the different game actions that basketball players face during a game, they must constantly identify, select and organize the most relevant information that allows them to make the most appropriate decision at all times. All this is conditioned by a high level of uncertainty, little information and time limits, circumstances that make it difficult to consciously and rationally evaluate the consequences of possible responses, which may lead to an increase in mental load and reduced performance.
This is why players need to use incidental or intuitive processing mechanisms, as it consumes few attentional resources and as a consequence does not generate high levels of mental load, allowing it to act quickly and efficiently in such circumstances. To do this, the trainer will design and propose tasks where he does not provide any kind of feed-forward, manipulating the contextual variables of the task through restrictions that respect the internal logic of the game, waiting for the subject to explore and search for the answers autonomously. , thereby seeking to generate adaptive motor behaviors to generic stimuli.
Objectives: To analyze the effect of temporal and functional restrictions on the behavior of basketball players in training stages.

Design: An intra-subject design with repeated pre-test and post-test measurements on a 3x3 collective game situation has been developed.
Method: Twelve participants belonging to a mens basketball team aged between 11-12 years (M = 11.26; ± 1.48) with less than 4 years of basketball practice. The type of sampling selected was non-probabilistic of an opinional nature. Attack possession time and number of pots per player were limited.
Results: The temporal and functional limitations favor the players to develop certain behaviors without the need for direct coach intervention, being able to act autonomously and effectively in such circunstances.
Conclusions: In general we can affirm that the subjects benefit if the amount of information that is provided during the tasks is reduced. For further studies, the manipulation of certain variables in different reduced situations is proposed, in order to identify patterns of environment-action interaction.
KEYWORDS: constraints, affordances, small side games, control learning, decision making, basketball.

THE EFFECT OF PLACEBO AND NOCEBO ON RUNNING PERFORMANCE DURING HIGH INTENSITY INTERVAL TRAINING

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INTRODUCTION
Research in sport and exercise science suggested that both placebo and nocebo can influence sport performance (1), with effect ranging from small to moderate (2). Most of studies proposed as treatment nutritional ergogenic aids or peripheral stimulation. However, a more ecological approach lowered into a conventional training session, could exploit some parts of the training itself to administer placebo/nocebo effect. The aim of the present study was to test the effect on the running performance of a placebo/nocebo treatment consisting in conditioning manipulation plus verbal suggestion.
METHODS
Thirty-nine active young students (mean age 22±0.9) were randomly assigned to CONTROL group, PLACEBO group and NOCEBO group. The experiment consisted in 3 sessions. During TEST Session participants performed the Cooper test to evaluate the cardiorespiratory fitness. During SESSION 1, they performed a high intensity interval training (HIIT) protocol till exhaustion (30s all-out, with 2 min of passive recovery) preceded by a conventional warm-up (20min, running and dynamic stretching). During SESSION 2, warm up consisted in the FIFA 11+ (20min, running and balance exercises) (3), and was used as conditioning treatment. Participants' expectancy about warm-up efficacy in not-changing/improving/worsening the following HITT performance was manipulated through verbal suggestion in CONTROL/PLACEBO/NOCEBO groups. At last, during the HIIT rest-period a surreptitious manipulation, consisting in none/positive/negative verbal feedback about the current performance, was administered to CONTROL/PLACEBO/NOCEBO group. The time to exhaustion (TTE) and total running distance (TRD) were considered as performance outcome. The rate of perceived exertion (RPE), maximal heart rate (HR) and blood lactate ([LA+]) were used to determine whether participants reached the exhaustion. ANOVA was applied to evaluate normally-distributed parameters, whilst non parametric analysis were applied to not-normally distributed data.
RESULTS
TTE and TRD values of the PLACEBO group significantly increased in SESSION 2 with respect to SESSION 1 whilst they significantly decreased in NOCEBO group ($p<0.05$ and $p<0.01$, respectively). Further, TTE ($p<0.05$) and TRD ($p<0.01$) in SESSION 2 of the PLACEBO group was significantly higher than those of NOCEBO group. No differences appeared in the CONTROL group. No differences among groups and session were found in RPE, HR and [LA+].
CONCLUSION
The innovative placebo/nocebo treatment proposed in this study succeeded to improve/worsen the running performance of active young adult. These results provide insight on the interaction between the athlete's cognitive domain and the running performance and pave the way for the application of combined cognitive/motor strategies during training.
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3 Silvers-Granelli et al. Am J Sports Med, 2015

EFFECTS OF VISUAL TRAINING ON SKILL ACQUISITION OF TENNIS NOVICES: EVIDENCE FROM THE EYE-TRACKING DATA

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Introduction
Tennis is a sport where visual function is fundamental for accurately striking balls delivered at high speeds, and players are required to quickly distinguish different types of strokes from a variety of ball rotations, bounce heights and speeds. Despite its importance, few attempts have been made to clarify the effects of visual training on the striking ability and visual function of tennis players. Therefore, the study aimed to examine whether visual training could help enhance the skill acquisition of novice tennis players.
Methods
A total of 64 young adults with none experience of playing tennis volunteered to participate the study, and they were randomly assigned into experimental group (visual and tennis training, 18.8±0.6 years) and control group (tennis training, 18.9±0.7 years). All participants had normal or corrected-to-normal vision. Both groups undertook two sessions of 90-min tennis training for 12 weeks while the experimental group performed additional five ball juggling practices for 20 minutes prior to the technique training. Numbers of forehand and backhand rally were recorded and binocular eye data during ball flying phase, ground contact phase, were collected via wearable eye tracker (Tobbi Pro Glasses 2) before and after the intervention. A two-way repeated ANOVA was conducted to compared the between and within group difference in eye-tracking related statistics and rally length.
Results:
There was a significant interaction effect between training group and time for the following eye-tracking variables when players stroke the forehand and backhand ball: fixation count (N), total Fixation time (s), average fixation time (s), average pupil diameter (mm), max pupil diameter (mm), average absolute distance (px), blink count (N) ($p<0.05$). The pos-hoc tests showed that the experimental group had better performance in eye-tracking variables than the control group ($p<0.05$), and their performance at post-training tests were significantly better than that of the pre-training ($p<0.05$). While the rally length was significantly increased after the intervention for both groups, there was no statistically significant between-group difference for post- training test ($p>0.05$).

Conclusion
The current results provided empirical evidence that visual training helped improve the visual search efficiency when compared with players that only had practiced techniques. Moreover, participants who had undertaken visual training had more efficient search pattern (i.e., longer fixation duration with fewer fixations, wider max pupil diameter). For a fast-tempo sport like tennis, visual training could promote sports performance of novices.

DROPOUT REASONS AMONG PROMISING SRI LANKAN JUNIOR TRACK AND FIELD ATHLETES

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INTRODUCTION:
Track and field are one of the most popular participation sports in Sri Lanka. Even though Sri Lankan junior athletes are gifted enough to win many international competitions, the majority of them do not progress to the senior level for a variety of reasons. However, the reasons why junior athletes discontinue participating are still unknown. According to studies, the dropout rate among young track and field athletes is very high (1,2,3,4). Although several studies have given useful information about the relative value of different participation motivations, there has been less research on the factors that influence dropout from various youth sports (2). Early sports specialization could impair motor skill development as well as a lifelong interest in games and sports (4,5). Therefore, this study aimed to identify the main reasons for dropout in Sri Lankan junior track and field athletes.
METHODS:
With institutional ethics approval, 64 dropped-out athletes, who have not reached up to the senior international level between 2008 and 2015, were selected randomly from a list obtained from the Athletic Association of Sri Lanka. The subjects were drawn from different geographical areas within Sri Lanka. A descriptive cross-sectional study was conducted using, pretested, self-administered questionnaire, which contained 38 items under the main six subscales (Education, training and practices, economic reasons, social and cultural, motivation aspects and family reasons) in a 5-point Likert scale. Data analysis was conducted using descriptive statistics and an Independent sample T-test using SPSS version 23 software.
RESULTS:
The level of significance was set as 0.05. The mean (SD) age of the participants was 25.42 (2.06) and the majority (56.2%, n=36) were males and the rest were females (43.8%, n=28). According to the dropout reasons subscales, the highest mean (SD) scores were reported for training and practice (23.92±4.68), economic (14.03± 3.20) and education (13.08± 3.20). Significantly, higher mean differences were reported in males for economic ($p<0.34$), family ($p<0.007$) and training and practice ($p<0.21$) related reasons. The highest dropout rate was reported in 2012=84.6%.
CONCLUSION:
The retention of competent young athletes to represent Sri Lanka at senior-level international athletic events could be ensured by improving organizational structure, motivational learning environment, advanced technological and physical training facilities, and implementing an LTAD approach.
Keywords: Drop-out reasons, track and field, junior athletes
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METHODOLOGY FOR THE INDUCTION OF COMPETITIVE STRESS DURING VIRTUAL REALITY TRAINING IN SHOOTING SPORTS

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Introduction
Stress management is a major issue in mental preparation and can be used to monitor sports performance.
To meet this challenge, the SportTrooper project was developed. It is a digital solution which aims to improve the management of stress in the course of high level shooters. It consists of a virtual environment (VE) dedicated to the display of a 360° video, a software interface, physiological indicators (heart rate, electrodermal response) and a sound system for shooting instructions. The solution's objective is to generate competitive stress during training, and to improve performance in competitions thanks to a better understanding of the stress experienced by each athlete.
The objective of this preliminary study is to verify that psychological readings of the real finale are higher than those of the finale shot with the SportTrooper solution.
Methods
9 french high level shooters participated in this experiment.
The immersion consisted of a training session (24 shots fired) where the shooter listened to the sound of a finale during 30 minutes, like a real one. For this first immersion, the shooter is in the SportTrooper solution, without video in order to verify that the VE itself does not produce psychological changes.
To carry out psychological measurements, the level of perceived stress, anxiety and work load of the athletes is evaluated thanks to three psychological questionnaires [1] [2] [3]. These questionnaires were self-administered by the 9 shooters after a final (control condition) and after their immersion in the solution.
Results
The mean PSS-10 score is higher for the competition ($x=16.6$; $\sigma=3.0$) than for the training with the VE ($x=14.2$; $\sigma=4.7$) but not significantly ($p=0.24$ with 95% confidence interval).
The mean STAI-Y score is significantly higher for the competition ($x=42.1$; $\sigma=5.5$) than for the training with the VE ($x=35.2$; $\sigma=6.5$) ($p=0.037$).
The mean NASA-TLX score is also significantly higher for the competition ($x=71.7$; $\sigma=11.7$) than for the training with the solution ($x=57.8$; $\sigma=14.1$) ($p=0.048$).
Conclusion and Discussion
This preliminary study shows that real competitions produced a higher level of psychological stress in comparison with the finale's immersion. A next step would be to test the solution's immersion with videos of competition, and to have physiological readings.
Long-term objective of this study is improving athletes' performances through a habituation effect to competitive stress.
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OP-SH02 Promotion

DO PHYSICAL FITNESS COMPONENTS HAVE A COMBINED IMPACT ON HEALTH-RELATED QUALITY OF LIFE DURING ADOLESCENCE? DADOS STUDY

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UNIVERSITAT JAUME I

INTRODUCTION:
Prior cross-sectional research suggested positive associations between individual physical fitness (PF) components (i.e., cardiorespiratory capacity, muscular strength, and motor competence) and health-related quality of life (HRQoL) in adolescents (1). Although PF components may synergically influence health, only one cross-sectional study investigated the combined impact of two PF components on adolescents' HRQoL (2), while the combined longitudinal association remains unknown. The purpose of the present study was to investigate the combined impact of PF components at baseline with HRQoL at 24-month follow-up in adolescents.
METHODS:
This is a longitudinal research carried out between 2015-2017. The analyses included 199 adolescents (13.9 ± 0.3 aged at baseline) from DADOS study. Cardiorespiratory capacity was assessed using the 20m shuttle run test. Muscular strength was assessed using the standing broad jump test. Motor competence was assessed using the 4×10m shuttle run test. Adolescents above the sex- and age-specific 60th percentile were classified as high PF level based on Tomkinson et al. (3) for cardiorespiratory fitness and muscular strength, and based on Ortega et al. (4) for motor competence. A fitness index, ranging from 0 to 3 points, was defined according to the number of PF components classified as high. HRQoL was evaluated using the KIDSCREEN-10 questionnaire. Logistic regression analysis was conducted to examine the likelihood of achieving high HRQoL according to the fitness index controlling for sex, pubertal status, socioeconomic status, waist circumference, and HRQoL at baseline. A p-value of $p<0.05$ was set as statistically significant.
RESULTS:
Logistic regression analysis revealed that adolescents with higher fitness index at baseline were more likely to achieve greater HRQoL at follow-up. The association between the fitness index at baseline and HRQoL at follow-up was significant for the adolescents with a score of 1 (OR: 4.588; 95% CI: 1.367-15.397), 2 (OR: 8.242; 95% CI: 2.357-28.818) and 3 (OR: 11.683; 95% CI: 3.134-43.547), compared to their peers with a fitness index score of 0.
CONCLUSION:
Our results reveal greater HRQoL at 24-month follow-up in those adolescents achieving at least 1 PF components. Thus, our findings show a cumulative positive impact of PF components at baseline on HRQL 24 months later. From a public health perspective, these findings underline the key role of promoting enhancements in overall PF in order to improve adolescents' health and well-being.
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EVALUATION OF BARRIERS AND FACILITATORS RELATED TO PHYSICAL ACTIVITY PROMOTION DURING PREGNANCY: FOCUS GROUP ANALYSIS OF PREGNANT WOMEN' AND MIDWIVES' POINTS OF VIEW.

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INTRODUCTION:
Regular physical activity (PA) during pregnancy offers health and fitness benefits for both mothers and babies. Besides, acute physiological responses to PA are generally increased during pregnancy compared to non-pregnancy. Therefore, the World Health Organization (WHO) recommends pregnant women without contraindications to perform 150 minutes of moderate PA per week. Nonetheless, PA levels are generally low among pregnant women. In order to tackle the situation providing new PA promotion strategies, investigating which determinants are involved, is required. Thus, the aim of this survey was to assess through focus groups the barriers and facilitators related to PA promotion during pregnancy, from both pregnant women and midwives' points of view.
METHODS:
Both pregnant women and midwives have been recruited at the University Hospital of Bologna (Italy) and included in focus groups carried out in the period between July 2020 and April 2021. The meetings were held online, due to SARS-CoV-2 restrictions. Focus groups were audio-recorded, transcribed verbatim and anonymized before being coded using a thematic approach. Data analysis was conducted according to the COM-B model framework.
RESULTS:
A total sample of 10 pregnant women aged 30-46 and 10 midwives aged between 43 and 61 were involved in 4 focus groups. The majority of the sample had already experience in practicing PA (10/10 women and 5/10 midwives) and overall reported to be aware about the importance of PA during pregnancy. However, the main barriers expressed by pregnant women were related to lack of specific indication and opportunity concerning PA practice, low levels of self-efficacy and motivation regard performing PA. On the other hand, midwives reported a lack of specific information and knowledge related to PA promotion in pregnancy and lack of confidence in managing PA, as main obstacles.
CONCLUSION:

Findings suggest that to sustain health and wellbeing improvement, both midwives and women need to be trained to support PA promotion during pregnancy. In particular, according to the COM-B model, for pregnant women to practice more PA it is necessary to improve their physical and psychological capability such as self-efficacy, but also social and physical opportunities to share PA practice and increase motivation. In light of this, the role of midwives, especially in enhancing women' self-efficacy and empowerment, could be crucial. These results can be used as a basis for stakeholders to target specific PA interventions in order to make pregnant women able to meet PA recommendations.
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The World Health Organization. WHO Guidelines on Physical Activity and Sedentary Behaviour; WHO: Geneva, Switzerland, 2020.

DOES PRIMARY SCHOOL CHILDREN CHANGE THEIR PHYSICAL ACTIVITY LEVELS DURING SARS-COV-2 OUTBREAK? A PRE-POST ANALYSIS FROM THE I-MOVE STUDY

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Background:
The World Health Organization (WHO) guidelines recommend children to reach at least 60 minutes of Physical Activity (PA) per day. In addition, the current literature confirms that PA improves general health, quality of life and provides mental wellbeing. Despite this, global estimates indicate that low percentages of children and adolescents comply with WHO recommendations. Moreover, to date, due to restrictions imposed during the SARS-CoV-2 pandemic, PA levels of individuals might be negatively affected. The aim of this study was to analyse the changes in PA levels from November 2019 to January 2021 in a randomized-sample of primary school children from the I-MOVE study.
Methods:
The assessed variables were: physical activity levels measured through Actigraph accelerometers considering Weekly time spent in Sedentary Behaviour (W-SB), Weekly and Daily time spent in Moderate to Vigorous PA (respectively W-MVPA and D-MVPA), self-reported levels of PA using a validated questionnaire for children (PAQ-c) somministrated through the Google Forms web survey platform. Data were analysed by IBM SPSS version 22 (Statistical Package for Social Science) from baseline (T0) and time 1 (T1) using paired T-test to find possible significant differences between 2019 to 2021.
Results:
A total of N= 80 children, mean age 8.88±1.42, were evaluated using Actigraph accelerometer and a subsample of N= 52 were evaluated using PAQ-c.
A pre-post change (Δ) from November 2019 and January 2021 was calculated. Weekly Sedentary Behaviours statically increased: ΔW-SB= +1156 minutes time spent in sedentary (p-vale<0.01) and Daily time spent in moderate to vigorous PA decreased: ΔD-MVPA= -13.51±18.47 minutes with a significant p-value<0.001. The Weekly time spent in moderate to vigorous PA decrease from Baseline to Time 1: ΔW-MVPA= -20.76±116.66 but without statically significant p-value. Finally, considering PAQ-c results, we reported a negative change from T0= 2.97±0.75 to T1= 1.96±0.58 with a p-value<0.01.
Conclusion:
Results showed that PA level, both objectively measured and self-reported were lower than 1-year before, in a sample of Italian primary school children. Classroom Physical activity programs should be included in guidelines as an integrative approach carried out in cooperation with educative stakeholders trying to re-establish the recommended level of PA.
Reference:
WHO Guidelines on Physical Activity and Sedentary Behaviour; WHO: Geneva, Switzerland, 2020.

EFFECTIVENESS OF WORKSITE WELLNESS PROGRAMS BASED ON PHYSICAL ACTIVITY TO IMPROVE WORKERS' HEALTH AND PRODUCTIVITY: A SYSTEMATIC REVIEW.

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Introduction: An increasing number of employers are concerned about improving the health levels of their employees. Some of the indirect consequences are an increase in productivity and a decrease in absenteeism. The practice of physical activity (PA) has proven to be an effective resource for improving the well-being of workers and reducing their stress levels. Therefore, promoting initiatives that contribute to increase PA and reduce sedentary behaviours could have positive consequences for employees. However, it remains unknown which type of intervention strength-based training (ST), aerobic-based training (AT) or a combination of both (CT) has the greatest impact on worker health and productivity. Aims: The purpose of this review was to (1) analyse the effect of worksite programs based on PA on employees' health (2) investigate how workers' productivity is impacted by those interventions, and (3) identify which type of intervention (ST, AT, CT) is more effective for improving both the health and productivity of workers. Material y methods: This systematic review was carried out and reported following the PRISMA guidelines. Only RCT targeting non-clinical population and published in English were included in the study. Population, Intervention, Comparison and Outcome elements were used to define eligibility criteria. PubMed, Web of Science, MEDLINE, Scopus and SPORTDiscus databases were searched from 1997 to 2020. Reference lists were examined, key journals were hand-searched and experts were contacted in case of doubt. Interventions were included only if they involved any form of physical activity either at work or in leisure time promoted by the company. The data extraction, quality assessment, and determination of the risk of bias were performed independently and in duplicate by two investigators, using PEDro Scale. Results: After 3142 titles and abstracts were screened, 19 articles were reviewed, and 16 were accepted. These studies contained preliminary evidence for the positive effect of some form of exercise intervention in the workplace on productivity and health. All the health variables improved in some of the studies analyzed; variables related to cardiorespiratory fitness, muscle strength, and muscle disability improved in all the studies where they were included. The improvements on productivity variables are not as relevant as in the case of health. Work-ability is the variable that is most positively affected after interventions based on physical activity. Finally, interventions based on aerobic exercise seems to be more effective on employee's productivity and health (78,4%) than strength training (67,5%) or the combination of both types of intervention (61,85%). Conclusions: All interventions analysed increased the employees health. However, the improvements in productivity are not as remarkable as on health-related variables. Interventions based on aerobic training report better results on workers' productivity and health.

PSYCHOLOGICAL INTERVENTIONS AIMED TO INCREASE MOTIVATION AND PROMOTE ADHERENCE TO HEALTHY PATTERNS IN EXERCISE APPS: AN EVALUATION QUESTIONNAIRE PROPOSAL

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Introduction:
Limitations and barriers have been identified when planning physical activity (PA) programs, where psychological factors play a very important role. In addition, several studies have also identified behavioural counselling interventions, which can be applied to PA programs. Many applications (apps) in the market offer training plans which could potentially help to lead more active lifestyles; however, attrition rates to training apps tend to be high and behavioural change remains still a challenge. Little is known about the different variables and specific barriers to adherence to exercise or PA within the new technologies. Thus, the goal of the present research work is to design and validate a questionnaire in order to determine the motivational profile of app users.
Methods:
In order to determine the motivational profile of Mammoth Hunters App users, an App that personalizes exercise plans, a questionnaire was created, applied, and validated. When users submitted their permission to use the app, they were invited to answer the questionnaire. Anonymous information about demographics, app usage, prevalence of chronic disease, emotional and motivational status was collected. The final proposed questionnaire consisted of 9 questions with 5 answer options based on a Likert scale.
Results:
A total of 231 active users answered the motivational questionnaire and 222 were considered as correctly answered. Participants descriptive data showed: age range 18-69 years, weight range 50-80 kg, mean BMI=24. Correlations between their motivation (intrinsic vs extrinsic) and their levels of engagement to their exercise plan, were obtained. The questionnaire (created specifically for this study) showed consistency (Cronbachs alpha-coefficients >0.70). Exploratory factor analysis of the questionnaire with 9 items resulted in two factors (intrinsic and extrinsic motivation) explained 63,14% of variance. Exploratory factor analysis presented satisfactory goodness fit indices.
Conclusions:
A motivational questionnaire was created, applied, and validated with Mammoth Hunters app users. Therefore, the results that have been sorted out by questioning can be considered reliable for the determination of the individuals motivation. These results will enable us to identify user patterns, predict adherence rates and dropout risk, and develop a series of motivational interventions to promote user adherence to exercise to reduce app attrition.

EXPLORING THE ENJOYMENT OF THE INTERGENERATIONAL PHYSICAL ACTIVITY

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INTRODUCTION
Intergenerational physical activity (PA), practiced closer together by preschool children and elderly people, could be a pleasant method to prevent elderly sedentary behaviours. In the elderly, intergenerational programs seem to prevent loneliness and depression, improve attitudes towards young people, and participants self-esteem. These programs effectively maintain physical functioning, intellectual activities, mental well-being and health-related life quality. In young people, intergenerational programs lead to decrease preconceptions and negative attitudes towards elderly, improving in empathy [1]. The study purpose was to provide a basis for developing an intergenerational PA program.
METHODS
A survey design based on three questionnaires assessing enjoyment were administered to 140 participants (aged 67.8 ± 9.1): the Global Physical Activity Questionnaire (GPAQ), assessing the sedentariness degree, Physical Activity Enjoyment Scale (PACES-Q) assessing enjoyment for the physical activity usually practiced and Physical Activity Enjoyment Scale assessing the enjoyment for a hypothetical intergenerational program (PACES-INT). Successively, the sample was divided into sub-groups based on Age, Gender, Marital status, Education, Employment, Sports background, Sedentariness level and Residential location. Four multi-choice questions, aiming to have guidelines in organizing an intergenerational program, were administered.
RESULTS
The 44.3% of the sample found the PA practiced pleasant, whereas 81.5% enjoyed the intergenerational program (only 7.1% expressed a negative judgment). Separated one-way ANOVAs showed significant differences in PACES-INT for Gender, ($p= 0.009$), Residential location, ($p< 0.001$), and Employment ($p= 0.004$). About 80% of the sample would adhere to the intergenerational programs, despite the fatigue fear and logistic or family relationship problems.
CONCLUSION
This survey confirmed that Intergenerational PA, could be a pleasant method for elderly people to prevent sedentary behaviours. The lack of correlation between age and enjoyment for intergenerational PA, showed a willingness to this new proposal, regardless of age. Participants preferred a recreational activity based on games and sport involving both generations in achieving a common goals than fitness programs.
Regarding the barriers in carrying out this program, the responders indicated as the main barrier was the fear of fatigue during the activity and the difficulty to keep up with children.
Intergenerational proposals should be more familiar to older Italian people, who are still unaware of their existence, although these programs exist for a long time and have demonstrated benefits for both younger and older people.
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THE ROLE OF AUTONOMY SUPPORT FROM PEERS, PARENTS AND PHYSICAL EDUCATION TEACHERS ON ADOLESCENTS' PHYSICAL ACTIVITY AND HEALTH-RELATED QUALITY OF LIFE: A ONE-YEAR TEST OF THE TRANS-CONTEXTUAL MODEL

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INTRODUCTION:
Physical activity (PA) and health-related quality of life (HRQoL) have been endorsed as key outcomes in pediatric population health (Meade & Dowswell, 2016; Poitras et al., 2016). Research based on the trans-contextual model (TCM; Hagger & Chatzisarantis, 2016) emphasize the facilitative role of perceived autonomy support from parents, peers, and physical education (PE) teachers on adolescents' PA. The current research adds by adopting the TCM as a theoretical framework in investigating the role of perceived autonomy support from parents, peers, and PE teachers on both adolescents' PA and HRQoL. An additional objective was to investigate the reciprocal relationships over a one-year period between adolescents' HRQoL and PA.
METHODS:
A four-wave longitudinal design was used. Adolescents (N = 264) aged between 11 to 15 years old (M = 13.24; SD = 0.96) completed measures of perceived autonomy support from PE teachers, peers and parents, and autonomous motivation in PE at baseline (T1), autonomous motivation in leisure-time and constructs of theory of planned behaviour five weeks later (T2), self-reported PA and HRQoL another five weeks later (T3), and self-reported PA and HRQoL at one-year follow-up (T4).
RESULTS:
A well-fitting structural equation model (CFI = .96, RMSEA = .057) revealed that perceived autonomy support from peers, parents, and PE teachers are all important predictors of PA and HRQoL mediated by variables specified in TCM (indirect effects βs > .021, ps < .009). Both regressions of PA (β = .45, p > .001) and HRQoL (β = .55, p > .001) on themselves over a one-year period (T3 – T4) were significant. Importantly, PA measured at T3 significantly predicted HRQoL measured one year later at T4 (β = .20, p > .001), but not vice versa (β = .04, p = .523).
CONCLUSION:
The current findings highlight the importance of autonomy support from peers, parents, and PE teachers in increasing adolescents' PA and HRQoL. Importantly, the unidirectional cross-lagged relationship with the flow from PA to later HRQoL suggest researchers that intervention programs focusing on promoting PA behaviour in adolescents should produce the most pronounced effects if the aim is also to promote their HRQoL.
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THE ROLE OF HOME ENVIRONMENT IN THE EARLY MOTOR DEVELOPMENT OF YOUNG CHILDREN: A CROSS-SECTIONAL STUDY BASED ON TGMD-2

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Introduction:
The preschool period is crucial for a childs gross motor development. Hence, scientific research, targeted guidance, and training are required to improve gross motor competence in a child during this critical period. The home environment, as the primary living environment for young children, has an important influence on their development in numerous ways. Thus, we have investigated, in detail, the ways in which the home environment influences gross motor development of young children aged 3–6 years and their gender differences.
Method:
The participating children's (N = 600, boys =291, girls =309) actual gross motor competence was measured using the Test of Gross Motor Development-2 (TGMD-2). The scores of gross motor skills and its sub-terms, object control and locomotor skills were obtained. A customized questionnaire was used to gather basic family information provided by the parents and quantify their attitudes (divided into four subdimensions: involvement, concern, awareness, and support), education, and income. Finally, the correlations between the total TGMD-2 score and its sub scores with family environmental factors and gender differences were compared and analyzed.
Result:
1. There were no significant differences between scores of the four sub-items of the attitude dimension, and the total score was relatively high (83.91±10.30).
2. The mean correlation coefficient for the four sub-dimensions of parental attitude to locomotor skills and object control was 0.470 (median = 0.428, range = 0.353–0.636). Parental support had a more significant effect on operational skills (r=0.542, P< 0.01), and their concern played the most important role in children's locomotor skills (r=0.636, P< 0.01).
3. The correlation coefficients between locomotor skills, object control, and total parental attitude scores were approximately at the same level: 0.656 and 0.658 for males and 0.578 and 0.529 for females, respectively.
4. The correlation coefficients of education, income, and object control were 0.432 and 0.507, respectively, both of which were higher than their correlation coefficients with locomotor skills (0.427, 0.333).
Conclusion:
It was found that most parents recognize the importance of physical education, and their attitude toward it considerably influence childrens gross motor skills. Boys are more likely to be influenced by parental attitudes toward sports than girls. Higher economic levels can significantly affect operant sports, presumably due to the availability of more exercise equipment at home. The findings of this study made it possible to state that the family environment and conditions can play an important role in a childs gross motor development, providing adequate and enriching development opportunities for gross motor skills.

EXAMINING OF THE BEHAVIOURAL REGULATION IN EXERCISE QUESTIONNAIRE (BREQ–2) AMONG HIGHER EDUCATION STUDENTS IN CENTRAL AND EASTERN EUROPE

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UNIVERSITY OF DEBRECEN

The factors influencing sports motivation create a complex system, integrating internal drivers such as the love of sport and the need for competence and external factors such as the environment, institution, or media. Our study defined and examined the types of sport motivation by measuring tool that has not been used in the studied region yet (the Behavioral Regulation in Exercise Questionnaire [BREQ–2, Markland & Tobin, 2004]). The research explores the socioeconomic and institutional factors influencing student sport motivation and presenting the peculiarities of sport motivation following the variables mentioned above among students learning in Hungary, Slovakia, Ukraine, Romania and Serbia. Also, we aim to explore the sociocultural, socialisation and institutional factors that affect the frequency of students sporting activities in each country and the role of sport motivation in addition to these factors. The PERSIST 2019 research was carried out in 2018–2019 among students learning in higher educational institutions of the Northern Great Plain and four cross-border regions (Highlands, Transcarpathia, Vojvodina, Transylvania and Partium) where Hungarian is the language of instruction (N=2005). It is one of the easternmost higher educational regions in the European Higher Education Area. The target population was second-year BA/BSc training and second- or third-year students learning in undivided training. The Hungarian sample is a quota and representative for the faculties, the field of training and funding. In the cross-border institutions, we used probabilistic sampling, and students were approached in groups at university/college courses, where they were comprehensively interviewed in the same grades. Based on the factor analysis, instead of the original five factors, three factors could have been detected in the sample (intrinsic and identified motivation, introjected motivation, and extrinsic and amotivation). Based on the results of logistic regression analysis, higher social status facilitates the retention of intrinsic motivation, while lower socioeconomic status facilitates extrinsic and amotivation. This can also be seen in the frequency of sporting activities, as the highest frequency of sports can be detected among people with high intrinsic motivation. The strongest effect is exerted by individual variables, of which intrinsic and identified motivation supports regular physical activity as a significant factor among students in all countries.

Reference

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A COMPARATIVE STUDY ON THE INTERVENTION EFFECTS OF HIIT AND MICT ON BINGER EATING DISORDER TENDENCY FOR FEMALE UNDERGRADUATES

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INTRODUCTION:
This study aimed to explore the effects of eight-week high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) on Binger Eating Disorder tendency (BED) for female undergraduates with low physical activity.
METHODS:
A total of 366 female undergraduates who were non-physical education majors (20.4 yrs), were recruited through advertisements on campus. First, 92 participants with eating disorder tendency were selected using the EDI-3 RF (including Drive for Thinness [DT], Bulimia [B], and Body Dissatisfaction [BD] scales and five behavioral questions) combined with BMI. Second, 61 of the 92 participants with higher scores on the B scale and lower levels of physical activity (accelerometer, NL-2000, USA) were screened. Then, 45 among the 61 female undergraduates who promised to participate throughout the experiment, were randomly divided into HIIT(H), MICT(M), and control groups(C) of 15 people each. The H and M groups practiced HIIT and MICT, respectively, three days a week for eight weeks. During the experiment, the subjects were asked to record their daily diet logs. The exercises were as follows: (1) H: treadmill exercise, 10 min of warm-up, 5×(3min of 90% VO2max exercise + 3min of 50% VO2max exercise), 5 min of relax, 3 times/wk. (2) M: treadmill exercise, 10 min of warm-up, 30min of 65% VO2max, 5 min of relax, 3 times/wk. (3) C: daily physical activity (PA) without extra exercise. Before and after 8 weeks, the eating habits, daily intake and level of PA of C remained basically unchanged. Moreover, except the interventions, there was no significant difference in the level of PA among C, M and H. At the end of 8-week experiment, EDI-3 was conducted again.
RESULTS:
(1) Compared to the C group, the B scores were significantly reduced in both H and M groups (H: from 13.13 ± 4.49 to 9.38 ± 6.43; M: from 14.31 ± 6.22 to 11.44 ± 7.10; both $P<0.05$), and the reduction in group H is greater. (2) The BD score was significantly decreased in group H (from 27.06 ± 8.72 to 19.13 ± 6.34, $P<0.05$) but not in group M ($P>0.05$).
CONCLUSION:
The results of this study suggest that (1) both the eight-week H and M interventions could reduce the risk of B in female undergraduates, and the reduction in group H is greater. (2) It was H not M that could reduce the risk of BD in female undergraduates.(This work was jointly supported by the National Natural Science Foundation (Grant No. 31571229) and the Qinghai province science and technology project (Grant No. 2021-SF-156).)

OP-SH03 Sport and PA: Cognition - Intellectual - Impairment

THE EFFECT OF THERAPEUTIC HORSEBACK RIDING PROGRAM ON SOCIAL INTERACTION AND COMMUNICATION IN CHILDREN WITH AUTISM SPECTRUM DISORDER

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INTRODUCTION:
Children with autism spectrum disorder (ASD) typically have impairments in social communication and stereotyped behavior patterns. Educational approach and behavior therapies for children with ASD have attracted increasing attention over the past decade. Various therapeutic interventions have been studied and found to be effective in reducing the impairments in children with autism spectrum

disorder (ASD). There has been increasing interest in using animal-assisted interventions (AAIs) as an alternative approach to therapeutic rehabilitation for children with ASD, and many studies have reported that AAI has significant benefits for the cognitive, psychological, and social behavior of children with ASD. The present study was designed to examine the effects of a 16 weeks therapeutic horseback riding program on social interaction and communication skills in children with autism spectrum disorder.
METHODS:
Eighty-four children diagnosed with ASD, aged between 6 and 12 years old, were recruited for this study. All selected participants met the DSM-V criteria, and a total of sixty-one participants (N = 61) completed the study. A quasi-experimental design with an experimental group and control group was implemented for this study, taking measurements at pre-test, interim-test, and post-test to monitor the behavior changes in social and communication throughout the 16-week intervention. Repeated measures ANOVA and the independent sample t-test were used for data analysis, to assess the difference between the experimental group and control group.
RESULTS:
The results indicated that the THR program had positive influences on overall social skills and communication, based on the SSIS and the ABLLS-R scores, compared to the control group ($p < 0.05$). A notable improvement in the overall social interaction score was observed from the interim-testing point to post-test. In addition, participants in the therapeutic horseback riding (THR) group achieved significant improvements on six out of seven items in their communication evaluations. In conclusion, after 16 weeks of intervention, the THR program significantly enhanced the subdomains of social and communication skills in the areas of social interaction, communication, responsibility, and self-control, compared to the control group.
CONCLUSION:
The current study investigated the effects of a 16-week therapeutic horseback riding program on social interaction among children with autism. The results of the study suggested that the THR program may be beneficial for children with ASD in the areas of social skills, communication, responsibility, and self-control. Animal-assisted interventions (AAIs) are known to be beneficial for children with developmental disorders, especially children with ASD. AAIs may increase sympathy and understanding of other's minds through specially structured social interactions. Another possible explanation for the effectiveness of the intervention for children with ASD is the nature of the THR program. The program is structured, goal-directed, progressive, and involves interrelated interactions.
In summary, the structured routines, visual cards, scripts, prompts, and natural environment of the THR are considered essential and evidence-based key points for training children with ASD and make it possible to develop and improve their social and communication skills. The findings of this study are not only in line with the results of the existing literature, but also provide evidence of the efficacy of horseback riding programs as a therapeutic approach for children with ASD.

THE IMPACT OF INTELLECTUAL IMPAIRMENT ON GAME RHYTHM AND PERFORMANCE IN BASKETBALL

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INTRODUCTION
In the recent years, there has been a growing interest in the identification of critical variables of basketball performance of players with and without Intellectual Impairment (II). Game rhythm, defined as the teams 'frequency of ball possessions', seems a promising dimension to analyse sport-specific performance. However, research is still scarce. This study aimed to examine the impact of game rhythm on basketball performance and to explore how game rhythm develops over the course of a basketball game for players with and without II.
METHODS AND RESULTS
Ball possession data were obtained through video observations (53 II-games) and open-access FIBA play-by-play records (53 non-II games). A two-way MANOVA ($p \leq .05$) and a three-way ANOVA ($p \leq .05$) revealed that basketball players with II adopt a faster game rhythm ($F7,202 = 9.536$, $p = .000$) and regulate their game rhythm differently throughout the game ($F2.88, 600.55 = 6.04$, $p = .001$) compared to players without II. Moreover, a slower game rhythm may be more beneficial for basketball players with II as it is increasing their likelihood to win the game ($F1,104 = 4.200$, $p = .043$).
DISCUSSION
The study took a step further to understand how II impacts on game rhythm and the ability of players with and without II to regulate their actions and intuitively respond to environmental cues during a basketball game. The differences between the two groups might be related to the decision-making, tactical proficiency, and self-regulatory deficits of individuals with II, but these assumptions warrant further investigation. Finally, the study sheds more light on how individuals behave, perform, and distribute their energy during an exercise bout, and how principles related to pacing are relevant in a team sport such as basketball.

THE RELATIONSHIP BETWEEN FUNDAMENTAL MOVEMENT SKILLS AND EXECUTIVE FUNCTIONING UNDER THE CONSIDERATION OF THE DEVELOPMENTAL STATUS IN KINDERGARTEN CHILDREN

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INTRODUCTION
Since Diamond's (1) theoretical claim that motor development and cognitive development are fundamentally interrelated several studies have examined the relationship between motor skills and executive functions (EF) in young children up to adolescents. These cross-sectional observations, however, revealed heterogeneous results ranging from weak to moderate correlations. To substantiate the assumption that cognitive and motor tasks are mastered by common control processes, we reassessed the motor-cognitive performance link in a normative sample of preschool children. Our study focused on the strength of the relationship between fundamental movement skills (FMS) and EF when controlling for chronological age and developmental status.
METHODS
Cross-sectional data of 117 children (51% girls) from a local kindergarten aged 3 to 6 years were assessed on a battery of process-oriented and product-oriented tests for fundamental motor competences on locomotion, object manipulation and postural control. A second comprehensive battery was employed to determine executive functioning on inhibitory control, cognitive flexibility, working memory and short-term memory. Children's developmental status was evaluated by two educationalists applying the EBD 48-72. To statistically control for age and development, zero-order and second-order partial correlations were calculated between FMS and EF.
RESULTS
Both FMS and EF were linked to the exact age (.416 CONCLUSION

Our findings supports the notion that EF and gross-motor skills share some information processes in young children. Even though controlling for age and development reduced the shared variance between specific FMS and EF items substantially, the relationship was found to be still stronger than recently stated in a similar age group (2). The link between single-leg stance performance and EF of inhibition and working memory is in line with findings in adolescents (3) and strengthens the evidence that balance abilities rely on attentional resources and interference control in younger and older children.

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INFLUENCE OF MOTOR SKILLS ON THE AFFECTIVE-EMOTIONAL DEVELOPMENT OF CHILDREN

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The regular practice of Physical Activity (PA) is associated with health benefits for children and adults from different perspectives, being very important for appropriate growth and development. Participation in family PA when children are young is a determining factor in the acquisition of healthy physical habits.

Among the new educational methodologies, Cooperative Learning and Gamification have been selected. The former is used to group schoolchildren and intervene in learning in a positive way, as working in groups improves attention, participation and knowledge acquisition. Gamification is applied because it generates motivating experiences that can be applied in other areas such as games (Kapp, 2012; Cachón et al., 2021).

Objectives: 1. To design and implement a PA programme for children aged 3 to 8. 2. To encourage joint PA in children and parents, sharing play, movement and fun. 3. To make this programme the basis for the learning of new teaching methodologies in these age groups for students of the Degree in Teaching: cooperative learning and gamification.

Method: Longitudinal study, over 4 years, consisting of the design and didactic application of innovative physical activities, adapted to children and parents together, with the following contents: 1. Circuits with different routes and the use of balls of different sizes and materials. 2. Narrations by the parents and staging of motor stories by the children. 3. Initiation to sports through games. 4. Music, expression and dance. 5. Yoga and relaxation.

Procedure and Instruments: Participation of 20 students and their families from whom photos and videos are taken with parental consent for later analysis. Personal written reflection of the student teachers. Semi-structured interview of parents. Observation sheet and oral narratives of the children.

Results and Conclusions: Parents express their motivation towards PA shared with children. The children explain their satisfaction with the classes held and with what they play with their classmates and their family; they express their emotions on frequenting a facility for adults and carrying out PA with their parents. The student teachers emphasise the benefit for their professional preparation of the implementation of PA with children and families, as well as their learning of the new didactic methods that are fundamental in the 21st century.

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Pre-recorded CP-poster presentations

CP-AP01 Physical activity promotion

ACCURATE ASSESSMENT OF ENERGY EXPENDITURE IN THE MAIN SEAFRONT WALKING ROUTE OF LAS PALMAS DE GRAN CANARIA TO PROMOTE HEALTH-RELATED TOURISM

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INTRODUCTION: The touristic industry is greatly influenced by factors affecting lifestyle and health. Many tourists are interested in maintaining a physically active lifestyle and burn some calories to reduce their body fat or compensate for some occasional excessive food intake. Walking is among the most common activities undertaken by tourists and represents a well-tolerated exercise modality for those seeking health-related tourism. Nevertheless, no information is available regarding energy expenditure (EE) associated with walking routes. Thus, the purpose of this investigation was to determine the EE incurred by men and women in one-kilometre-long sectors while walking in the most popular walking route in Las Palmas de Gran Canaria using state-of-the-art methods.
METHODS: For this purpose, physical education students (11 men/3 women) and adults with overweight or obesity (11M/8W) were recruited (M:33.8±12.5yr, 88.7±15.2 kg, 27.2±4.5 kg.m-2; W:39±10.9 yr, 78.1±13.1 kg, 27.7±4.9 kg.m-2. The volunteers walked a round trip along the 6.5-Km main seafront walking route of Las Palmas de Gran Canaria (total distance=13km) while their EE was assessed by a portable metabolic cart (COSMED K5). To record walking speed, subjects were equipped with a heart rate strap (Garmin Forerunner 210) equipped with GPS connected to the K5. Body weight was measured with a balance scale and body composition by DEXA. EE was calculated in kcal using Peronnet and Massicotte equation (1991).
RESULTS: During the walks, the physiological responses were similar in men and women. Although there were marked differences in physical characteristic between men and women, EE was only slightly higher in men (M=10.8±1.0; W=10.4 ± 0.8 kcal/kg, P=0.047). During the walks, men burned more carbohydrates (154.9±46.7g) than women (115.2±19g), while the amount of fat burned was similar in both sexes (M=36.2±14.5g; W=37.4±8.1g). EE increased slightly more than 10 kcal per km from the beginning to the end of the route. The information obtained was used to create "walkers´points of interest" (WAPI), to provide feedback on EE and related recommendations for tourists walking along the route.
DISCUSSION AND CONCLUSIONS: A walking route has been defined extending along the main beach and natural surrounding areas of Las Palmas de Gran Canaria, a principal European touristic destination. We have defined the energy expenditure and walkability of the route, aiming for a wide range of age and adiposity levels. Given that walking is an essential part of the touristic activity and that physical fitness, including weight and appearance is a significant-top priority for the three Atlantic markets, the concept of WAPIs with recommendations regarding walking velocity, hydration, and the number of calories burned depending on the distance covered is introduced, which could enhance the attractiveness of this and other touristic destinations in the context of health-related tourism.
Grants: ProID2017010106

THE HERIZON PROJECT - A FORMATIVE EVALUATION OF A HOME-BASED PHYSICAL ACTIVITY INTERVENTION FOR ADOLESCENT GIRLS

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INTRODUCTION:
Over 84% of adolescent girls in the UK and Ireland are not meeting the minimum physical activity (PA) guidelines [1], putting them at an increased risk of multiple health issues. The HERizon Project is a home-based multi-component PA intervention for adolescent girls in the UK and Ireland. This study was a formative evaluation which aimed to assess the feasibility and preliminary effectiveness of HERizon during the initial COVID-19 lockdown restrictions.
METHODS:
42 female participants aged 13 to 16 years old (mean = 14.2, SD = 1.1), were randomly allocated to: (i) the HERizon intervention group (n = 22) or (ii) a wait-list control group (n = 20). The HERizon Project was a six-week intervention developed using self-determination theory. Participants in the intervention group were asked to complete three PA sessions of their choice each week, engage in weekly need-supportive videocalls with an Activity Mentor, and had access to live workouts and a private social media group where they could interact with other girls if they so wished. The primary outcome was self-reported habitual PA. Secondary outcomes included cardiorespiratory fitness (20 m shuttle run), muscular strength (standing long jump), muscular endurance (push up test), and psychosocial outcomes (Perceived Competence Scale, Body Appreciation Scale, Self-Esteem Questionnaire, Behavioural Regulation in Exercise Questionnaire). Outcome measures were assessed at baseline and after the six-week intervention. Quantitative and qualitative process evaluation data were also collected which included online interviews (n = 10). Linear mixed modelling and reflexive thematic analysis were used to analyse the data.
RESULTS:
There was no significant change in habitual PA between groups ($p = 0.767$). The intervention group had significantly increased cardiorespiratory fitness ($p = 0.001$), muscular endurance ($p = 0.022$), intrinsic motivation ($p = 0.037$), and body appreciation ($p < 0.003$) in comparison to the wait-list control group. All participants in the intervention group completed the intervention and compliance to the intervention was high (participants completed 18 ± 2 sessions). The live workouts, behaviour change support and routine were identified as key facilitators to adhering to the programme. Benefits of the programme reported during interviews included increased enjoyment of exercise, increased confidence and improved performance.
CONCLUSION:

Although no change in PA was observed, HERizon resulted in improved physical fitness and psychosocial outcomes. These preliminary findings, alongside positive findings for feasibility and acceptability, highlight potential benefits from the home-based intervention, thus further investigation is warranted. Future trials should include accelerometers for a more accurate measurement of habitual PA.
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VALIDITY AND RELIABILITY OF GAIT ANALYSIS USING MOBILE SYSTEMS DURING WALKING AT SELF-CHOSEN COMFORTABLE VELOCITY

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INTRODUCTION:
Basic gait analysis provides important insights in specific clinical conditions, such as overall health, quality of life, and mortality. 3D-motion capture systems (3D-MOCAP) are utilized as the gold standard for gait analysis due to high reliability and validity [1]. However, they are cost-intensive, require laboratory settings and experts for application [1]. Mobile gait analysis systems are getting popular, but their validity for basic gait analysis is conflicting. Therefore, the purpose of the study is to investigate the validity of two mobile systems (IMU system, smartphone application) against a 3D-MOCAP and to assess intra-session reliability.
METHODS:
11 healthy participants (7 women; 30±4years; 1.75±0.08m; 71±14kg) walked at self-chosen comfortable velocity three times on a 14 meters walkway equipped with the three different systems (3D-MOCAP: Vicon system (VS), 15 cameras, markers at heels and posterior superior iliac spine; IMU-system: Muscle Lab (ML), sensors affixed on the front dorsum of feet; smartphone application: Gait Analyzer (GA), fixed on L3 vertebra level). Outcome parameters were number of steps, gait velocity [m/s], and cadence [steps/min]. Average values of the three trials were compared between systems by repeated measure ANOVA or Friedman ANOVA depending on data distributions with post-hoc tests based on paired t-test or Wilcoxon signed-rank test. Further, intraclass correlation coefficient (ICC 3.1), test-retest variability (TRV%) and Bland-Altman analysis (BA; Bias ± Limits of Agreement) were assessed. Reliability of ML and GA measures was tested by ICC and TRV comparing the results of the first to the third trial.
RESULTS:
Statistically significant differences of the two mobile system compared to VS were found for steps via ML system (VS 19.1±1.6, ML 13.2±2.1, p=0.001), and for steps, gait velocity and cadence via GA system (steps: VS 19.1±1.6, GA 15.8±2.6, p=0.011; gait velocity: VS 1.6±0.1, GA 1.2±0.2, p=0.001; cadence: VS 111.5±8.3, GA 93.5±19.9, p=0.010). ICC, TRV and BA between VS and ML were for steps: ICC=0.13, TRV=44%, BA=-5.4±5.3 for gait velocity: ICC=0.11, TRV=7%, BA=-0.1±0.4 and for cadence: ICC=0.82, TRV=1%, BA=1.8±16.8. Between VS and GA the respective results were for steps: ICC=0.16, TRV=18%, BA=-3.1±6.1, for gait velocity: ICC=0.04, TRV=31%, BA=-0.4±0.5 and for cadence: ICC=0.37, TRV=18%, BA=-17.3±33.3. Test-retest reliability for ML showed ICCs from 0.43 to 0.88 and TRVs from 7% to 9%, and for GA from 0.72 to 0.79 and 10% to 11% respectively.
CONCLUSION:
Validity of basic gait parameters of both mobile systems retrieved by the manufacturer's software (without further processing) is limited, despite fair to good intra-session reliability. Therefore, clinical application of mobile systems should be handled with care.
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DOSE-RESPONSE ASSOCIATION BETWEEN PHYSICAL ACTIVITY GUIDELINES AND SEDENTARY BEHAVIOUR ON WORKERS' QUALITY OF LIFE OF A SPANISH MULTINATIONAL COMPANY.

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INTRODUCTION:
Full-time workers typically spend approximately one-third of the day or more at the workplace (1), which means a limited time to achieve World Health Organization (WHO) guidelines. A better health-related quality of life (HRQOL) is associated with improved results for both the employee and the company. Therefore, the aim of this study was to analyse the associations of four mutually exclusive behavioural categories between compliance with WHO guidelines and sedentary time on HRQOL in workers of Grupo Red Eléctrica.
METHODS:
An online survey was sent to 1,810 employees of the company Grupo Red Eléctrica. Physical activity and sedentary behaviour were measured by the IPAQ-SF and Occupational Sitting and Physical Activity Questionnaire (OSPAQ), respectively. EQ-VAS was used to determined HRQOL. Workers who met the WHO guidelines (i.e., ≥150 minutes of moderate-to-vigorous physical activity and ≥2 days of strength training per week) were classified as physically active. Low sedentary was defined as residing in the first quartile of the time spent in sedentary activities throughout the day. Those who completed all the questions, were included in the statistical analysis and classified into one of four behavioural groups: (1) 'Physically active & low sedentary', (2) 'Physically active & high sedentary', (3) 'Physically inactive & low sedentary', and (4) 'Physically inactive & high sedentary'. Two-sample t-test was used to compare compliance with WHO guidelines and sedentary status on HRQOL. A multiple linear regression model adjusted for covariates was used to investigate the differences in HRQOL across the four movement categories.
RESULTS:
1,004 employees of the company Grupo Red Eléctrica participated in this cross-sectional study (238 women; ≥18 and ≤65 years). Workers who met physical activity guidelines, showed significantly higher levels of HRQOL ($p < 0.001$). Likewise, higher levels of sedentary behaviour were significantly associated with lower HRQOL ($p < 0.001$). Compared to 'Physically inactive & high sedentary' workers, those classified as 'Physically active & low sedentary' and 'Physically active & high sedentary' had significantly better levels of HRQOL ($\beta = 5.47$; $p = 0.006$ and $\beta = 4.10$; $p = 0.003$; respectively). However, no significant association was found for 'Physically inactive & low sedentary' workers ($\beta = 0.89$; $p = 0.570$).
CONCLUSION:

Employees meeting with WHO guidelines were associated with higher levels of HRQOL, even in those who spent a high amount of time being sedentary. Beyond reducing sedentary time, companies should direct their efforts to promote an active lifestyle among their workers to improve their well-being and thus have better results.
References:
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CP-AP02 Training and testing I - Intervention

ACUTE RESPONSES TO DIFFERENT BLOOD FLOW RESTRICTION-RESISTANCE EXERCISE PROTOCOLS DIFFERING IN THE MOVEMENT VELOCITY

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INTRODUCTION:
Blood flow restriction resistance exercise (BFR-RE) has been shown to be effective to induce muscle hypertrophy (1) and strength gains (2), as well as marked acute metabolic and hypertrophic signalling responses (3,4). This method has traditionally been conducted performing each repetition at a control manner (1,2,3,4). However, it remains unknown whether the lifting velocity could influence on the effects induced by these methodology. Therefore, the aim of this study was to analyze the acute responses to two different BFR-RE protocols that differed in the movement velocity in the full-squat (SQ) exercise.
METHODS:
Twenty resistance-trained young men (age 24.8 ± 4.2 years, height 1.78 ± 0.05 m, body mass 76.0 ± 8.9 kg) performed two different BFR-RE protocols in the SQ exercise which consisted of three sets of eight repetitions against the 60% 1RM with 2-min rest between sets and a 50% of individual arterial occlusion pressure, but differed in the lifting velocity: maximal intended velocity (MaxV) or half-maximal velocity (HalfV). The occlusion was maintained during the entire training session (excluding the warm-up) and all repetitions were recorded with a linear velocity transducer and a force platform. In order to analyze the acute responses to these BFR-RE protocols, blood lactate concentration, countermovement jump (CMJ) height, maximal isometric force (MIF) and maximal rate of force development (RFDmax) during a maximal isometric SQ contraction, as well as mean propulsive values of velocity, power and force (MPV, MPP, MPF) against the 60%1RM load were assessed at Pre- and Post- protocols, in this order. Moreover, time under tension (TUT) and MPV were evaluated in each set to observe the descriptive characteristics of both protocols
RESULTS:
Significant “protocol x time” interactions ($p<0.05$) and significant “time” effects ($p<0.05$) were found for MPV and TUT in the training sets. Significant ($p<0.05$) differences between HalfV and MaxV protocols were found in MPV and TUT in each set. In addition, only MaxV showed significant ($p<0.05$) decreases in MPV and increases in TUT throughout the sets. On the other hand, no significant “protocol x time” interactions ($p<0.05$) were found for any variable analyzed. However, significant “time” effects ($p<0.05$) were observed for all parameters. Both protocols resulted in significant ($p<0.001$) impairments in MPV, MPP, MPF, CMJ height, and MIF. Moreover, both protocols induced significant ($p<0.001$) increases in blood lactate concentrations, but no significant changes in RFDmax were observed.
CONCLUSION:
Despite both protocols showed different values of MPV and TUT in each set performing the SQ exercise under the same conditions (volume, intensity, rest time and partial occlusion), the mechanical and metabolic responses were similarly decreased in both protocols.
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WHICH STRENGTH TRAINING IMPROVE LOWER-BODY STRENGTH AND SPORT-RELATED PERFORMANCE BETTER FOR TEAM SPORT ATHLETES?: SQUAT VS DEADLIFTS

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INTRODUCTION:
The purpose of this study is to examine the effects of squat and deadlift training on lower-body strength and sport-related performance. These results may suggest more effective and scientific lower-body strength training method for athletes and coaches.
METHODS:
This study recruited 19 male amateur soccer players (age = 23.16±2.00, height = 173.48±4.46cm, body weight = 70.91±7.45kg, body fat = 17.87±5.73%, V̇ O2max = 45.82±5.06ml/kg/min) with no reported injuries for at least 6 months. All participants took the basic tests (anthropometric characteristics), then familiarized to the exercises over three training sessions over the course of a week. Afterwards, all players were tested for knee extension and flexion maximal voluntary isometric contraction test (MVIC), vertical jump (VJ), 20m sprint (SP) and agility (AG). Following baseline testing, players were randomly allocated to a squat group (SQ, n= 6), deadlift group (DL, n= 6), or combined group (COM, n=7) and participated in a strength training intervention twice per week over a course of 6 weeks. Statistical analysis was performed using SPSS/PC+ Ver. 25.0K. A two-way repeated ANOVA was conducted in order to measure the effects of Type (Squat, Deadlift, or Combined) and Time (Pre vs. Post). Paired t- test and one-way ANOVA were used to determine differences between groups.
RESULTS:
The results of this study are as follows. All groups experienced a significant increase the peak torque of knee extensor ($p<.05$). Only the SQ and COM groups experienced a significant improvement in peak torque of knee flexor ($p<.05$) With no significant difference between the two groups. The DL group showed a significant increase in vertical jump ($p<.05$) but no significant change was found in either the SQ or COM groups. Furthermore, no significant difference existed between groups. No significant changes in 20m sprint times and agility performance was found in any group.
CONCLUSION:

These results suggest that, squat and deadlift training both might positively affect at knee extension. However, squat training is suggested to be more effective than deadlift training for knee flexion. Similarly, vertical jumping is suggested to be improved by deadlift but not squat training. Interestingly, 20m sprint times and agility performance is suggested to not be affected solely by traditional resistance training method such as squatting and deadlifting. Future studies examining the effects of training on athlete performance in relation to training level, training periodization (e.g. training phase, preseason, in-season) are required to better understand the physiological adaptations to specific training.

EFFECT OF SPRINT INTERVAL TRAINING BY BICYCLE ERGOMETER ON AEROBIC CAPACITY OF COLLEGE LEVEL FOOTBALL PLAYERS DURING OFF-SEASON

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INTRODUCTION:
Football is a sport where aerobic capacity, muscular strength, power and speed are of paramount importance for most of the actions during playing. Especially aerobic capacity is thought to be necessary since elite players run about 10-12 km during a game, and the total distance is positively related to VO2max [1]. However, VO2max of football players significantly decreased between a 6-week off-season period [2]. Recently, it has been reported that low-volume short-duration sprint interval training that improves VO2max to a similar extent of traditional high-volume endurance training [3]. Therefore, the aim of this study was to assess the effect of sprint interval training (SIT) executed by a bicycle ergometer during off-season on peak oxygen uptake and blood lactate level during incremental exhaustive exercise.
METHODS:
Volunteers (19.4±1.2yr, 171.8±4.2cm, 63.0±3.0kg) were all college level male football players, who were randomly assigned to Training group (TG; n = 9) or Control group (CG; n = 8). TG performed SIT, 2 or 3 days per week over an 8-week during off-season. SIT comprised 3 bouts of 30-sec 'maximal effort' sprints following 2-min of very low intensity cycling. A workload was set at 4.3±0.6 kp, which was obtained by anaerobic power test in Power Max VII. All volunteers participated in normal football training for 2-h, 3 days per week. Before (Pre) and after (Post) the 8-week period, TG and CG performed incremental exhaustive exercise test (IEE) by the bicycle ergometer. Volunteers started cycling at 20 W and the work rate increased by 20 W every 3-min to 160 W. From this work rate point onward, increments of 20 W were given every 1-min until volitional exhaustion. Peripheral blood was collected at every 3-min until 160 W and after exhaustion for analyzing lactate acid (bLa) concentration. Heart rate, blood pressure and respiratory gas parameters were measured by automatic gas analysis system throughout the test. Volunteers provided both verbal and written consent according to the guidelines of the Helsinki Declaration.
RESULTS:
In CG, VO2peak significantly decreased from Pre (55.4±2.5 ml/kg/min) to Post (51.3±2.3 ml/kg/min). There was also a significant decline in maximal work rate reached in IEE (Pre; 265.0±14.5 W, Post; 252.5±14.1 W). However, in TG, VO2peak unchanged from Pre (56.6±2.6 ml/kg/min) to Post (56.6±2.4 ml/kg/min), and maximal work rate significantly increased from Pre (257.8±10.8 W) to Post (286.7±10.0 W). The values of bLa from 100 W to 160 W in TG were significantly lower than those of CT at Post, although peak bLa values after exhaustion did not differ in groups (TG; 14.0±0.8 mmol/L, CT; 13.7±0.7 mmol/L).
CONCLUSION:
We suggest that sprint interval training executed by the bicycle ergometer is to sufficiently increase muscle power while maintaining aerobic capacity of college level football players during off-season.
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EFFECT OF AN 8-WEEK WEIGHT TRAINING PROGRAM ON ROPE SKIPPING PERFORMANCE

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INTRODUCTION:
Rope skipping is an aerobic sport and has been widely used as a common cardiorespiratory training protocol in both fitness and athletic training programs. Double under is one of the important tricks in rope skipping. To master double under requires rope skipper to jump higher and swing faster. Weight training has been widely adopted in sports training for powering athletic performance. However, it is still unknown whether weight training program could benefit performance of double under. This study aimed to examine the effect of an 8-week weight training program on double under performance in secondary school students.
METHODS:
Forty secondary school students were recruited in the study and were divided into two groups: an experimental group (EXP) (n=20) and a control group (CON) (n=20). Both groups maintained their regular training for 8 weeks, while the EXP group attended two additional weight training sessions per week. The weight training program included three phases of fundamental endurance training using the barbell. All participants completed double under test (DUT), push-ups test (PUT), sit-ups test (SUT), and repeated squat test (RST) before and after the 8-week training.
RESULTS:
Significant interaction effects (group × time) were observed for all measurements. Specifically, compared with the pre-tests, there were significant improvements in post-tests in EXP including DUT (71.9 ± 29.2 vs. 104.9 ± 30.1, p = 0.029), PUT (35.9 ± 7.4 vs. 43.6 ± 6.3, p = 0.029), SUT (28.7 ± 8.6 vs. 45.1 ± 8.4, p = 0.001), and RST (36.9 ± 5.2 vs. 44.9 ± 5.3, p = 0.000). In contrast, the only improvement in CON was found in RST (34.75 ± 5.50 vs. 36.9 ± 5.12, p = 0.001). There were no differences between pre-tests and post-tests in CON regarding DUT (76.55 ± 32.51 vs. 81.9 ± 32.29, p = 0.120), PUT (35.55 ± 6.57 vs. 38.80 ± 5.64, p = 0.08), and SUT (31.90 ± 8.97 vs. 35.00 ± 9.56, p = 0.198).
CONCLUSION:
These results suggested that an 8-week weight training program may improve performance of continuous double under in rope skipping in secondary students.

CP-AP03 Training and testing II - Cross - sectional

ISOKINETIC AND HANDGRIP STRENGTH ON PORTUGUESE MALE U-17 RINK HOCKEY PLAYERS: CHARACTERISTICS BY PLAYING POSITION

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INTRODUCTION:
Rink hockey is an indoor intermittent team sport, played with specialized four wheeled quad skates and a wooden stick to play a hard rubber ball. Despite the sport specific skills, the demands of rink hockey seem to be similar to other elite team sports, and therefore, strength is a key component. The rink hockey specific practice as well as the specialization on a particular playing position may result on different strength patterns and consequently muscle imbalances, which increases the risk of injury. Along with winning, the rate of injuries in sports is one of the major concerns. The aim of the present study was to identify the strength levels (hand grip and isokinetic), and muscle imbalances (knee extensors vs knee flexors) by playing position (defenders vs. attackers) in young rink hockey players.
METHODS:
The sample comprises 60 Portuguese male U-17 rink-hockey players [defenders (n = 29) and attackers (n = 31)]. Static grip strength was assessed with an adjustable dynamometer (Lafayette model, Lafayette, IN, USA). Isokinetic knee extension (KE) and knee flexion (KE) were measured in concentric (CC) and eccentric (ECC) action using a calibrated dynamometer (Biodex System 3, Shirley, NY, USA) at angular velocity of 60°·s-1. Isokinetic concentric conventional ratio (CON(KF)/CON(KE)), functional extension ratio (ECC(KF)/CON(KE) and functional flexion ratio (CON(KF)/ECC(KE)) were calculated.
RESULTS:
No playing position differences ($p > 0.05$) were found between training experience (years of practice), age (CA and SA) and anthropometry (stature, body mass or sum of skinfolds). Hand grip strength did not differ ($p = 0.516$; $d = 0.17$ between defenders (40.1 ± 8.3 Kg) and attackers (38.7 ± 8.4 Kg). Although no differences between playing position were identified on the different peak torques (PT), the functional flexion ratio was significantly different ($p = 0.024$; $d = 0.56$) between defenders (0.45 ± 0.09) and attackers (0.40 ± 0.07). Nevertheless, no differences were found between defenders (0.86 ± 0.16) and attackers (0.91 ± 0.18) on the functional extension ratio.
CONCLUSION:
Whilst differences between defenders and attackers were noted, both groups presented higher functional flexion ratios than the reference values (0.3). This indicates that both playing positions presented lower PT on the ECC KE compared to CON KF, or higher PT on CON KF compared to ECC KE.
Although differences were identified for functional extension ratio, both defenders and attackers presented ratios < 1 (reference value). This suggests muscle imbalances, in particular, deficits on the posterior chain of the lower limbs (ECC KF). Therefore, young male rink hockey players may benefit from strength training to reduce/correct muscle imbalances, and consequently decrease the likelihood of injury occurrence, independently of the playing position.

THE CONSTRUCT VALIDITY AND TEST-RETEST RELIABILITY OF PORTABLE JUMP MEASURING SYSTEMS: MY JUMP 2, HOMECOURT & TAKEI VERTICAL JUMP METER FOR MEASURING COUNTERMOVEMENT JUMP

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INTRODUCTION:
Coronavirus Disease 2019 limits onsite sports training and necessitates the development of remote monitoring and assessment of functional performance in sports. Numerous cheaper, non-invasive and safer instruments have recently been invented to serve the purposes. Countermovement jump test, which is commonly used to examine athletes' neuromuscular performance, was probed in this study. Mobile applications and portable assessments make remote self-assessment to be possible. This study aimed to investigate the construct validity and test-retest reliability of three portable measurement systems for countermovement jumps.
METHODS:
Thirty physically active collegiate students (14M : 16F; age 23.03 ± 1.67 years; body mass: 61.89 ± 9.82 kg; height: 167.86 ± 6.27 cm, 4614.52 ± 1332.69 MET-min/wk) participated in this study. Each participant was invited to a laboratory twice with two days in between and performed three jumps on each day after 10 minutes of warm-up and familiarization. All jumps were recorded by My Jump 2 (video frame identification mobile application), HomeCourt (AI motion tracking mobile application) and Takei Vertical Jump Meter (wire-type linear encoder) simultaneously.
RESULTS:
An ANOVA with repeated measures indicated significant differences among the three systems ($p < .001$). Homecourt tended to present the highest jump height mean value (46.10 ± 6.97 cm) compared with Takei Vertical Jump Meter (42.02 ± 7.97 cm) and My Jump 2 (40.85 ± 7.47 cm). High Pearson's correlations revealed a high construct validity among the three systems ($r = 0.81$ to 0.87, $p < 0.001$). A good to excellent reliability of both within-day (intraclass correlation coefficient [ICC]3,1 = 0.74 – 0.96) and between-day (ICC3,1 = 0.80 – 0.96) jump assessments was demonstrated. Reliable coefficients of variation (CV) were shown in all measurements (within-day: 2.96% to 5.91%; between-day: 3.07% to 6.40%). Takei Vertical Jump Meter demonstrated the highest reliability [within-day ICC3,1 = 0.96 (95% CI: 0.91 to 0.98); between-day ICC3,1 = 0.96 (95% CI: 0.92 to 0.98)] compared with the other two devices. The standard error of measurement (SEM) and minimal detectable change (MDC) of Takei Vertical Jump Meter were 1.65 cm and 4.59 cm, respectively.
CONCLUSION:
All three jump measurement systems were reliable for assessing jump height while Takei Vertical Jump Meter was the most reliable. Regarding the pandemic, the two mobile applications, i.e. Homecourt and My Jump 2, would be alternatives for remote assessment. However, when monitoring changes in physical conditions, the same device should be adopted because of the computational differences among the devices.

PEAK LOCOMOTOR INTENSITY IN ELITE HANDBALL MATCHES: EFFECT OF PLAYERS POSITIONS AND TRAINING PRACTICE.

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PSG/INSEP

INTRODUCTION:
Handball being highly intermittent in nature, quantifying movement intensity in competition may assist adapting training demands. Peaks locomotor intensity in team sport has been recently analyzed using rolling averages [1]. While this approach has been investigated in other sports, little is known in handball. The aims of the study were to describe the peak locomotor intensity sustained during matches and compare them with small-sided games (SSGs) commonly used in elite handball training.
METHODS:
SSGs (n=342) and matches (n=121) data were collected from a French elite Handball team. Players' locomotor activity was recorded using 20-Hz Local Positioning System [2] and a 100Hz accelerometer (Kinexon™, Kinexon GMBH, Munich, Germany). To evaluate the decrease in peak locomotor movement intensity as rolling average duration increase, each variable (i.e. Total distance: TD [m]; high-speed running distance: HS [m] and mechanical load: Accel'Rate (AR) [u.a]) was assessed relative to the rolling average periods (0.5 to 15 min) and modelled using a power law relationship for each individual observation. Linear regression of log transformed variables (time and intensity) produced values for slope (decline in intensity) and intercept (the highest theoretical intensity). Difference between match and SSGs and between-position during match (i.e. Backs, Pivots, Wingers) were assessed using linear mixed model and magnitude-based inference.
RESULTS:
During matches, higher peak locomotor intensity was found for Wingers (TD: 156±13m·min-1; HS: 96±12m·min-1; AR: 13±3u.a) compared with other playing position for TD (Backs: 127±10m·min-1; Pivots: 136±13m·min-1); HS (Backs: 56±9m·min-1; Pivots: 57±11m·min-1) and AR (Backs: 11±2u.a; Pivots: 11±2u.a). However, there was no difference between the positions with regard to the slope. Additionally, peak locomotor intensity sustained during matches were largely-to-very largely higher compared with SSGs.
CONCLUSION:
This study showed that, during matches, peaks locomotor intensities sustained by Wingers were higher for all variables compared with other positions. Practitioners should be particularly attentive when loading Wingers, and when necessary should individualise training with the inclusion of top-up running sessions. Moreover, the peak locomotor intensity during the 3 selected SSGs formats were lower than during matches for all the variables. Thus, to reach the locomotor intensity sustained during match, practitioner should consider using isolated conditioning sessions (e.g. short or long intervals, repeated sprints or off-feet conditioning) and keep SSGs for technical and tactical purposes only.

ANALYSIS OF THE DECISION-MAKING TIMES IN REPEATED AGILITY TRIALS: A PILOT STUDY.

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INTRODUCTION:
Situational team sport performances are characterized by a continuously mutual relationship between cognitive and physical factors, making interesting the analysis of abilities which involve both these 2 factors. Agility is the ability to change velocity and direction in response to an external stimulus and has been shown to be correlated with players' decision-making ability [1]. The aim of this study is to investigate if decision-making times (DTMs) and their correlation with the agility times change over the execution of repeated trials.
METHODS:
After warm up, 16 amateur soccer players (age: 19.5 ± 1.8; height: 180.1 ± 6.4 cm; body mass: 74.5 ± 7.8 kg) performed 20 consecutive agility trials. Participants had to sprint for 5 meters, then perform a 45° change of direction to the right or left for further 5 meters, according to a light stimulus. The test has already been shown to be reliable [2]. The recovery time between each repetition was 20 seconds. DTMs were calculated through the later video-analysis of the period between the stimulus appearance and the first lateral movement of the foot which initiates the change of direction [3]. We divided the 20 repetitions into 4 blocks (1-5, 6-10, 11-15, 16-20 repetitions, respectively) for the analysis. Repeated measures ANOVA was used to assess differences between blocks in agility performance (total time) and DMTs. Pearson's r was used to assess correlations between respective agility times blocks and DMTs blocks.
RESULTS:
No differences were found between the four blocks of agility times ($p = 0.432$). No differences were found between the four blocks for DMTs ($p = 0.231$). There was a moderate positive correlation between the first agility and DMT block ($r = 0.626$; $r2 = 0.39$) and between the second agility and DMT block ($r = 0.740$; $r2 = 0.55$). Poor correlation was found between the third agility and DMT block ($r = 0.008$) and the fourth agility and DTM block ($r = -0.120$).
CONCLUSION:
The results showed that the performance (agility time and DMT) remained stable during the repeated trials (1:8 work:rest ratio). However, the strength of the correlation was moderate in the first two blocks (1-10 repetitions), while was poor in the last two (11-20 repetitions). This may suggest that decision-making ability and other different factors in agility (i.e.: acceleration) may play different roles with different relative determination values over the execution of repeated trials.
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EFFECT OF ELITE SPRINTERS' TOE FLEXOR STRENGTH ON SPRINT PERFORMANCE

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INTRODUCTION:
There is some evidence that intrinsic foot muscles propel the body forward during running (1). Nearly 80% of intrinsic foot muscles consists of toe flexor muscles (TFM) (2), whose strength capacity create a good prerequisite for enhanced performances in horizontal movement

directions (3). For being able to run fast, we hypothesized that i) elite sprinters have stronger TFM than a group of sport students, and ii) there is a correlation between elite sprinters' personal best and their TFM strength.
METHODS:
18 male sprinters (21 ± 4 y, 77 ± 5 kg, 1.82 ± 0.04 m) of the German national team with an average 100 m personal best of 10.42 ± 0.21 s and a control group of sport students (n = 28, 25 ± 3 y, 77 ± 8 kg, 1.83 ± 0.06 m) performed three maximum voluntary isometric contractions of TFM for each foot. TFM strength was determined by measuring the moment about the transverse axis of a custom-made dynamometer in 25 degrees toe dorsiflexion. The external moments of force about the axis represented the moments of force produced by the TFM (3). The best of three trials was used for further analysis. Maximum moments were determined as the mean value of a 2 s time window of the plateau region. Statistics: Kolmogorov-Smirnov, unpaired t-test, Pearson correlation.
RESULTS:
TFM strength significantly differed ($p < 0.05$) between sprinters (left: 0.29 ± 0.08 Nm/kg, right: 0.29 ± 0.09 Nm/kg) and non-sprinters (left: 0.22 ± 0.05 Nm/kg, $p = 0.001$, right: 0.25 ± 0.06 Nm/kg, $p = 0.03$). Sprinters' TFM strength did not correlate with 100 m personal best ($r = 0.25$, $p = 0.31$).
CONCLUSION:
Elite sprinters showed 16% to 31% stronger TFM than non-sprinters, but TFM strength was not associated with sprint performance within this homogenous group of elite sprinters. This is in accordance with the findings that foot muscles are more developed in sprinters than in non-sprinters, but muscle sizes may not contribute to achieve superior sprint performance (4). Since a heavy resistance strength-trained group demonstrated values of 0.38 ± 0.07 Nm/kg and 0.40 ± 0.08 Nm/kg for the left and right foot (3), respectively, with the same dynamometer, sprinters have the potential to increase TFM strength by 38%.
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THE EFFECTS OF VIDEO-BASED DECISION TRAINING IN WATER POLO AND THE INFLUENCE OF DECISION REINVESTMENT ON PERFORMANCE

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INTRODUCTION:
Decision making is a key differentiating factor between experts and novices and is a skill which is trainable.1 Research has shown that an individual's tendency to pay conscious attention to the decision making process (decision reinvestment) can influence decision making, especially under pressure.2 There is limited research in decision making in water polo,3 especially in relation to decision reinvestment, so this study used a video-based decision making task to examine the role of reinvestment in the sport of water polo and test its transferability to a real-world context.
METHODS:
Twenty female national water polo players were involved in a 3 week video-based decision training programme. All participants completed the Decision Specific Reinvestment Scale.2 All participants completed video-based decision making tasks in baseline, pre-test, training, post-test, transfer and retention conditions. The baseline and pre-test were carried out 3 weeks apart with no training (within subjects control). The transfer condition required participants to make decisions in the pool after intense physical exertion (work to rest ratio similar to a game). Decision accuracy, response time (RT) and confidence levels were assessed for all tests. Physical exertion was measured using Heart Rate (HR) and RPE measures. Separate repeated measures ANOVAs and planned contrasts were used to detect differences in decision accuracy, RT and confidence between conditions.
RESULTS:
Mean decision accuracy differed across conditions ($F(4,76) = 3.48, p=0.012, \eta p2=.16$) revealing significant differences between the pre-test (50.85%± 9.77) and the post-test (65.94%±9.82) ($p=.007$). The mean RT significantly differed across conditions ($F(3,60)=5.69, p=.007, \eta p2=0.22$) with differences between the pre-test (2509.73 ±854.43) and the post-test (2060.27±359.75) ($p=.010$). The mean confidence levels differed significantly across tests ($F(4,72)=4.64, p=.002, \eta p2=.205$) with higher scores in the post- than pre-test ($p = .003$). HR (pre=69.5±9,post=134.2±15.6 Beats min-1 ; $p< .001$) and RPE (pre=4.0±1.7,post=9.7±0.3;$p< .001$) measures indicated significant increases in physical exertion in the transfer test. Pearsons correlations showed DSRS scores were positively correlated with performance in the post-test ($r=.473, p =.026$) and negatively correlated with RT in retention ($r=-.461, p=.031$).
CONCLUSION:
This study is the first to show the effectiveness of a video-based decision training intervention in water polo and its robustness under physical exertion and over time. The results suggest a positive influence of decision reinvestment on decision making in the post-test and retention but also showed that reinvestment had no detrimental effects on decision making performance under intense physical conditions. It is possible that a higher physical exertion increased attention demands which might have reduced the propensity for decision reinvestment
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2. Kinrade NP,et al. 2010
3.. Royal KA, et al 2006

DESIGNING A TRUNK CONTROL TESTING METHOD FOR THE PARA-DRESSAGE CLASSIFICATION PROCESS, A SYSTEMATIC REVIEW.

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HARTPURY

INTRODUCTION:
Dressage is an equestrian discipline where horse and rider combinations are judged on the quality and accuracy of their movement. Previous studies have shown that superior performance in equestrian athletes (riders and para-riders) is linked to trunk control and stability. For dressage, the para-athlete physical assessment includes a dynamic balance test that is not sport-specific in position or movement. The

development of an evidence-based stability test should be informed by research in across rehabilitation and clinical studies. alongside evaluating existing testing methods used to test athletes in other para-sports. This systematic review aimed to (1) identify established methods of testing aspects of trunk control relevant to para-dressage, (2) collate and present how para-sports test their athletes, and (3) use perspectives and opinions of para-athletes across sports to make a recommendation to inform the design of a Para-dressage specific stability-trunk control test.
METHODS:
Five databases (Google Scholar, PUBMED, ScienceDirect, SPORTDiscus, Web of Knowledge) were systematically search from 1990 to Jan 2021. Papers were collected, screened and put through eligibility criteria following PRISMA guidelines and quality assured using MMAT. Criteria differed for each of the 3 sub-sections of the review.
RESULTS:
Overall, 77 papers were analysed (qualitative n=8, handbooks n=26, quantitative trunk control n=43). Para-athletes emphasise lack of understanding and knowledge around testing and feeling unable to voice opinions during classification. Classifier handbooks show a base-level stability test across sports, and some that consider stability fundamental have developed further testing in sport-specific positions and in unstable conditions. Finally, analysis of trunk testing methods produced the recommendation of a modified limits of stability test in a straddle position (ideally integrating the para-rider's saddle) on an unstable surface.
CONCLUSION:
A composite score approach is advocated instead of using the most ecologically valid anterio-posterior direction as reliability decreases when collecting individual scores. This method is recommended as (1) it simulates the base of support and points of contact, resultant tactile information and stability strategy used on horseback, (2) it matches amended tests in other sports that employ similar sitting postures and experience perturbations, with evidence suggesting it is resistant to training, and (3), testing in this format will be easily understood by para-athletes as the concept of LOS is well-established in the rehabilitation and sport fields and may already be in classifier's scope of practice.

CP-AP04 Training and testing III - Methodology

DETECTION OF CATCHES OR DROPS IN AMERICAN FOOTBALL USING DATA OF WEARABLES AND A NEURAL NETWORK APPROACH

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INTRODUCTION:
Data driven, automated training in professional sports, is currently state of the art in soccer, baseball, and other sports. In American football, even for professional teams, state of the art training requires a high amount of human involvement. Receiving players perform their route running and catching exercises with the involvement of quarterbacks and coaches. With a passing machine and corresponding sensors an automated training would be possible, freeing quarterbacks and relieving coaches from performing simple data acquisition tasks. We hypothesized that we would be able to gather enough data of a player that attempts to catch a ball (using two wearable sensors) to be able to automatically detect catches and drops with an accuracy of 90% using neural networks for data analysis.
METHODS:
In recent years, the use of neural networks for classification tasks in the sports domain has become more prevalent (Minhas, 2019; Stetter, 2019). These experiments were generally performed on already existing datasets. Unfortunately, no dataset of motion data during catching footballs exists, so we had to record our own. Ten male athletes were recruited to record data for around 700 attempted catches under a variety of conditions (standing, jumping, running, one handed, etc.). The passes were thrown either by other athletes or a passing machine (Hollaus, 2018) and were performed with a variety of release velocities and angles. For each pass, two wearable devices (STEVAL-STLKT01V1), one on each wrist, gathered data of accelerations, spin rates and flux densities (9 DOF IMU sensor, with a sampling rate of 1kHz), ambient pressure (100Hz) and audio (8kHz). Each sample of the dataset contains 3 seconds of data. After the attempted catch was completed, data was immediately labeled as a catch or a drop. One forth of the recorded data was used to fit a classification model in the form of a deep convolutional neural network with 1D convolutions and around 2.2 million free parameters. We used Ranger as the optimizer together with a binary crossentropy loss and utilized early stopping as a regularization measure. In addition, we performed an ablation study to determine the impact of the different sensors on the final accuracy of the system.
RESULTS:
Using 100 random train/test splits of the recorded data we were able to achieve a maximum accuracy of 98.86%, a minimum accuracy of 87.43% and an average accuracy of 94.73%. The ablation study revealed that the IMU data was most important.
CONCLUSION:
With state of the art technology and adequate design, it is possible to detect whether a pass with an American football was caught or dropped by a player. This opens up the possibility of automated, streamlined, training of receiving players, likely improving athletic performance.
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THE POSITIONAL AND TEMPORAL RUNNING DEMANDS OF ELITE CAMOGIE PLAYERS FOR TOTAL DISTANCE AND PEAK SPEED METRICS.

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INTRODUCTION:
Camogie is a female stick and ball game, indigenous to Ireland- Hurling is the male equivalent. The game is played on a grass pitch (dimensions: 145m x 90m), with teams composed of fifteen players each. This investigation aimed to report on the positional and temporal running demands over 5-minute intervals during competitive camogie match-play. Previous research in this area is limited to half-by-half

comparisons (Connors et al. 2020, Young et al., (2020), therefore this investigation aims to give greater insight into the demands of match-play.
METHODS:
Thirty-one (n=31) elite senior inter-county camogie players (age: 23.65 ± 3.74 years; height: 167.18 ± 6.25cm; body mass: 66.97 ± 7.49kg) wore 10Hz Playertek GPS (Playertek by Catapult, Australia) units for all games in the All-Ireland championship series. Games were played in quarters (~15-minute duration), with each quarter subsequently broke into 5-minute intervals for analysis. Total distance (TD) and peak speed measures were assessed to quantify players' performance. Data was assessed using non-parametric analysis, with significance set at $p<0.05$.
RESULTS:
Mean total distance and peak speed was 0.45 ± 0.10km and 6.01 ± 0.76m/s, respectively. Mid-fielders covered significantly greater TD than defenders and forwards (ES= 0.37-0.41), with forwards covering significantly higher peak speeds compared to other positions (ES=0.26-0.39). Temporal reductions were also present, with significant differences noted between the 0-5min interval and all second half intervals for TD (ES=0.63-1.37) and 0-5min compared to 50-55min and 55-60min intervals for peak speed (ES=0.58-0.61). Mean TD and peak speed was highest during the 0-5min interval (0.52 ± 0.10km and 6.26 ± 0.66m/s).
CONCLUSION:
Therefore, both positional and temporal differences exist, and position-specific training methods may be necessary. This research gives new-found insight into the running demands of elite camogie players, which may be useful in developing appropriate training methods to match the demands of match-play, and reduce temporal decrements in performance.
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CREATING A RANDOM FOREST TO DETERMINE SUCCESS IN WOMEN'S COLLEGIATE LACROSSE

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INTRODUCTION:
Predicting the outcome of a sports match is difficult due to the variation created by human performance, player mentality, match-ups between teams, match location, environmental conditions, style of play, referees, and specific game scenarios. Traditional linear models have proven ineffective in creating usable equations that hold true across these variations. The purpose of this study was to use a random forest to determine the variables involved in predicting game success (i.e., wins versus losses) in Division I women's collegiate lacrosse.
METHODS:
Archived aggregate game statistics were used for analyses during the 2013-2019 seasons. No individual data were gathered, rather all data collected were composite team data. The following variables for the team of study (TOS) and opponents were recorded for the first half, second half, and whole game: shots, shots on goal, saves, turnovers, clears, ground balls, draw controls, and free position shots. Data were also gathered from the Big South Conference teams for the 2019 season to evaluate if the random forest prediction would hold true for teams outside of the TOS. Data from the 2013-2018 season (103 games) were used as training input to the basic random forest model, with the 2019 season (17 games) used as a hold-out set to test the accuracy of the model. During training, the random forest model parameters were optimized using a cross-validation grid search algorithm. The Boruta method was used to determine which variables were important to the prediction. The optimized model created from the 2013-2018 data was evaluated for outcome prediction accuracy with the 2019 data from 1) the TOS and 2) other teams within the Big South Conference. Big South Conference teams were used to test if the model for the TOS was generalizable to other teams.
RESULTS:
The original accuracy of the random forest model for the TOS was 76.5%, but was improved to 88.2% after optimiziation. The Boruta method determined that 10 variables were most important to determining a win or loss (alpha level 0.001): Shots and shots on goal (1st half, whole game), and opponent shots and shots on goal (1st half, 2nd half, whole game). The model's prediction accuracy for the Big South Conference was 85%.
CONCLUSION:
Taking shots on offense and preventing the opponent from taking shots were the most important predictor variables in this random forest model. These variables predicted match outcomes with similar accuracy between the TOS and matches played between other teams within their conference. The predictor variables seem to be generalizable to other collegiate women's lacrosse teams, which may be useful for coaches when planning game strategies. Subsequent analyses should attempt to remove the "blackbox" nature of random forest analyses to reveal if there is a threshold in these predictor variables to provide context for game success.

HUMAN MOVEMENT VARIABILITY IN VOLLEYBALL SPIKE MOVEMENT WITH VOLLEYBALL CONSTRAINT IN DIFFERENT CATEGORIES OF FEMALE ELITE PLAYERS

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INTRODUCTION:
Attack is described as the most important ability to win a game (1) in youth and senior volleyball games. The volleyball spike approach movement (SM) represents one of the more sophisticated attack actions.The use of nonlinear tools like entropy can be a good alternative to explore the nature of human movement and its relationship with coordinative development (2), reflecting changes in movement variability (MV) during the movement execution and over time. SM oscillations can be evaluated through entropy calculation techniques (3) that allow to identify variability from a spatiotemporal perspective. In general athletes manage to reduce the variability of their sports movements through practice (4), the players are considered experts when achieve mature stage in the SM movement pattern (5).
The aim of this study was to identify the differences in human movement variability (MV) through the experience in SM by category with and without ball constraint.
METHODS:

One WIMU(Realtrack systems) were placed in a belt to forty eight female first division players in 4 different categories: Infanitl (Mean ±SD: Age13,83±0,39; Height: 1,73±0,05; Weight: 57,18±5,74), Cadete (Mean ±SD: Age15,67±0,49; Height: 1,77±0,04; Weight: 65,06±3,69), Juvenil (Mean ±SD: Age18,08±0,79; Height: 1,79±0,05; Weight: 69,90±6,40), Senior (Mean ±SD: Age 22,67±2,53; Height: 1,81±0,05; Weight: 73,99±6,15) who performed SM in both conditions (with ball and without ball). The players performed an eight minutes standardized warm-up after which they realized four sets of six SM, two of them with ball and two of them without ball in random order, completing eight series performed in two sessions on different days. The human movement variability was analysed with entropy values in Sample Entropy (SampEn).
RESULTS:
The SampEn response variable was analysed using a Mixed linear Model, where with or without ball is the main variable explanatory and, category as a secondary variable explanatory. In SampEn without ball (Infantil=0,08; Cadete=0,071; Juvenil=0,06; Senior=0,058) with ball (Infantil=0,093; Cadete=0,088; Juvenil=0,087; Senior=0,089). Without ball Infantil is different to Senior (p=0,0091), to Juvenil (p=0,0623), to Cadete (p=0,0549); with ball Infantil is different to Senior (p=0,0510), to Juvenil (0,0541), to Cadete (0,0549).
CONCLUSION:
At category as a constraint, the MV decreases significantly between the Infantil and Cadete categories, stabilizing in the rest of categories in the condition with and without ball, considering that from Cadete category the SM motor pattern is consolidated, acquiring a maturity level.
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CRITICAL SPEED, D' AND PACING IN SWIMMING: RELIABILITY OF A POPULAR CRITICAL SPEED PROTOCOL APPLIED TO ALL FOUR STROKES

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INTRODUCTION:
For the most valid estimation of critical speed CS, it is recommended that 3-7 performance trial efforts lasting ~2 to ~15 minutes are used, with at least 5 minutes difference in duration between the shortest and longest trials. In front crawl swimming swimming this equates to a range of distances between 200-m to 1,500-m. Such criteria pose practical challenges in a high-performance sport environment as completing more and longer trials causes further fatigue and disruption to an athlete's training schedule. To make CS estimation more practically feasible some researchers and practitioners have used only two relatively short distance performance trial distances, commonly a 200-m and 400-m combination. The reliability and practical feasibility of CS protocols with strong face validity remain unknown in all four swimming strokes. This study aimed to assess reliability and practical feasibility of a CS protocol in all strokes.
METHODS:
32 national-level swimmers (butterfly n=7; backstroke n=8; breaststroke n=7; front crawl n=10) performed three 200-m and three 400-m performance trials in their specialist stroke over a three-week period. CS and supra-CS distance capacity (D') were modelled from the linear distance-time relationship. At the end of the three weeks, all swimmers were asked whether they felt they could or would want to complete an additional 800-m performance trial as part of a CS protocol to give them a valid measure of their critical speed and anaerobic distance capacity.
RESULTS:
Mean CS were 1.22 ± 0.10 m.s-1, 1.34 ± 0.09 m.s-1, 1.18 ± 0.07 m.s-1 and 1.44 ± 0.08 m.s-1 for butterfly, backstroke, breaststroke and front crawl, respectively. Mean D' were 31.07 ± 9.65 m, 19.63 ± 10.01 m, 19.03 ± 7.94 m and 20.10 ± 6.91 m for butterfly, backstroke, breaststroke and front crawl, respectively. There were no significant differences in CS or D' across trials for any of the strokes ($p>0.05$). CS derived from 200-m and 400-m performance trials is reliable (typical error ≤ 0.04 m.s-1; coefficient of variation < 4% for all strokes) while D' is not (typical error 4-9 m; coefficient of variation 13-45%) . ICC analysis showed moderate to excellent relative reliability between CS calculated over the 200-m and 400-m performance trials (ICC ≥ 0.70). D' displayed poor relative reliability for backstroke, breaststroke and front crawl swimmers (ICC ≤ 0.70), but good relative reliability for butterfly (ICC = 0.76). Butterfly swimmers were less likely (14.3%) to say that they would want to complete an 800-m trial as part when compared to backstroke (75%) ($p = 0.041$) and front crawl (90%) ($p = 0.004$) , but not breaststroke (57%) ($p>0.05$) swimmers.
CONCLUSION:
Using 200-m and 400-m performance trials is a reliable and practical method for determining CS in backstroke and front crawl. Including an 800-m performance trial would not be practical with butterfly swimmers, would be challenging with breaststroke swimmers, but would be feasible with front crawl and backstroke swimmers.

THE TACTICAL AREA OCCUPIED BY THE TENNIS BALL DISPLACEMENT ON THE COURT

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INTRODUCTION:
Racket sport like tennis is a dynamic and complex game between two players who repeatedly make shots with their strategy to increase their chances to win. Players' behavior and ball trajectory are essential factors in tennis. Annotative research has focused on the distance the players covered, tracking players' location, and rally length in a game. Tennis ball displacement dispersed all over the court when bouncing on the court during a rally is the outcome of the player's strategy. Highly skilled players might use a larger tennis court area consisting of tennis ball displacements. The primary strategy to win is to send the ball further from an opponent, trying to make opponents move further back and forth or left and right. Players who moved less might have the advantage in tournaments when compared to the players who moved more. The purpose of this study was to explore the tactical area of the tennis ball displacements as a pilot study to find out the possibility as the potential performance indicator to differentiate experts from novices.
METHODS:
High-definition video (720p, 25fps) of four matches were selected to analyze the tactical area of the tennis ball displacements. All matches are men's singles between highly skilled athletes in a competitive tournament. Two matches were first-round professional matches, and there was one match from the semi-final and one match between the junior players. We captured every frame containing the ball displacements using Kinovea software and calculated the tactical area of the tennis ball displacements by using the convex hull algorithm. This technique computes the convex hull of a finite set of tennis ball landing points on the court.

RESULTS:
In the first-round matches, the tactical area of ball displacements for the winner was 75.80 & 66.89 square meters for the winner and 77.00 & 73.73 for the loser. Additionally, the tactical area of player displacements for the winner was 162.25 and 174.48 for the loser on average. In the semi-final match, tennis ball displacements' tactical area was 79.63 for the winner and 80.03 for the loser. The tactical area of player displacements for the winner was 185.19 and 197.50 for the loser. For the junior match, the tactical area for the winner was 78.24, and it is larger than the loser's tactical area of 67.71. The tactical area of player displacements showed 116.94 for the winner and 152.87 for the loser.
CONCLUSION:
Losers in every match showed the tactical areas of player displacements were more extensive, supporting that the winners might make the opponent player move more. Interestingly the tactical area of ball displacement for losers tended to be larger than the winner. Only in the junior match, the tactical area of ball displacement was larger. In a future study, we may need to collect more samples whether the current findings can be generalized. This result is preliminary, offering the potential performance indicator to assess the performance better and understand tennis.

ASSESSMENT OF ATHLETIC DEVELOPMENT IN YOUTH PLAYERS – GOAL SETTING WITH NORMATIVE DATA FROM BASKET-BALL

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INTRODUCTION:
The nationwide implementation of physical performance test batteries for youth squad players can be valuable for compiling individual physical performance profiles based on age- and gender-specific norm values. This approach is frequently used for optimizing training prescription and thus athletic development. The aim of this study was to introduce a distribution-based approach to derive an effect size scale for assessing athletic development from normative testing data in youth players, which can then be translated to setting performance goals for athletic development.
METHODS:
Secondary analysis of norm values (mixed longitudinal and cross-sectional data [1]). In the age-groups under 12 to under 17, a maximum number of 1,172 and 846 tests were available for male and female basketball squad players, respectively. Biannual testing was conducted as part of a federal research project (20-m sprint, 20-m change of direction sprints with/without basketball, jump & reach, standing long jump, chest pass, mid-range jump shot, multistage fitness test). An effect size scale was derived from norm values which were available as quintile scores (five categories). Trivial changes were defined as the age-related mean annual performance development which was estimated as the average age-group-to-age-group change for the quintiles. Threshold values for small, medium, and large changes were calculated as average changes that were required to increase performance classification by one, two or three categories, respectively. These thresholds were additionally compared to the default effect size scale commonly used for interpreting standardized mean differences (between-player standard deviation: small 0.2, medium 0.6, large 1.2 [2]).
RESULTS:
For example, the age-related mean annual development in the jump & reach for male players was 4 cm (trivial change). To reach one, two or three higher performance categories, jump height must improve by 8, 12 and 15 cm, respectively (i.e., small, medium, large). Compared with the default standardized effect size scale, these quintile-based thresholds were larger.
CONCLUSION:
The quintile-based analysis presents a simple and practical approach to derive effect size thresholds based on norm values created from regular physical performance testing. These effect size scales can be easily visualized and communicated to players and coaches, as they are typically familiar with percentile-based performance classification of testing data. A limitation of this study was that only norm values in the form of quintile scores were used for analysis. Future research should attempt to model longitudinal datasets while accounting for within- and between-player effects. Furthermore, the choice of appropriate and realistic percentile-based thresholds clearly remains up for debate and requires adequate analysis of original longitudinal data.
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PREPRINT https://doi.org/10.31236/osf.io/e3tk4

CP-AP05 Training and testing IV - Methodology

VALIDITY OF A MAGNET-BASED TIMING SYSTEM USING A WIMU MAGNETOMETER

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INTRODUCTION:
Time is a parameter that determines performance in many sports. There has been a tendency to measure smaller time intervals than the total time in order to explain the performance of athletes with greater quality. This has been possible thanks to the advance of technology that has enabled to obtain much more information with smaller sensors. The aim of this study was to evaluate the validity of a magnet-based timing system for detecting gate crossing time using a WIMU magnetometer in different sporting contexts.
METHODS:
The system was validated with photocells. Forty-eight athletes and eight skiers performed a 60 m linear run test and a ski slalom, respectively. The times of different sections and the total times obtained with the two methods were compared.
RESULTS:
The 95% error intervals for the total times were less than 0.077 s for the running test and 0.050 s for the ski slalom.
CONCLUSION:
The system could be used to detect the time of passing through the different skiing or running gates and would also allow accurate cutoffs of the signal from the other sensors integrated in the inertial device.

CHARACTERISTICS OF MOVEMENT ON THE SEAT DURING THE TURN OF ALPINE SITTING SKIS IN THE SEAT PRESSURE DISTRIBUTION

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INTRODUCTION:
Sitting skiing is turned by outriggers of both hands and movement of the upper body on the seat. In particular, many sitting skis are unstable with a single ski, and it is difficult to maintain balance when cornering and switching, and how to take posture (positioning) on the seat is important1). However, there is no material on positioning during the turn. On the other hand, there is a seat pressure distribution sheet that can calculate the center of pressure from the pressure distribution. If you use that seat, you may be able to evaluate the movement of the sitting skier during the turn from the seat pressure distribution.
Therefore, in this study, we tried to measure the sitting pressure distribution during the turn of two sitting skiers using a seat pressure sheet, and compare and evaluate the movement on the seat.
METHODS:
Two skilled male sitting skiers participated in the study. One person had complete dislocation at L11 (subject A) and the other had a below-the-knee amputation of one leg (subject B). Skiers made four cones at 8m intervals on the fall line, each with three trial turns in two different widths (narrow and wide). All trials were bi-shot at 60 frames per second from below the fall line, and then the angle of inclination (IA) of the line connecting the head and binding at the turn width (Wid), turn speed (Vel), and maximum turn width was analyzed. In addition, the sitting pressure distribution during the turn was measured by the sitting pressure distribution sheet, and then the seat pressure center (COP) was calculated.
RESULTS:
In video analysis, Wid averaged 1.5m (A 1.4m and B 1.6m, subsequent numbers are averages) for narrow turns and 2.6m (A 2.5m, B 2.7m) for wide turns. Vel was 16.6m/s (A 17.2m/s, B 16.0m/s) for narrow turns and 12.2m/s (A 11.2m/s, B 13.2m/s) for wide turns. In addition, IA was 25.0° (A 23.6°, B 26.3°) for narrow turns and 27.7° (A 25.6°, B 29.8°) for wide turns. There was not much difference between the two. On the other hand, in cop calculated by the seat pressure distribution sheet, there was a difference between subjects A and B. Subject A had a large leftward-rightward (COPx) displacement (narrow turn 2.5 cm, wide turn 2.0 cm), but slight forward-backward (COPy) displacement (narrow turn 0.1 cm, wide turn 0.3 cm). On the other, subject B had smaller COPx than subject A (narrow turn 1.2cm, wide turn 1.3cm), while COPy was larger (narrow turn 0.5cm, wide turn 0.6cm).
CONCLUSION:
These results suggest that sitting skiers move differently depending on the disability situation. And, it was considered that such a difference could be shown by the seat pressure sheet.
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THE RELATIONSHIP BETWEEN CRANK ANGULAR VELOCITY AND CRANK TORQUE AT HIGH CADENCE CYCLING.

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INTRODUCTION:
In performance for time-trial of track cycling, the pedaling skill for maintaining high cadence around 120-150 rpm is required to keep maximum speed. When a steady state pedaling at constant power is performed, it is reported that the negative crank torque increases and maximal crank torque decreases as the cadence increase. However, maximal cadence condition in this previous study was only 120 rpm, and higher peak cadence, even above 150 rpm, was observed at the competition site. Therefore, it is necessary to investigate the crank torque profile at beyond 120 rpm. This study aimed at investigating the pedaling strategy at beyond 120 rpm.
METHODS:
Six cyclists (5 males and 1 female) performed constant pedaling at 50%Vo2peak and 5 cadences (120, 150, 180, 200, 220 rpm). Crank torque data were recorded at a rate of 500 Hz by the Powertec® pedal forces measurement system mounted to the both side pedals, then the both-side resultant crank torque was calculated from both side crank torque. The coordinates of pedal's axis were recorded at 200 Hz using a 3D motion capture system. The crank angler velocity was determined by coordinate of pedal's axis, and calculated their mean, SD and CV. Spearmans rank correlation coefficient were calculated for investigate the relationship between crank torque data and crank angler velocity data. The significance level was set at $\alpha = 0.05$.
RESULTS:
The maximal both-side resultant crank torque data was increased and shifted to high crank angle with the increase of cadence, and the decrease in minimum both-side resultant crank torque was also observed. In addition, negative value of both-side resultant crank was observed for crank torque beyond 180 rpm. The fluctuation of angular velocity during entire of crank rotation increased with the increase of cadence. The significantly negative correlation between minimum both-side resultant crank torque and coefficient variance of instantaneous crank angular velocity was observed ($p < 0.01$).
CONCLUSION:
As a result of performing constant pedaling exercise at cadence conditions beyond 120 rpm, maximal both-side resultant crank torque increased and shifted to high crank angle with the increase of cadence. In addition, minimum both-side resultant crank torque was significantly correlated with the CV of crank angular velocity. It is concluded that the crank angular velocity that decreased due to increase in negative crank torque was compensated by the increase in maximal crank torque during high cadence pedaling.

STROKE ANALYSIS OF CANOE SPRINT KAYAK SINGLE USING RTK GNSS

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INTRODUCTION:
Kayak speed is proportional to stroke rate and stroke distance. Therefore, precise analysis of the stroke is essential to improve competitive performance (1), which is, however, difficult with conventional VTR, IMU, and low-precision GNSS methods (2). In this study, we proposed

an analysis method of the stroke rate and the stroke distance of a sprint kayak single in 0.01 second and 0.01 meter orders, respectively, using RTK GNSS with centimeter-level accuracy.
METHODS:
Two GNSS system were used, each of which consisted of an RTK GNSS receiver (BizStation, DG-PRO1RW, 10Hz), a multiband GNSS antenna (u-blox, ANN-MB-00-00), a battery and a smartphone as a data logger. The antennas were mounted on (i) the stern of a kayak, and (ii) the top of the kayaker's head. They were aligned center line of the kayak when stationary.
One top-level university male kayaker conducted flatwater canoe sprint kayak single 500m time trial. The weather was fine with 1.5-2.0m/s headwind. A base station for RTK GNSS was set near the kayak. Video was recorded from behind the kayak during the sprint for validation. At first, 10Hz measured GNSS position data of (i) and (ii) were interpolated to 100Hz by 3D spline using MATLAB. Then use these interpolated data with Hubeny formula to calculate azimuth angle from (i) to (ii) at every 0.01 second from start to finish of the sprint. Since kayak paddling is a repetitive movement, the azimuth angle over time becomes a waveform. Here, we define that the right stroke period starts at a peak of a wave and ends at the next valley, and the left stroke period is vice versa. The stroke rate and the stroke distance were given by the inverse of the stroke period and the travel distance during the period, where the travel distance was calculated using the GNSS position data of (i).
RESULTS:
Positioning accuracy of the RTK GNSS was less than 0.01m. The number of strokes counted by the video and that by the RTK GNSS were matched (left 103 times, right 102 times). Average stroke rates were 1.67 Hz(left) and 1.71 Hz(right), and average stroke distances were 2.31m(left) and 2.38m(right). The azimuth angle difference between a peak/valley and the next valley/peak was 5.73/5.74 degree on average with maximum 9.3/11.4 degree and minimum 3.15/3.61 degree. The 3D spline interpolation yielded the azimuth angle waveform with small subpeaks, making it easy to detect peaks and valleys. Accordingly, it was easy to determine the stroke periods.
CONCLUSION:
We proposed a kayak stroke analysis method using two RTK GNSS system, by which the stroke rate and the stroke distance were generated. Since the movement of the kayakers head was as small as about 10cm, it was found that the RTK GNSS with centimeter-level accuracy was effective. One of the main features of the proposed method is that bilateral stroke analysis can be performed.
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STROKE ANALYSIS DURING A CANOE CANADIAN 500 M TIME TRIAL USING HIGHLY PRECISION KINEMATIC GLOBAL NAVIGATION SATELLITE SYSTEM

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INTRODUCTION:
Analysis of the paddling properties of the canoe kayak (1) and Canadian (2) has been studied. However, precise analysis of the changes in canoe velocity, stroke frequency, stroke time, stroke distance, and the distance of canoe propulsion during whole 500 m race has not been analyzed. Our study tried to analyze stroke property during paddling and speed change of the canoe Canadian using highly precision kinematic global navigation satellite system (GNSS).
METHODS:
One Japanese university top level male canoe Canadian (C1), aged 22 years old, conducted 500 m time trial in the flat water. Three sets of GNSS systems (Drogger, RTK W-band Bluetooth GNSS Receiver: DG-PRO1RW, 10 Hz), 2 frequencies GNSS active antenna (U-blox, ANN-MB-00-00) and smartphone (ASUS ZenFone 6) were prepared. Of the 3 GNSS systems, each antenna was mounted on the front of canoe, top of the head of the subject, and the rear ends of the canoe. For the validation of the paddling counts, the movie (HUAWEI MatePad T8) was recorded from the side of the subjects using video camera. In order to evaluate the characteristics of paddling, the movements of the canoe itself and the head of the canoeist were considered. That is, when the paddle enters the water, the head of the canoeist moves to the front. At the end of each paddling, the head moves to the most backwards to the canoe. Therefore, it was possible to consider that the paddling characteristics could be clarified by evaluating of the positional relationship of the head of the canoeist with respect to the canoe. The coordinates of the median of the front and the rear ends of canoe assumed as the center of the canoe itself. The positional relationship of the head of the canoeist in relation to the center of the canoe was analyzed. The changes in the velocity of the canoe, stroke frequency (Hz), time (sec) and distance (m) of each stroke, and the total translation of the canoe propulsion were analyzed.
RESULTS:
From the results of the study, the change in the velocity of the canoe, stroke frequency, time and distance of each stroke, and the total distance of the canoe propulsion during time trial were clearly drawn during 500 m. The counts of the paddling analyzed from GNSS was fully matched with the video counts. The change in canoe speed was highly correlated with the changes in stroke frequency ($r = 0.79$, $p < 0.001$) and stroke time ($r = -0.79$, $p < 0.001$). Total distance of propulsion was 504.7 m to 504.4 m of the straight distance.
CONCLUSION:
Our results suggested that stroke properties of paddling of canoe Canadian can be analyzed with highly precision of kinematic GNSS and the change in canoe speed was affected by stroke frequency and stroke distance per stroke.

STROKE TECHNIQUE IN C1 CANOE SLALOM

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INTRODUCTION:
Canoe slalom is a sport where athletes navigate through a set of slalom gates on a white-water course in the fastest time possible. C1 canoe athletes place one hand on the top of their paddle shaft, and their other hand near the blade. Some white-water features are better negotiated with the paddle blade on the left of the boat whereas other features are better negotiated with the paddle blade on the right side. Traditionally, male C1M developed a technique whereby they move the paddle blade across the bow of the boat (in a 'cross' transition) to paddle on their "off-side": these off-side strokes are asymmetrical compared to their "on-side" strokes on their regular side. Recently, women C1W athletes introduced a different 'switch' transition to the sport where the athletes swap the position of their hands on

the paddle shaft as well as moving the paddle blade across the bow of the boat: this means they can do “on-side” style strokes on both the left and right side of the boat, resulting in a more symmetrical style of paddling.
We recently showed that the switching transition takes longer than the cross transition, however, there have been no studies to assess the performance consequences of the different types of transition stroke. The purpose of this study was to use a model of C1 canoe slalom races to predict differences in race time that can be attributed to differences in these paddle strokes.
METHODS:
We measured paddle forces from an indoor ergometer for on-side and off-side strokes and for both types of grip on the shaft. The drag of a C1 slalom boat was determined using IMUs and GPS on an outdoor course. We created a model in which we varied the timing parameters for the drive phase, and the transition time between strokes, in accordance with the probability distributions of these parameters from 33 international race runs (between 2018-2020). We additionally varied the number of each type of transition based on these race data. We evaluated the race times that would occur when the paddle forces, stroke types and number of cross- and switching transitions were changed.
RESULTS:
Off-side paddle strokes generated less force than on-side paddle strokes, and the force varied between on-side strokes on the left and right side. The main effect of the stroke transitions was that the more times an athlete moves the paddle blade to the other side of the boat then the longer the race time becomes, with the effect being more pronounced (up to 3-s on the race time) for switch transitions than cross transitions.
CONCLUSION:
There are a range of advantages to the switching technique: it allows for a more balanced training across the body, may minimize muscular fatigue, and enhance stability for challenging moves. However, switching transitions take longer than cross transitions. Here we show that the more times an athlete uses a switch transition during a race, the more likely the extra time associated with the transition will contribute to a longer race time.

A SYSTEMATIC REVIEW AND META-ANALYSIS ON THE ACUTE EFFECTS OF FOAM ROLLING AND STRETCHING ON PERFORMANCE PARAMETERS

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INTRODUCTION:
Foam rolling and stretching are frequently used as a warm-up routine to increase the range of motion of a joint. While the magnitude of the changes in range of motion between foam rolling and stretching is similar [1], it is not clear if this also holds true for performance parameters (e.g. strength, jump height). Therefore, the purpose of this meta-analysis was to compare the effects of an acute bout of foam rolling with the effects of an acute bout of stretching on performance parameters in healthy participants.
METHODS:
The electronic literature search with appropriate keywords in three databases (PubMed, Scopus, Web of Science) revealed 169 hits from which 13 studies were included in the meta-analysis. We assessed the results from overall 35 effect sizes by applying a random-effect meta-analysis. Moreover, by applying a mixed-effect model, we performed subgroup analyses with the stretching technique, type of foam rolling, tested muscle, treatment duration, and type of task.
RESULTS:
We found no significant overall effect, and the analysis revealed only a trend of the performance parameters in favor of foam rolling when compared to stretching (effect size = −0.071; Z = −1.748; CI (95%) −0.150 to 0.009; P = 0.08; I2 = 0.0). Significantly favorable effects of foam rolling on performance were detected in the subgroup analyses when compared to static stretching, when applied to special muscles (e.g. quadriceps) or special tasks (e.g. strength), when applied for longer than 60 s, or when the foam rolling included vibration. When foam rolling was compared to dynamic stretching or applied in the non-vibration mode, the same magnitude of effect was observed.
CONCLUSION:
In summary, there seems to be evidence that foam rolling has a superior effect on performance parameters when compared to stretching, at least under specific conditions (e.g. static stretching, longer durations). Besides the warm-up and placebo effect of foam rolling [2], a further possible reason could be the different mechanical effects of the different methods on the muscle-tendon unit. When applied for longer durations (>60 s [3]), there is evidence that a single static stretching exercise can lead to a decrease in soft tissue compliance (e.g. muscle stiffness), whilst this is not observed following dynamic stretching [4] or foam rolling [5]. Since muscle stiffness is positively related to the rate of force development [6], a decreased muscle stiffness might negatively affect force production.
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IS IT POSSIBLE TO ASSESS PHYSICAL FITNESS BY REAL-TIME VIDEOCONFERENCE? RELIABILITY AND FEASIBILITY STUDY

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INTRODUCTION:
Objective measures of physical fitness are essential to prescribe exercise in an individualized manner and assess changes over time. Online exercise programs and health consultations have increased exponentially since the start of the Covid-19 pandemic. However, there is a lack of validated tools to evaluate physical fitness remotely. Therefore, the aim of this study was to analyse the test-retest reliability and feasibility of three tests to assess muscular capacity carried out by real-time videoconference.
METHODS:

64 healthy people (32 women and 32 men, 18-65 years old) performed three previously validated and equipment-free tests to assess the main muscle groups: a) 5 repetition sit to stand test (5RSTS; lower limb strength), b) kneeling push up test (KPU; upper limb strength) and c) Shirado-Ito flexor test (SIF; trunk endurance). All tests were conducted by the same evaluator using real-time 1:1 videoconference, and they were repeated 7 days later and at the same time of the day. Relative reliability was assessed using the Intraclass Correlation Coefficient (ICC) and its 95% Confidence Interval (CI), and absolute reliability included the Typical Error (TE) and Minimal Detectable Change (MDC). Feasibility outcomes included testing duration, participant acceptability (1-5 Likert agreement scale to assess easiness of the videoconferencing system, communication quality, resource preparation, easiness of the tests, duration of the tests and general satisfaction) and presence of adverse events (divided in technical (connection/operation problems), related to participant safety (pain/discomfort) and appearance of delayed onset muscle soreness (DOMS)).
RESULTS:
Reliability outcomes were the following: a) 5RSTS ICC 0.92 (0.85-0.96), TE 4.3%, MDC 6.4% in women and ICC 0.98 (0.96-0.99), TE 2.9%, MDC 4.4% in men; b) KPU ICC 0.98 (0.96-0.99), TE 16.2%, MDC 24.3% in women and ICC 0.96 (0.92-0.98), TE 10.0%, MDC 14.9% in men; and c) SIF ICC 0.93 (0.86-0.97), TE 10.6%, MDC 15.9% in women and ICC 0.93 (0.87-0.97), TE 12.0%, MDC 18.0% in men. Mean test duration was 3.3 ± 0.7 minutes for the 5RSTS, 3.8 ± 0.9 minutes for the KPU and 4.0 ± 0.8 minutes for the SIF. Participant acceptability was excellent, with mean scores of 4.7 or higher in all the assessed variables. Minor technical and participant safety-related adverse events were present in 14.8% and 12.5% of the testing sessions, respectively. DOMS appeared in 48.4% of the participants, being the muscles involved in the KPU (upper limb/chest) the most affected (45.3%) and with a mean duration of 2.6 ± 1.2 days.
CONCLUSION:
The three physical fitness tests assessed showed to be reliable and feasible when conducted by real-time videoconference. This study provides a tool that could be both logistically and economically advantageous for researchers and clinicians in the exercise and health fields.

AN INTELLIGENT ANALYSIS METHOD FOR FITNESS ACTIONS WITH A MOBILE CAMERA

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INTRODUCTION:
Intelligent analysis of fitness actions with visual information is one of the important applications of computer vision technology in intelligent sports and active health. According to the camera moving state, visual based action analysis technologies can be divided into two situations: fixed position shooting and moving position shooting. The former does not consider the motion of the camera, but only needs to analyze the human motion, and there are lots of research work. The latter needs to consider both camera motion and human motion, which is more suitable for application scenarios with mobile devices, but there are still few studies. Aiming at the application requirements of intelligent fitness sports, this paper proposes an intelligent analysis method of fitness actions based on computer vision and machine learning, which can conveniently realize the automatic recognition and evaluation of fitness actions with a freely moved camera.
METHODS:
We selected 28 kinds of fitness actions, and collected 2927 videos from 15 subjects with a fixed position camera (60fps, 1920*1440) and 112 videos from 2 subjects with a mobile camera (30fps, 1920*1080) in static and mobile model. The data from the fixed position camera has been organized to a training set, while the data from the mobile camera has been organized to a test set. The proposed fitness action analysis method consists of three modules. Firstly, the motion model of the camera and human body is established based on geometric projection analysis, and the camera pose is estimated with ORB-SLAM framework by extracting static features of the image. Secondly, the 3D human pose was extracted out from the fitness video, and the 3D human pose was transformed to the same coordinate system by combining the camera pose. Finally, the feature coding of three-dimensional human posture information was carried out, and a support vector machine (SVM) learning model based on spatial information of human pose trajectory was trained to realize fitness action recognition.
RESULTS:
In order to verify the proposed method, the following comparative experiments have been conducted: 1) action recognition of fitness videos from the mobile camera in static shooting; 2) action recognition of fitness videos from the mobile camera in mobile shooting before and after 3D coordinate alignment. The experimental results show that the recognition accuracy of fitness videos processed with our method in static and mobile shooting is 75% and 50% respectively, while the recognition accuracy of the original mobile captured fitness videos is 0%. The camera pose estimation and 3D coordinate transformation algorithms used in the experiments are helpful to improve the recognition accuracy of fitness actions under static and mobile shooting.
CONCLUSION:
In this paper, an intelligent analysis method for fitness actions with a single mobile camera is proposed and verified. The motion model between the camera and human is established firstly, and the movement information of human body in the world coordinate system is obtained through camera position and visual algorithm to realize the fitness movement analysis. The proposed method can effectively identify fitness actions in the case of perspective change, and is superior to other similar methods in the data set of fitness movements, and has higher accuracy and robustness. The research results of this paper can be applied to the intelligent exercise instruction learning and play an auxiliary role in the fitness exercise under the home environment.
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CP-BM01 Tissue and muscle tendon

ETHNIC DIFFERENCES IN MUSCLE-TENDON ARCHITECTURE BETWEEN YOUNG KENYAN, FRENCH AND JAPANESE MEN

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INTRODUCTION:

Anthropometric measurements of large populations show that there are systematic differences between ethnicities such as Africans (or people of African descent), Caucasians and Asians (1). In endurance running, the elite Kenyans are characterized by longer thigh, shank and Achilles tendon (AT) lengths combined with shorter fascicles and larger pennation angles of the medial gastrocnemius (MG) muscle than the Japanese elite runners (2,3). However, it is still questionable whether the differences in muscle-tendon architecture observed between Kenyans and Japanese (i) are athlete-specific or exist in non-athletes and (ii) whether they differ from those of Caucasians. Therefore, the present study compared the skeleton and muscle-tendon architecture of young Kenyan, French, and Japanese men.
METHODS:
A total of 235 young men (54 Kenyans, 81 French and 100 Japanese) aged 17–22 participated in this study. Anthropometric measures included body height, body mass, thigh and shank lengths. AT and MG muscle architecture were measured using ultrasonography (Noblus with L55 probe, 5-13 MHz, Japan). Inter-group differences for each parameter were tested by one-way ANOVA analysis. ANCOVA analyses were used to adjust the population effect with different covariate factors: (i) body height for thigh and shank lengths, (ii) shank length for AT and MG fascicle lengths, and (iii) MG muscle thickness for MG pennation angle and fascicle length.
RESULTS:
For this age group, the French were taller and heavier than the others ($p<.001$). Kenyans were characterized by longer absolute and relative (% body height) thigh and shank length values than the French ($p<.05$) and Japanese ($p<.001$), the French having longer values than the Japanese ($p<.05$). The Kenyans also differed in their muscle-tendon architecture, showing the longest AT and shortest MG fascicle length, both in absolute and relative (% shank length) values ($p<.001$). Only the absolute AT length of the Japanese was shorter than that of the French ($p<.001$). Regardless of shank length, Kenyans had longer AT than the other two groups ($p<.001$). Regardless of the MG muscle thickness, the Kenyans also had shorter MG fascicle and greater pennation angle ($p<.001$).
CONCLUSION:
The present study performed on much larger and non-athletic populations confirmed the differences previously observed between Kenyan and Japanese Elite endurance runners in their lower limb length and muscle-tendon architecture (2,3). The thigh and shank lengths of the French were intermediate while their muscle-tendon unit was close to that of the Japanese. The previously reported characteristics of the elite Kenyan runners may thus be considered as a common feature for this ethnic population.
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ELONGATION OF RECTUS FEMORIS DURING HIP EXTENSION ASSOCIATES WITH ELONGATION OF VASTUS MEDIALIS IN HEALTHY WOMEN

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INTRODUCTION:
Force transmission between muscle and its surrounding tissues via connective linkages is referred to as epimuscular myofascial force transmission (EMFT) (Maas H., 2019). Considering only muscle origin and insertion, the stiffness of monoarticular muscle such as vastus medialis (VM) would increase only with knee flexion. However, we have recently reported that the VM stiffness increases when hip joint was passively extended, even though knee angle was constant (Yanase K.,2021). The mechanism of this phenomenon can be explained by EMFT from biarticular rectus femoris (RF) to VM via connective tissue between the muscles. But it is not clear whether the increased degree in VM stiffness depends on the amount of RF elongation, or the RF or VM stiffness during hip extension. The purpose of this study was to examine the factors affecting EMFT to VM stiffness during hip extension.
METHODS:
Forty-six healthy women (age: 40.2 ± 15.2 years, height: 158 ± 6.4 cm, weight: 54.8 ± 8.8 kg) participated in this study. Shear elastic moduli (G) in RF and VM were measured as an index of muscle stiffness using ultrasound shear wave elastography. The participants lay in a supine position with knee fixed at 90° flexion. The measurements were performed in two positions: hip flexion at 90° (HF) and hip extension at 5° (HE). Amount of change in G from HF position (i.e. rest position) to HE position (i.e. elongation position) was calculated as an index of elongation. A paired t-test was conducted to compare G between HF and HE for each muscle. Stepwise multiple regression analysis was conducted with amount of change in G in VM as the dependent variable; independent variables were: 1) amount of change in G in RF, 2) G in RF at HF, and 3) G in VM at HF.
RESULTS:
A paired t-test showed that in both RF and VM, G at HE was significantly higher than that at HF. Stepwise multiple regression analysis identified amount of change in G in RF as independent determinants of amount of change in G in VM.
CONCLUSION:
Our findings showed that elongation of RF during hip extension was associated with that of VM during hip extension, even though the knee angle was constant. This suggests that, by the EMFT phenomenon, monoarticular muscle is affected by degree of elongation in biarticular muscle.
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BIOMECHANICAL DIFFERENCES AMONG SPRINTERS, LONG-DISTANCE AND MIDDLE-DISTANCE MALE RUNNERS: AN ISU STUDY

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INTRODUCTION:

In the last decade, accelerometry technology has been widely used to study running patterns in a wearable manner. Besides, accelerometry has the advantage of measuring outdoor running while other technologies would be inconceivable. Accelerometry seems to be a reliable implement to predict some running stride kinematics in gait rehabilitation and sports performance (Del Din et al, 2015; Gindre et al, 2015; Clermont et al, 2019). The purpose of this study was to analyse trunk displacement kinematics among athletes of different modalities.
METHODS:
17 long-distance runners (664±76 IAAF points), 18 middle-distance runners (727±122 points) and 13 sprinters (802±139 points) performed a submaximal incremental test on a treadmill (ERG-ELEK-EG4, ISSA Engineers, Vitoria, Spain) with the gradient set at 1%. Initial speed was 8 Km·h-1 and was incremented 1 Km·h-1 every minute until 15 Km·h-1. Mediolateral (ML) and Vertical (VT) displacements (cm) were measured using an inertial orientation tracker (ISU) (MTw, 3D Human Orientation Tracker, Xsens Technologies B.V. Enschede, Netherlands) attached over the lumbar region (Centre of Mass). ML/VT centre of mass (CoM) displacements were calculated by double integration of the corresponding acceleration and was defined as i) the maximal distance between the right/left ML displacement and ii) the vertical distance between the lowest and the highest CoM position, respectively. Regarding statistical analysis, data were screened for normality of distribution using Shapiro-Wilk test and mean differences were calculated by ANOVA with Bonferroni corrections. Level of significance was set at $P<0.05$ and Effect Size (ES) was calculated using Cohen's d. Furthermore, data analysis procedure was implemented with both SPSS version 20.0 (SPSS Inc. Chicago, USA) and MatLab 7.11 (MathWorks Inc; Natick, MA, USA).
RESULTS:
No significant differences were found among modalities in height/weight (not reported) or ML displacements at any speed tested ($P>0.05$). Regarding VT displacement, significant differences were found. Bonferroni correction detected that at any speed between 12-15 Km·h-1, sprinters runners showed 1.2 cm higher VT displacement than long-distance runners (Mean12-15: 10.7±0.4 cm versus 9.5±0.5 cm, respectively; ES=2.7).
CONCLUSION:
The main result obtained is that VT displacement pattern during the higher speeds tested is greater in sprinters than in long-distance runners. In accordance with the spring-mass model (Morin et al, 2006), sprinters could show greater compliance (better utilization of elastic energy) which could imply greater aerial times (AT) despite longer contact times (CT) than long-distance runners (Taylor & Beneke, 2012). However, although the speeds tested are not usual in sprinters (low economy), it is unknown if an inverted yield curve could appear at maximal speeds. Finally, trunk displacements could not be a variable as modality differentiating as CT/AT ratio in running biomechanics.

A STUDY ON THE RELATIONSHIP BETWEEN LOCUS LENGTH PER UNIT AREA AND BODY SWING WHEN WEARING BAREFOOT AND ARCH SUPPORT

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INTRODUCTION:
In previous studies, an inverted pendulum model with the ankle joint as the fulcrum has been used for the biomechanical analysis of the standing position. Many studies have reported that the effect of joint movement, other than the ankle joint, on standing posture control cannot be ignored. In addition, there are individual differences in the shape and ground area of the plantar ground, and the influence from such plantar is not negligible. In our previous study, we reported that wearing an arch support for the foot during a 3-point handstand increases the head vertex and COP upset than going barefoot, but significantly reduces the head vertex/COP ratio and increases dynamic stability. This study aimed to focus on the correlation of body swing with the locus length per unit area (L/A) and to determine how head vertices and COP change when wearing arch support or going barefoot.
METHODS:
The subjects were 10 healthy Japanese males who volunteered to participate in the study. A 1 cm-diameter reflective marker was attached to the head vertex of the subjects and they were subjected to a 30-sec standing posture on a force plate. A force plate was used to measure ground reaction force at a frequency of 200 Hz, and the total length of COP (LGN), environmental area (ENV.area), and locus length per unit area (L/A) were measured. At the same time, two high-speed video cameras were used to shoot videos at 30 frames per sec from two directions (shutter speed: open; shooting time: 30 sec).
RESULTS:
In the open-eye standing conditions, going barefoot showed a significant negative correlation between the L/A, head vertex REC.area ($r=-0.75$, $P<0.05$), and head vertex LGN ($r=-0.85$, $P<0.01$), and there was also a significant negative correlation in the ENV.area with COP ($r=-0.85$, $P<0.01$). On the other hand, when wearing an arch support, there was a significant correlation only in the head vertex LGN ($r=-0.70$, $P<0.05$). In the closed-eye standing conditions, there was a significant negative correlation between L/A and head vertex REC.area ($r=-0.67$, $P<0.05$), head vertex LGN ($r=-0.74$, $P<0.05$), and COP ENV.area ($r=-0.84$, $P<0.01$) in barefoot condition. On the other hand, when wearing an arch support, only the head vertex REC.area ($r=-0.73$, $P<0.05$) and the head vertex LGN ($r=-0.66$, $P<0.05$) showed a significant negative correlation, and there was no significant correlation with COP.
CONCLUSION:
In barefoot condition, it was clarified that the inverted pendulum model with the ankle joint as the fulcrum was presented because the turn-off movement affected the sole and head.
However, since the turn-back operation did not affect the sole when an arch support was attached, it was suggested that the head may be adjusted while controlling the posture using the upper joint as a fulcrum from the ankle joint depending on the shape and material of the sole.

CP-BM02 Gait and movement

WEARABLE RESISTANCE DURING HIGH-SPEED RUNNING: EFFECT OF LOAD AND LOAD PLACEMENT

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INTRODUCTION:

Wearable resistance (WR) training is a modality that allows athletes to perform loaded sport-specific movements to develop force and power outputs.1,2 However, the mechanics by which WR works is still relatively unknown, and the effect of the WR load and location of the load has not been examined. The aim of this study was to investigate the acute neuromuscular and stride kinematic responses to different WR loads and placements on the lower limbs during high-speed running.
METHODS:
10 well-trained participants completed a workout of 10 sets of three 10-s runs at 18 kmh-1(20-s of rest between runs and 1-min between sets). Five different WR conditions were tested: 1) control without load, 2) 0.75 vs. 1.5% of body mass (BM) loading positioned on the distal posterior calf, 3) proximal vs. distal loading of 1.5% BM positioned posteriorly 4) anterior vs. posterior loading of 1.5% BM positioned distally, 5) unilateral loading of 1.5% BM positioned on the distal, posterior calf (conditions 2-4 were bilaterally loaded). Muscle activity was measured using Electromyography (EMG) (BTS, USA) for the bicep femoris, semitendinosus, gluteus maximus, vastus lateralis and rectus femoris muscles of both legs. Contact time, peak force, step frequency and vertical stiffness were measured using back-mounted accelerometers (952Hz, StatSports, NI). Data for each condition was compared with the control. Effect sizes (ES) were used to determine the magnitude of differences using Hopkin's scale. Data presented as ES±90% confidence limits (CL).
RESULTS:
Accelerometry data showed the effect of 1.5% BM loading on step frequency was slightly higher than the effect of 0.75% BM loading (0.45±0.43). Step frequency showed small to moderate increases for all loading placements compared with control (ES±90%CL: Anterior; 0.66±0.52, Posterior; 0.46±0.35, Proximal; 0.60±0.64, Distal; 0.52±0.43) while effects on contact time, peak force production, and vertical stiffness were unclear.
All bilaterally loaded conditions induced small to moderate (-0.21 to -0.97) decreases in muscle activity of all muscles compared with control. Regarding unilateral loading, the effect of the loaded leg on EMG activity of all muscles was unclear compared with the unloaded leg.
CONCLUSION:
To conclude, WR loading had a small effect on stride frequency during high-speed running but no clear effect on neuromuscular activation. Also, changes in lower limb load positioning did not show clear effects on neuromuscular activity or kinematic measures. Further research is required to identify if load location effects running patterns and if using small loads (1.5% BM) modifies neuromuscular activity during high-speed running.
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ADDITIONAL LOAD BY BODY ARMOUR CHANGES THE GROUND REACTION FORCE PATTERN IN EARLY STANCE

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INTRODUCTION:
Military or police personnel must often carry additional load in form of body armour and weapons, which impacts the biomechanics of human locomotion resulting in increased injury risk [1] and increased energy cost [2]. The effect of load carriage on walking gait has been extensively investigated, whereas only little is known about the effect of carrying loads on the mechanics of slow running. Therefore, the aim of this study was to expand the empirical evidence of the effect of load carriage on the kinetics of running.
METHODS:
28 physically active subjects (1.87 ± 7.1 m; 77.1 ± 9.5 kg; 24.9 ± 4.3 yrs.) ran on a single-belt treadmill at 2.4 ms-1 both with (w PPE; 20.9 kg) and without body armour (w/o PPE). The vertical ground reaction force (GRFv) was measured through 4 triaxial force transducers (1000 Hz, MC3A-3-500-4876, AMTI Inc., Watertown, USA) which were embedded into the treadmill. The data were averaged over 20 steps per subject and normalized to body weight. Differences in GRFv between the two conditions were tested for significance using statistical parametric mapping. Additionally, the duration of the stance time was tested using the Mann-Whitney-U test.
RESULTS:
Wearing PPE affected the GRFv while running at 2.4 ms-1 on a treadmill. Statistically significant differences ($p < 0.001$) were found for the time period from initial touchdown (TD) until 14 % of the stance phase and from 19 % of the stance phase until toe-off (TO). The maximum GRFv w/o PPE amounted to 2.19 ± 0.17 times body weight and was significantly ($p < 0.001$) increased to 2.55 ± 0.22 times body weight when the subjects wore PPE (Fig. 1.). Additionally, the stance time was significantly ($p = 0.003$) longer w PPE (328 ± 23 ms vs. 310 ± 23 ms).
CONCLUSION:
The maximum GRFv was reached at 40 % of the stance phase for both conditions. It is noteworthy that the relative increase of the maximum GRFv was lower than the increase of body weight by the additional load (16.4 % vs. 27.1 %) which is in accordance with [3]. This disproportional increase might be a result of the prolonged stance times in the loading condition. The period from TD until 14 % of the stance phase showed a higher loading rate and a distinct impact peak w PPE which is not identifiable w/o PPE. Since the impact peak is associated with rearfoot-running [4], carrying additional load might have forced the subjects to strike the ground with the heel. This foot strike pattern would move the point of force application at TD posteriorly which would decrease the external moment arm of the GRFv and thereby increase the mechanical advantage of the plantarflexors. Future research should therefore investigate whether a strengthening of the plantarflexors enhances the ability to cope with additional load during running.
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RUNNING IS MORE DEPENDENT ON INTRA-ABDOMINAL PRESSURE THAN WALKING: EXPLORING APPROPRIATE GAIT FOR THE PREVENTION AND TREATMENT OF LOWER BACK PAIN IN OPENSIM

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INTRODUCTION:
Relevant evidence shows that running is a good preventive intervention of low back pain (LBP) [1], and walking is a good treatment of LBP [2], but running and walking are controversial in terms of treatment and prevention of LBP respectively [3]. In addition to the difference between biomechanical patterns of walking and running, low intra-abdominal pressure (IAP) in LBP patients [4] may also be a key factor contributing to this phenomenon. The aim of this study was to assess the difference of the lumbar biomechanical effects of walking and running under different levels of IAP, and to provide guidance for identifying appropriate exercise interventions for prevention and treatment of LBP respectively.
METHODS:
Some joint parameters of Raabes model were modified, and the IAP module was added. Kinematic and kinetic data of 5 movements of 15 healthy male participants were collected by 8 Vicon MX-T40 cameras (Vicon Motion Systems; Oxford, UK) and force plates (Bertec Corp; Columbus, OH), which were: slow walking (1.34±0.11m/s), fast walking (1.96±0.19m/s), slow running (2.43±0.17m/s), medium-speed running (3.18±0.17m/s) and fast running (4.03±0.15m/s). These data were input into the musculoskeletal modeling software OpenSim to create a subject-specific simulation. The simulation was performed again after the removal of IAP module to estimate the condition of 5 movements under low IAP. Activation levels of lumbar muscles and lumber compressive and shear spinal loads under 10 scenarios (2 conditions of IAP *5 modes of movement) was output and analysed by two-way mixed-design ANOVAs.
RESULTS:
When the IAP existed, the activation level of lumbar muscles of three running speeds was higher than that of two walking speeds ($P<0.01$). IAP produced/required by running was much higher than that by walking ($P<0.01$). The lumbar compressive spinal loading produced by slow running and fast walking were similar ($P>0.05$) and were good for intervertebral discs (300-1200N). When the IAP was removed, there was some increase in the activation of lumbar muscles in all five movements. The increase rate of muscle activation of running was higher than that of walking, and erector spinae and multifidus muscles during running showed the most significant increase ($P<0.01$). Compressive spinal loading of running increased more than that of walking ($P<0.01$) and far beyond the optimal intervertebral disc loading (1200N).
CONCLUSION:
1. Compared with walking, running can better activate the lumbar muscles and maintain IAP level, but it is also highly dependent on IAP. If IAP is insufficient, it is easy to cause musculoskeletal compensation. 2. For people with normal IAP, slow running (2.4m/s) may be the better exercise to prevent LBP. 3. For LBP patients, who has lower IAP, fast walking (2m/s) may be the better intervention means.
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JUMP PERFORMANCE AND STRETCH REFLEX RESPONSE CHANGE AFTER HOPPING ON THE TRAMPOLINE.

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INTRODUCTION:
Countermovement jump (CMJ) height decreases immediately after the submaximal hopping on a trampoline [1]. This phenomenon, called “trampoline aftereffect” has been investigated to examine the mechanisms from various aspects, but it has still been unclear. It is well known that stretch shortening cycle and stretch reflex contribute to CMJ height [2]. It can be suspectable that the lower muscles during hopping on the trampoline with elastic surface is stretched more than that on the normal stiff surface. Since stretch reflex response is altered after successive small stretch of the muscles [3], it is likely that stretch reflex is also altered after hopping on the trampoline. We hypothesized that hopping on the trampoline would alter stretch reflex, resulting in decrease in CMJ height. The purpose of this study was to clarify the changes in stretch reflex and CMJ height after hopping on the trampoline.
METHODS:
In order to identify the trampoline’s specific effects on CMJ, thirteen young healthy adults (6 female) performed hopping on a stiff surface (SS hopping) and a trampoline (TP hopping) for 2 min. Two sessions under each hopping condition were conducted on a different day. In one session, participants performed CMJ with maximal effort on a force plate before, immediately after, and 10-min after SS and TP hopping. CMJ height was estimated by the take-off velocity calculated from the ground reaction force data. In another session, stretch reflex responses in the vastus lateralis muscle were measured by surface EMG when the hot spot on the right patellar tendon was tapped 10 times with appropriate force by a custom-built hammer. The stretch reflex responses were measured before, immediately after, and 10-min after SS and TP hopping.
RESULTS:
CMJ height decreased immediately after SS and TP hopping ($P < 0.05$). Decrease in CMJ height was maintained 10-min after SS hopping only ($P < 0.05$). Stretch reflex amplitude, assessed by the peak-to-peak value of evoked responses increased immediately after TP hopping only ($P < 0.05$) whereas there was no change after SS hopping ($P > 0.05$).
CONCLUSION:
The main finding of this study is that decrease in CMJ height immediately after TP hopping was accompanied with increase in stretch reflex responses. Increase in stretch reflex responses would be due to increases in excitability of the muscle spindle. Because muscle spindle plays a role in sensing muscle length, increase in stretch reflex response after TP hopping can mislead the angle of lower limb during CMJ [4]. Hence, trampoline aftereffects may be due in part to the fact that the kinematic characteristics during CMJ are different from those before TP hopping.
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ASSOCIATIONS BETWEEN FOOT VELOCITY DURING SOCCER KICKING AND KINEMATICS OF THE SWINGING AND SUPPORT LIMBS

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INTRODUCTION:
Kicking is one of the most important soccer skills. Besides being accurate, a successful kick usually generates the highest ball velocity, giving the goalkeeper less time to react (1). Because ball velocity can be challenging to measure inside a laboratory, most studies use foot swing velocity as a proxy for success since it has a robust association with the resultant ball velocity (2). Also, a high level of intersegmental coordination is required to perform an effective kick (3). The swinging limb must coordinate to achieve maximal foot velocity at the moment of ball impact, while the support limb must position the body's center of mass in an optimal position. Although intersegmental coordination is fundamental for a successful kick, it is still unclear if there are direct associations between joint angles and foot velocity at the moment of impact. Therefore, we evaluated the associations between joint angles and foot velocity during different maximal instep kicks.
METHODS:
18 male soccer players (age: 21±2 yrs, BMI: 22.4±1.9 kg□m-2, exp: 14±2 yrs) participated in the study. Players performed three kick trials with the ball stationary or rolling (□2 m□s-1) from four different directions (anterior, posterior, medial, or lateral) and with both feet. They approached the ball at a 45° angle and kicked it as fast as possible with the instep portion of the foot, hitting a target (1.2x1.2m) positioned 3 m away. 3D motion capture (BTS, Italy) was used to obtain swinging foot velocity, the distance between support and swinging feet, and angles in the sagittal plane for the hip, knee, and ankle joints at the moment of ball impact. Correlations between kick performance (foot velocity) and joint angles and feet distance were assessed with Pearson's correlation ($\alpha<0.05$).
RESULTS:
Foot velocity was significantly correlated with all variables, except swinging knee flexion angle ($p=0.118$; $r=-0.117$). Higher foot velocities were correlated with increased swinging ankle plantarflexion ($p<0.001$; $r=-0.436$), swinging hip extension ($p=0.003$; $r=-0.217$), support hip ($p=0.008$; $r=-0.198$) and knee ($p<0.001$; $r=-0.331$) extension, support ankle plantarflexion ($p<0.001$; $r=-0.288$) and feet distance ($p=0.001$; $r=0.241$).
CONCLUSION:
The results suggest that foot speed velocity is associated with joint angles, both in the support and swinging limbs, with the highest correlations associated to increased swinging ankle plantarflexion and support knee flexion. Furthermore, the distance between the support and swinging feet at the moment of ball impact also seems to be a relevant factor for kick performance. Coaches and athletes should consider the hip, knee and ankle angles of both limbs and the distance between feet to improve kicking performance.
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CP-BM03 Upper extremity

MUSCLE ACTIVATION DURING ISOMETRIC MAXIMAL VOLUNTARY CO-CONTRACTIONS: A REPRODUCIBILITY STUDY IN CHILDREN

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INTRODUCTION:
Recent studies have investigated the maximum isometric voluntary co-contractions (MIVCC) and muscle co-activation during MIVCC of the flexor (BB: biceps brachii) and extensor (TB: triceps brachii) muscles on the same joint. Furthermore, isometric force improved as response to MIVCC training in adults' participants without increase of co-activation level at MVC. Many factors may be able to change the results (electromyographic (EMG) valriabilty measures, experimental precision, etc. Our study aimed to investigate the intra-session and the inter-day reproducibility of MVC of the elbow flexor and extensor and EMG of BB and TB muscles during MIVCC in children.
METHODS:
Fifteen active children (9.6±0.45 yrs) performed during two sessions 48 hours apart, in order to verify the intra- and inter-session reproducibility. Each participant achieved in a randomized order 3 MVC repetitions during test session of the elbow flexor (MVCflex), extensor (MVCext) and MIVCC) of BB and TB. Participants exerted their force by pulling on a strap, located around the wrist and linked to the force transducer (1 kHz). Simultaneously, surface EMG activities were collected. In each session (S1 and S2), the EMG of each muscle of the best two trials were integrated on a 512 ms window (iEMG). Furthermore, iEMG during MIVCC of 2 trials were calculated. iEMG during MIVCC was expressed in % of iEMG at MVC.
RESULTS:
Very high inter-day reproductibility was observed in MVCflex (ICC=0.99, SEM%=1.8, CV%=2.2) and MVCext (%SEM=3.66, ICC=0.97, CV=4.1). iEMG data of BB during MVCflex showed high to satisfying intra-day reproductibility (SEM%=9.4; ICC=0.93; CV%=10.4) in S1 and S2 (SEM%=14.6; ICC=0.84; CV%=14.1). The same results were obtained for inter-day reproductibility (SEM%=7.52; ICC=0.95; CV%=8.2). iEMG data of TB during MVCext showed high intra-day reproducibility in S1 (SEM%=2.6; ICC=0.94; CV%=2.8) and S2 (SEM%=5.3; ICC=0.81; CV%=6.4). The same results were obtained for inter-day reproductibility (SEM%=5.26; ICC=0.78; CV=5.04%),
BB %iEMG data during MIVCC were (41.16±18.42 vs. 46.66±26.04) in S1 with SEM%=2.6, ICC=0.91 and CV%=14.2. The same results were obtained in S2 (46.65±22.28 vs. 42.08±25.08 %) with SEM%=13.2, ICC=0.94 and CV%=14.9. The comparison between S1 and S2 showed the same BB %iEMG (43.53±21.44) in S1 and S2 (43.85±23.06) with SEM%, ICC and CV% equal to 12.7, 0.94 and 13.4, respectively.

TB %iEMG data during MIVCC was (47.13±8.04 vs. 48.35±7.76) in S1 with SEM%=6.9; ICC=0.8 and CV%=7.64. The same results were obtained in S2 (48.67±11.26 vs. 49.25±12.26) with SEM%=7.65, ICC=0.89 and CV%=8.7. The comparison between S1 and S2 showed the same TB %iEMG (47.71±7.14 vs. 48.83±11.02) with SEM%, ICC and CV% equal to 9.61, 0.73 and 10.51, respectively.
CONCLUSION:
High reliability of MVCflex and MVCext was observed with satisfying reproducibility of BB and TB activations during MVCflex, MVCext and MIVCC. MIVCC familiarization sessions could be suggested in some children to allow longitudinal evaluations.

THE RELATIONSHIP BETWEEN THE HISTORY OF ELBOW PAIN AND MORPHOLOGIC CHANGE OF THE MEDIAL COMPONENT IN JAPANESE JUNIOR HIGH SCHOOL BASEBALL PLAYERS

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INTRODUCTION:
The ulnar collateral ligament (UCL) is a major stabilizer of elbow joint valgus stress (1). Repetitive external valgus elbow torque often injures the UCL during throwing (2). Therefore, we investigate the relationship between the history of elbow pain and morphological changes of the UCL in throwing side using ultrasound (US) imaging in Japanese junior high school baseball players.
METHODS:
One hundred twenty-three junior high school baseball players who participated in medical check from March 2019 to November 2020 were included in this study. Basic information (age, height, weight, baseball history) and the history of elbow pain were obtained by questionnaire. Elbow pain was defined as continuous elbow pain of the throwing side at least 2 weeks in the past year (painful group). We classified the painful group and no history of elbow pain in the past year (painless group). The evaluation of the US imaging was performed at 70 degrees of elbow flexion, and forearm in maximum external rotation. The cross-sectional US image which delineated the medial epicondyle of the humerus (MEC), ulnar tuberosity and anterior oblique fibers of the medial collateral ligament (AOL) were analyzed for morphologic change. We assessed by 4 type classification of AOL and MEC morphology (3)(4). Briefly, these assessments indicate that type 1 is normal morphology (normal), and Type 2, 3, and 4 is abnormal morphology (abnormal). In addition, we analyzed the thickness of AOL by Nazarian technique (5). We compared between painful group and painless group using unpaired t-test, chi-square test, and logistic regression analysis, and significance level was set at less than 5%.
RESULTS:
There were 42 patients (34%) in the painful group and 81 patients (64%) in the painless group. In the painful group, there were 30 patients (76%) with abnormal AOL morphology and 35 patients (83%) with abnormal MEC morphology. In the painless group, there were 57 patients (70%) with abnormal AOL type morphology and 46 patients (57%) with abnormal MEC morphology. The number of abnormal MEC morphology in the painful group was significantly higher than that in the painless group ($p<0.01$). The mean thickness of the AOL was 5.6 ± 1.1 mm in the painful group and 5.4 ± 1.0 mm in the painless group. The results of logistic regression analysis showed that the elbow pain was significantly associated with a group combining painful and painless (OR 3.89,95% CI 1.54-9.8, $p<0.01$).
CONCLUSION:
Our findings suggested that the history of elbow pain was associated with the elbow morphological changes such as MEC by US imaging in junior high school baseball players. Therefore, the periodical evaluation may be important to prevent the elbow joint injury in adolescent baseball players.
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THE EFFECTS OF POSTERIOR PELVIC TILT ALIGNMENT ON SHOULDER KINEMATICS DURING THE EARLY COCKING PHASE OF PITCHING

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INTRODUCTION:
Decreased shoulder abduction angle and increased external rotation and horizontal abduction angle during pitching are risk factors for shoulder injury. In addition, faulty shoulder position during pitching is related to posterior pelvic tilt alignment at non-throwing side foot contact during the early cocking phase (foot contact), but few reports have analyzed this relationship quantitatively. The aim of this study was to investigate the relationship between shoulder kinematics and anterior and posterior pelvic tilt alignment at foot contact.
METHODS:
Fifteen healthy baseball players participated in this study (mean age, 22.3 ± 1.9 years; mean height, 171.1 ± 3.0 cm; mean weight, 67.3 ± 8.0 kg). Throwing motions were analyzed using a three-dimensional motion analysis system and force plate. We assessed anterior and posterior pelvic tilt angles at foot contact, angles of shoulder abduction, external rotation, and horizontal adduction during the same phase and the maximum shoulder external rotation position during the late cocking phase (MER). Foot contact was defined as the instant when the vertical ground reaction force from non-throwing side foot exceeded 10N and the MER was determined using the joint angle data. Based on the median pelvic angle, the subjects were classified into an anterior and a posterior pelvic tilt group. The difference in shoulder angle between the two groups was compared using Mann-Whitney U test. The significance level was set at $p < 0.05$.
RESULTS:
There was no between-group difference in shoulder abduction, external rotation, and horizontal adduction angle at foot contact, and shoulder abduction and external rotation angle at MER ($p=0.201$, $p=0.798$, $p=0.523$, $p=0.250$, and $p=0.160$, respectively). Shoulder horizontal adduction angle was lower in the posterior pelvic tilt group than in the anterior group at MER ($p=0.005$).
CONCLUSION:
It has been reported that posterior pelvic tilt alignment at foot contact affects motions of the shoulder in the horizontal plane (Iwahori et al, 2015). In addition, posterior pelvic tilt alignment leads to early trunk rotation (Motowaki et al, 2013). In the posterior pelvic tilt group, early trunk rotation caused the upper extremity to lag behind the trunk, which may have decreased the shoulder horizontal adduction

angle at MER. In conclusion, anterior and posterior pelvic tilt alignment at foot contact could be an important checkpoint for preventing shoulder injury.

RELATIONSHIP OF SHOULDER ABDUCTION ANGLE AND TRUNK AND STANCE LEG MUSCLE ACTIVITIES DURING PITCHING MECHANICS IN A JUNIOR HIGH SCHOOL AND HIGH SCHOOL BASEBALL PITCHER

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INTRODUCTION:
There is a growing number of pitching-related upper extremity injuries among young baseball pitchers. Previous biomechanical studies of kinematic and kinetic factors relevant to pitching injuries have indicated several pathologic mechanics leading to shoulder and elbow overload such as decreased shoulder abduction angle, excessive horizontal shoulder abduction, and insufficient elbow flexion. Generally, the decreased shoulder abduction angle from stride foot contact (SFC) to maximum external rotation (MER) are associated with shoulder and elbow injuries in adolescent baseball pitchers. In addition, the shoulder and elbow injuries are associated with bodily features such as relative muscle tightness and bony vulnerability during growth phase. Notably, the muscular strength and flexibility of shoulder and lower extremity are associated with the increased incidence of elbow and shoulder injuries. However, the relationship of shoulder abduction angle and trunk and stance leg muscle activities during pitching mechanics are still not understood. Therefore, we investigated the relationship of shoulder abduction angle and trunk and stance leg muscle activities on MER in an adolescent baseball pitcher.
METHODS:
Twenty-eight junior high school or high school baseball pitchers (14.0 years) were participated in this study. The shoulder abduction angle during MER was measured using the video camera. Based on the shoulder-shoulder-elbow line in MER, i.e.proper pitching or improper pitching from the point of view of elbow injury. The trunk and stance leg muscle activations (internal oblique muscle, gluteus maximus, gluteus medius, rectus femoris, and the medial hamstrings) from SFC to MER were collected using a Myosystem with a sampling frequency of 2000Hz. EMG data was normalized to the maximum EMG obtained during maximum voluntary contraction (MVC), and expressed as percentage of MVC (%MVC). Pelvic and trunk kinematics were measured by three wireless sensors of an inertial and magnetic measurement system. The wireless sensor units were placed on the center of episternum and sacrum. Statistical analysis was performed using the student t-test and spearman rank correlation. The level of significance was set at $p < 0.05$.
RESULTS:
Fifteen subjects were indicated the decreased shoulder abduction angle during MER. Interestingly, their internal oblique and medial hamstrings muscle activations on stance leg were significantly decreased compared with those of the subjects indicating the normal shoulder abduction angle ($p < 0.05$). The shoulder abduction angle was correlated with internal oblique muscle activations on stance leg ($r = 0.46$).
CONCLUSION:
Our findings suggested that decreased shoulder abduction angle on MER may be associated with the oblique muscle activations on stance leg during pitching mechanics.
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ANALYSIS OF THE EFFECT OF FATIGUE ON THE PITCHING KINEMATICS IN YOUTH BASEBALL PITCHERS USING WEARABLE SENSORS

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INTRODUCTION:
Overuse and poor throwing mechanics should cause pitching injuries for baseball pitchers. Grantham et al found that repeated throwing over 15 times make it difficult to maintain correct pitching form in a collegiate baseball pitcher. Pitching count regulation in youth baseball aims to reduce injury caused by excessive stress or incorrect form in youth pitchers. However, few reports analyzed the changes in pitching kinematics due to fatigue in youth pitchers. The purpose of this study was to clarify the effect of fatigue, caused by 25 repetitive pitchings, on the pitching kinematics in youth baseball pitchers using wearable sensors.
METHODS:
Thirty-nine junior high school and high school baseball pitchers aged between 13 and 16 years were recruited (14.3 ± 1.1 years). All participants were right-handed. Participants warmed up by stretching and playing catch before the pitching trial. The motion of pelvis, thorax, and shoulder during twenty-five fastball pitching from a mound to a target for a distance of 18.44 m were measured using a wearable sensor and a high-speed video camera. The absolute angle of the thorax and pelvis during pitching was obtained from sensors attached to the sternum and the sacrum. The positive value of thorax and pelvis angle indicated the posterior tilt, the left lean, and the right axial rotation. The shoulder abduction angle was also calculated from data of the markers attached to bilateral acromions and right elbow. These angles at knee highest position (KHP), stride foot contact (SFC), maximum external rotation (MER) and, ball release (BR) were compared between first and 25th pitch by paired t-test or Wilcoxon singed-rank test. The relationship among changes in each angle between the first and the 25th pitch was also tested by a correlation analysis.
RESULTS:
At HKP, the right axial rotation angle of the pelvis was significantly decreased from 22.3 ± 18.6° to 17.9 ± 17.8°, and the posterior tilt angle of the thorax at HKP was significantly increased from 16.9 ± 10° to 19.0 ± 10.4° by repetitive pitching. At BR, the left lean angle of the thorax was significantly increased from 24.4 ± 16.3° to 26.8 ± 15.5°. At MER, shoulder abduction angle was significantly decreased from -1.7 ± 7.5° to -3.6 ± 7.6° after 25 pitchings. A significant negative correlation was observed between changes in the shoulder abduction angle at MER and the left lean angle of the thorax.
CONCLUSION:
Twenty-five repetitive pitching changed the kinematics of trunk and shoulder joint in youth baseball pitchers. Shoulder abduction angle at MER decreased due to fatigue. A previous study reported that the height of the throwing hand remained consistent at BR even when the joint motion changed. Increase in the left lean angle at MER might compensate for the decreased shoulder abduction to maintain the position of the throwing hand at BR.
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DOES THE EMG BIOFEEDBACK ALLOW LOW LEVELS OF UPPER TRAPEZIUS MUSCLE ACTIVITY DURING A RESISTANCE TRAINING EXERCISE?

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INTRODUCTION:
The upper trapezius muscle is often excessively activated during resistance training exercises (e.g., the seated row, 1), positing a risk factor for the development of shoulder disorders. By making subjects aware of the degree of muscle excitation, biofeedback based on electromyograms (EMGs) has been shown to reduce the upper trapezius loading during different circumstances (2). Whether the EMG biofeedback helps in avoiding the overload of upper trapezius' during resistance training exercise remains an open issue.
METHODS:
Eight male volunteers were instructed to perform the wide-grip seated row exercise without and with the EMG biofeedback, at 70% of 10-repetition maximum and at a fixed cadence (1repetition/2s). In the biofeedback condition, raw EMGs from upper trapezius were presented on a tablet screen and subjects were asked to perform the movement while minimising the raw trace as much as possible. In both conditions, the experimenter ensured subjects kept the trunk upright, and the scapulae slightly retracted and depressed during the movement. Surface EMGs from the serratus anterior and from the three portions of trapezius muscle were sampled with a pair of surface electrodes (3 cm center-to-center inter-electrode distance). A triaxial accelerometer was positioned to the stack of weight for the identification of exercise repetition by the double integration of the time series. For each exercise condition and muscle tested, the Root Mean Square (RMS) amplitude of surface EMGs was computed over each of the eight, 12.5% duration percentiles, and averaged across repetitions. RMS values obtained without and with biofeedback were both normalised by the highest RMS value found between conditions. A two-way ANOVA was applied to test for differences in the RMS amplitude between conditions (without and with EMG biofeedback), with the repetition interval regarded as between factor (post-hoc Tukey-HSD and significance level of 5%).
RESULTS:
ANOVA revealed significant main effect of biofeedback on the normalized RMS amplitude for the upper trapezius ($F=29.543$, $p<0.001$) and for the serratus anterior ($F=20.376$, $p<0.001$), with lower values (~10%) with than without EMG biofeedback ($p<0.001$ in all cases). For the other trapezius' portions, there was no main effect of biofeedback on the RMS amplitude ($p>0.05$).
CONCLUSION:
Key results revealed subjects were able to perform the exercise while reducing the excitation of upper trapezius with EMG biofeedback. Moreover, the attenuation effect of EMG biofeedback seems to generalize to other stabilizers muscles, i.e. the serratus anterior. These findings support the study of training protocols aimed at assisting subjects in reducing the overload on stabilizers muscles during resistance training exercises, with implications on the prevention of shoulder disorders.
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CP-MD01 Performance and fatigue

EFFECTS OF SLEEP DEPRIVATION ON PERCEIVED AND PERFORMANCE FATIGABILITY

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INTRODUCTION:
Sleep deprivation (SD) impairs cognitive performance and emotional well-being; however, little is known about its effect on performance fatigability. The study aimed to identify the effect of 24 hours of no sleep on perceived and performance fatigability.
METHODS:
On two visits (control and SD), eight females sustained a 20-min isometric elbow flexion at the level of integrated EMG recorded at 25% maximal voluntary contraction (MVC) torque (25% iEMG). Before, during and after the fatiguing task, transcranial magnetic stimulation (TMS) was used to evoke a superimposed twitch (SIT) during an MVC in order to assess neural drive to the muscle; i.e., a larger SIT indicates poorer drive. Motor pathway excitability was evaluated using a sequence of stimuli at the motor cortex (motor evoked potential, MEP), corticospinal tract (cervicomedullary motor evoked potential, CMEP), and brachial plexus (Mmax). The evoked responses were elicited 2.5s apart in the order of CMEP, Mmax, then MEP. To control for the influence of unknown levels of descending drive on the size of the MEP and CMEP, these responses were elicited during the silent period induced by a conditioning TMS pulse delivered 100ms earlier. The MEP was normalized to the ongoing CMEP and the CMEP to the ongoing Mmax to isolate cortical and motoneuronal excitability, respectively. Intermuscular coherence values were also obtained between the biceps brachii and triceps brachii throughout the fatiguing contraction.
RESULTS:
Perceived fatigue was higher at the start of SD than control session (~6.9 vs. 2.9 out of 10). Rating of perceived effort at 25% iEMG was greater for SD than control at baseline (~2.9 vs. 1.6 out of 10), the end (~8.2 vs. 7.0) of the fatiguing contraction, and throughout recovery. At task completion, MVC torque was lower for SD compared to control (~71 vs. 80% baseline, respectively); however, the sessions were not different during recovery. The SIT increased with fatigue and was larger for SD than control during the fatiguing task (~12 vs. 7% ongoing MVC torque at 20min, respectively) but not recovery. No differences were found across conditions for CMEP or MEP area during the fatiguing contraction but pooled data showed reduced CMEP and increased MEP area (43 vs. 438% baseline at 20min, respectively). Throughout recovery, CMEP area was smaller and MEP area was larger for SD compared to control. Finally, there was a fatigue-related increase in intermuscular coherence for the control (~8%) but not SD session.
CONCLUSION:
These findings indicate that sleep deprivation heightens ratings of perceived effort during a sustained, fatiguing task and exacerbates the fatigue-related impairment of one's ability to maximally activate the elbow flexors. Furthermore, sleep deprivation appears to delay the recovery of motoneuronal and cortical excitability.

EFFECT OF RECOVERY METHODS ON ATHLETE PERCEPTUAL MEASURES DURING PRE-SEASON BASKETBALL TRAINING

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INTRODUCTION:
Pre-season basketball, a concentrated block of elevated volume and intensity, is used to prepare athletes for the sport season. Post-training recovery strategies employed to facilitate player preparedness may include cold water immersion (CWI), massage, or rest among others. The effectiveness of different strategies, when assessed by athlete perceptual measures is mixed (1,2). Further, limited information exists on women athletes and recovery methods. The purpose was to compare the effect of post-training recovery methods on next-day, pre-training athlete perception during basketball pre-season.
METHODS:
National Collegiate Athletic Association Division I women basketball athletes (n=12, mean ±SD age: 19.61 ±1.12 yr; height: 180.92 ±8.64 cm; 1-RM squat: 100.56 ±14.56 kg; 1-RM bench: 62.1 ±11.84 kg) completed 17 intervention sessions post-practice for a 28-day block. All were randomly assigned to 20-minute lower limb massage therapy (n=26 treatments) and 15-minute lower limb CWI (130 C) (n=66 treatments). There were 7 mandatory rest days (no training) (n=76 treatments) in the block. At 24-hours post-intervention following massage and CWI (n=10 days) or rest (n=7 days), athletes completed perceptual measures pre-training. Measures used a Likert scale (0=do not feel, 4=feel very strongly) and consisted of: 6-item Brief Assessment of Mood (BAM); 12-item Exercise-induced Feeling Inventory (EFI: refreshed, calm, fatigued, enthusiastic, relaxed, energetic, happy, tired, revived, peaceful, worn-out, upbeat); 3-item Readiness to Practice (RTP: emotional/mental/physical readiness). A BAM negative mood measure was created by excluding the vigor item and summing scores for tension, fatigue, anger, depression, and confusion. Due to non-normally distributed data, perceptual measures were log transformed. A one-way analysis of variance was used to compare perceptual measures across recovery methods ($p<0.05$).
RESULTS:
No differences ($p>0.05$) existed across recovery methods in items of EFI, RTP, BAM, or BAM negative mood ($p=0.73$). A possible trend of interest was noted for the EFI item of relaxed ($p=0.12$) across methods with CWI having the lowest mean score (massage 2.58 ±1.17; rest 2.50 ±0.92; CWI 2.20 ±0.99).
CONCLUSION:
When administered 24-hours post-intervention, athlete perceptual measures do not differ across the recovery methods of CWI, massage, or rest. Similar results have been reported for perceptual measures of men volleyball players exposed to 12 CWI sessions over a 16-day training block (2). However, in a study conducted post-competition, basketball athlete perception of recovery was higher for CWI than massage in men and women, with no difference found between methods at 24 hours post-competition (1). Athlete perception may be affected by type of recovery method and timing of scale administration relative to recovery method implementation.
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SWIMMING WITH A WETSUIT MITIGATES THE INCREASE IN FATIGUE AND REDUCES DRAG (TRUNK INCLINE) IN WELL TRAINED TRIATHLETES

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INTRODUCTION:
The use of wetsuits (WET) during triathlon and open water swimming competitions is regulated by water temperature[1]. Swimming with a WET has been shown to change buoyancy and biomechanics of swimming, with an associated enhancement of performance[2]. Rating of perceived exertion (RPE) or heart rate (HR) were not different between WET and swimsuit (SWI) conditions in short tasks[1]. This study aimed to evaluate the effects of WET on fatigue, comfort and trunk incline (a determinant of projected frontal area, and thus of drag) during longer performances.
METHODS:
Eleven national and international level triathletes (7 males: 18.9±3.6yrs, 179.1±5.1cm, 72.4±4.9kg; 4 females: 21.0±2.9yrs, 167.3±4.4cm, 57.6±5.0kg) experienced in wetsuit use performed 7x200m at a pre-set speed corresponding to individual Olympic distance race pace, in an indoor pool (Twat= 28.4±0.5°C; Tamb= 27.6±0.8°C) twice, with and without a WET, in a counterbalanced order. Time, mean HR (hrm-swim, Garmin), RPE (CR-10) and rate of swimming comfort (SC) were collected at baseline and after each 200m. Trunk incline (TI) was assessed by the mean values collected during the first and last length of each 200m using a 2D video-based system[3]. Friedman test with Kruskal-Wallis H test as post-hoc was run to assess differences in variables between and within conditions for every 200m (SPSS, v25). P was set as <.05 for all tests. Data are presented as median±interquartile range.
RESULTS:
The time of each 200m (158.02±14.12s) did not change nor between or within conditions (all $p>0.05$). HR was lower in WET condition compared to SWI (all $p<0.05$). RPE increased only within SWI (from 4.0±1.5 to 6.0±4.5) and, compared to WET (from 3.0±1.3 to 4.0±2.5), was significantly higher in each 200m (all $p<0.05$). A significantly lower TI was found in WET (from 8.30±6.59 to 9.94±6.13°) compared to SWI (from 11.71±6.92 and 12.91±7.66°) between the 2nd and the 5th 200m ($p<0.05$). No significant difference($p>0.05$) was found in SC (0.5±1.7).
CONCLUSION:
RPE and HR were lower in WET, while swimming speed was not different between conditions. A significant change in TI was observed only in the intermediate 200m. Therefore, the reduced perceived fatigue reported when swimming with a WET could be attributed to a decrease in drag, caused by changes in the projected frontal area and swimmer's body position. Contrary to previous studies performed on lower level athletes, SC was not different between conditions[4], meaning that the level of familiarity with WET decreases the discomfort especially in longer tasks. More research is necessary during longer swims and at lower water temperatures in high-level, wetsuit experienced athletes.
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IMPACT OF VAPORFLY SHOES MODEL IN CRITICAL SPEED IN ELITE RUNNERS.

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INTRODUCTION:
The possibility of running an official sub 2-hour marathon has motivated scientists to find a way to achieve this feat. The Nike Vaporfly shoe was released in May 2017 and since then, every record from the 5k event to the marathon have been broken. Physiologically, critical speed (CS) represents the highest intensity at which oxidative phosphorylation is sufficient to satisfy the energy demand (1), whereas D' represents a finite work capacity above CS (2). A metabolic steady state, therefore, can be achieved during exercise below CS, but not above CS. Given the profound differences observed during exercise below versus above CS, there is a growing body of evidence suggesting that CS and D' are strong predictors of endurance performance (3). The purpose of this study was to assess the impact of Vaporfly shoes on CS in elite runners.
METHODS:
Time data for five elite men and six women who had run 10k, half-marathon and marathon with and without Vaporfly shoes was collected between 2015 and 2019. The CS was calculated for the same athlete wearing and not wearing Vaporfly shoes from the data of the distances assessed. The shoes used by the athletes were identified by publicly available photographs, analysing the type of footwear, and environmental conditions (difference in altitude, temperature and wind) of each event were controlled to allow a more realistic comparison of the effect of the type of footwear used. A paired t-test was conducted to assess the CS of runners with and without Vaporfly shoes.
RESULTS:
CS improved a 3.45% when runners wearing Vaporflly shoes (5.09 ± 0.41 m/s compared to 4.92 ± 0.40 m/s for Vaporfly user and non-users respectively) ($p<0.05$). Environmental conditions and orography remained unchanged in the years after the appearance Vaporfly shoes.
CONCLUSION:
The Vaporfly shoes model has a clear impact in CS and thus on the performance in elite runners, possibly due to changes in biomechanics and their respective improvements in running economy (4).

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CP-MH01 Prevention

A 3 YEAR INVESTIGATION OF MATCH INJURIES IN AMATEUR RUGBY UNION

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UNIVERSITY OF LIMERICK

INTRODUCTION:
While the popularity of rugby union worldwide continues to grow among women (Davies 2021), injury surveillance research continues to lag behind the men's game (King et al 2019). This longitudinal study aimed to identify injury rates and risk factors among both cohorts. These data will support strategies aimed at reducing injury risk and enhancing player welfare across the men's and women's game.
METHODS:
Designated recorders for participating clubs used a secure web-based injury monitoring system (IRISweb) to upload match injuries over 3 competitive seasons in the highest level amateur league in Ireland. Female participants were: 2017-18 season: 4 clubs/129 players; 2018-19 season: 7 clubs/195 players; 2019-20 season: 5 clubs/126 players. Male participants were: 2017-18 season: 15 clubs/479 players; 2018-19 season: 25 clubs/959 players; 2019-20 season: 20 clubs/929 players. Outcome measures included >24hr time-loss match injury incidence rate, nature, timing, severity, event and playing position proportions.
RESULTS:
Match injury incidence rates (per/1,000 player hours) were: 2017-18 season 46.2 female Vs 49.7 male; 2018-19 season: 27.7 female Vs 47.2 male; 2019-20 season: 34.9 female Vs 49.1 male. Concussion followed by ankle ligament sprains were the two most common diagnoses each year for both cohorts. In men, hamstring strains were the third most common injury, whereas rotator cuff strains were third for women in 2017/18 but changed to knee sprains in 2018-19 and 2019-20. Timing of all injuries showed that while men were most commonly injured in the 3rd or 4th quarter, women's injuries manifested earlier in the 2nd quarter and plateaued or increased in rate thereafter. Each season showed that most men's match injuries were moderate (8-28day) to severe (>28day) regarding time lost from rugby participation. This was the same for women in the first two seasons, with a small increase in mild (4-7day) injuries in 2019-20. The 'tackle event' lead to the most injuries for both sexes. In 2017-18, male ball carriers received the highest proportion of injuries, but the following two seasons reported more for the tackler. Being tackled lead to the most injuries for women each season. For women's clubs, the forward positions averaged 55% of injuries across 3 seasons, whereas in men's clubs, forwards sustained 60% of the injuries.
CONCLUSION:

The rate of head and ankle injuries should be addressed through educational and intervention strategies. The women's game has presented differences in injury occurrence compared to the men's game, notably lower incidence rates and higher proportion for ball-carriers. Coaches will benefit from game management strategies in differences surrounding potential earlier match timing of women's injuries. Strength and conditioning coaches and physiotherapists working with men's clubs should address the observed frequency of hamstring strains, whereas those in the women's game should note greater priority of knee sprains.

SPORTS INJURIES IN A 4-YEAR SURVEY OF FRESHMEN IN MEDICAL UNIVERSITY

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SHOWA UNIVERSITY

INTRODUCTION:
The medical university doesn't have high-level athletes, but over 50% of its students have participated in sports. According to a cross-sectional survey about sports injury conducted in 2015, 40.8% of 2nd to 6th grade athletes suffered sports injuries. Notably, 13 anterior cruciate ligament (ACL) injuries had occurred in the 5 years between 2010 and 2015. Early education is important to sports injury prevention. The purpose of this study was to confirm the effect of sports injury prevention programs for freshmen.
METHODS:
Total 2,291 freshmen (575 students in 2015, 562 students in 2016, 573 students in 2017, 581 students in 2018) in the medical university completed a self-administered questionnaire about sports injuries. Soon after entering the university, members of the 2016-2018 freshmen classes attended a lecture on injury prevention and first aid including basic life support. The lecture was based on the cross-sectional survey data gathered in 2015. The "number of injuries," "whether or not injuries were treated with RICE," and "whether or not activity was accompanied by sufficient warm-up & cool-down" were compared between the years examined using the Chi-square test at an alpha level of 5% ($p<0.05$).
RESULTS:
The overall injury rate was higher in 2015 (19.3 injuries/100 students) than in 2016-2018 (11.4 injuries/100 students, 12.4 injuries/100 students and 9.1 injuries/100 students, respectively) ($p<0.001$). In 2015, 20 students had jammed finger injuries including fracture, 17 had ankle sprains, 9 had muscle strains, and 3 had knee ligament injuries. The number of jammed finger injuries were less in 2016 (n=4) and in 2018 (n=6) than in 2015 ($p<0.01$). The number of ankle sprains were not significantly different between 2015 and 2016 (n=20), 2017 (n=18), and 2018 (n=14). There were fewer muscle strains in both 2017 and 2018 (n=1 each) than in 2015 ($p<0.05$). No knee ligament injury occurred after 2015. The percentage of freshmen performing RICE was 10.4% in 2015 and increased in 2016, 2017, and 2018 (21.9%, 26.2% and 34.1%, respectively) ($p<0.01$), whereas the percentage performing warm-up & cool down did not significantly change from year to year (59.7%, 65.2%, 60.9% and 62.9%, respectively).
CONCLUSION:
This survey demonstrated that freshmen have fewer injuries and that sports injury prevention education has increased awareness of RICE. However, the prevalence of ankle sprain has not changed even though that of muscle strain has tended to decrease. The suggested explanation is the educational program's emphasis on stretching, alignment control, and RICE. The results of this survey indicate a need to modify educational programs for freshmen, and confirm the effect of injury prevention education on 2nd to 6th grade students.

EPIDEMIOLOGICAL PROFILE OF CROSSFIT ATHLETES IN THE FRENCH PART OF SWITZERLAND

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INTRODUCTION:
CrossFit is a growing sports phenomenon, with currently 14'000 affiliates and roughly five million athletes worldwide. Due to the technical difficulty of certain movements, the high intensity and the high variability between workouts (Glassmann, 2007), CrossFit has the reputation of causing many sports injuries and its safety has been questioned. Only a few studies evaluated CrossFit training injury prevalence (e.g. in Holland, Florida, Brazil and Canada). The aim of the present pilot-study was to evaluate injury prevalence in Swiss CrossFit athletes.
METHODS:
An online survey was designed based on previous work (Mehrab et al., 2017). Data from volunteers, members of an official CrossFit affiliate in the Canton of Vaud, was collected from 30. April 2020 until 15. May 2020. A musculoskeletal injury was defined as any new musculoskeletal pain, feeling, or discomfort as a result of a CrossFit workout that met one of the following criteria: Total removal from CrossFit training and other outside routine physical activities for >1 week; Modification of normal training activities in duration, intensity, or mode for >2 weeks; Any physical complaint severe enough to warrant a visit to a health professional (Weisenthal et al., 2014). Statistical analysis was performed using R Studio (Version 1.3.1093 © 2009-2020 RStudio, PBC). Descriptive, frequency and correlational analyses were conducted. Statistical significance was set at $p<.05$.
RESULTS:
Forty-eight total responses were collected. Two entries were incomplete and had to be excluded. Injured volunteers in this sample were older than the non-injured($p= .04$). Other personal data (bodyheight, bodyweight, BMI, level of education, physical exertion at work) were similar between both groups ($p \geq .20$). A total of 28 injuries were reported for the last 12 months. Mean training frequency and training duration was four days per week and 64 minutes respectively. This resulted in a yearly total exposition time of 236.84 hours per athlete. Injury incidence in this sample was 2.2/1000 exposition hours, which is comparable to other CrossFit studies from Dutch and US CrossFit athletes (Hak et al., 2021; Montalvo et al., 2017). No correlation between injury and level of education ($p=.407$),physical exertion at work ($p= .367$) nor age ($p=.473$) could be found.
CONCLUSION:
Conclusion Injury prevalence from this sample was comparable to data from other CrossFit studies (Hak et al., 2021; Mehrab et al., 2017; Montalvo et al., 2017). CrossFit seems to be as safe as other popular sports (Klimek et al., 2018). However, a bigger sample size including all regions of Switzerland is needed to compare the Swiss CrossFit injury prevalence data to international research.

SLEEP INFLUEUNCES VO2MAX, FATIGUE AND MOOD IN ACTIVE YOUNG SUBJECTS

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INTRODUCTION:
Sleep is an essential physiological process in human beings, and it is recognized as an important influencing factor on physical and mental performance outcomes. Inadequate sleep duration and recovery negatively affect physical performance, particularly endurance performance [1], and it is also responsible for higher fatigue levels and bad mood [2, 3]. The present study aims to assess if sleep quality can influence physical performance (VO2max), mood, and self-perceived fatigue in a sample of active young subjects.
METHODS:
We recruited 98 subjects (21.5±3; 52 males) at the German Sport University of Cologne. They completed an incremental exercise test at the bicycle ergometer and filled in the Pittsburgh Sleep Quality Index (PSQI), a visual analogue scale, and the Multidimensional Mood State Questionnaire (MDBF-Good vs bad mood, MDBF-Awake vs tired mood, MDBF-Calm vs nervous mood) to assess the VO2max sleep, self-perceived fatigue, and mood, respectively. For the statistical analysis, SPSS version 27 has been used.
RESULTS:
The overall sample is classified as good sleeper (4.9±2.1). However, females report a worse sleep index compared to males (5.3±2.1 vs 4.5±2.1, p=.04). The partial correlation analysis (Pearson coefficient; controlled by sex) reveals inverse correlations between PSQI and VO2max (r2=−.23, p=.03), PSQI and self-perceived fatigue (r2=−.23, p=.03), PSQI and MDBF-Good vs bad mood (r2=−.25, p=.02), and PSQI and MDBF-Awake vs tired mood (r2=−.38, p<.001). No significant correlation has been highlighted between PSQI and MDBF-Calm vs nervous mood.
CONCLUSION:
Lower sleep quality seems to negatively affect endurance performance, self-perceived fatigue, and mood in a cohort of active young individuals. Previous studies usually assessed the role of sleep on performance during an under-control or unusual situation, forcing subjects to unconventional sleep behaviours (e.g., total sleep deprivation). In our study, a chronic situation (30-day) of bad sleep may help in deteriorating VO2max, mood and increase the self-perceived fatigue. Furthermore, differently from prior research, sleep appears detrimental on active young subjects performance and not only on elite or professional athletes.
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DEVELOPMENT OF STRENGTH TRAINING SYSTEM USING ELECTROMYOGRAPHIC ACTIVITY

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Introduction
We aim to develop a versatile training system that can be used for training not only specified muscles but also various muscles. In recent years, the prevention of sarcopenia has been emphasized to extend healthy life expectancy. Strength training is required to maintain muscle mass, but it is difficult for some people to continue strength training without getting bored. In this study, we have developed a strength training system that encourages people to train at home without getting bored.
Methods
The developed system used a method of estimating the muscle strength from the amount of electromyogram (EMG). EMG was measured using a single board computer called “BITalino”, because it can communicate wirelessly with a personal computer (PC) via Bluetooth and does not interfere with strength training movements. We used Unity to create a content 1) to measure maximum strength (MVC) and 2) to train according to %MVC. In Step 1, the participants were required to exert MVC continuously for 10 seconds to measure maximum EMG. In Step 2, there were three thresholds: 80% EMG, 60% EMG, and 40% EMG. EMG electrodes were attached to the forearm flexor muscles that exert grip strength, or to the gastrocnemius muscles that was used to raise heels. When the participants exceeded each threshold value, light blue, yellow, and pink particles, which were shown like balloons from the bottom center to the top, were displayed respectively. The number of particles for each color was shown in the upper left of the display so that the participant could check how much force was applied. Furthermore, the sound of shooting stars gave off only when the 80% EMG was exerted. The training time was set to 30 seconds, and a countdown timer was shown in the upper right corner so that they could understand the experience time.
Results
As a result, we showed that our system could be useful for both small and large muscles and how versatile it was. In other words, it was shown that it could be used for various strength training. The three colors that were displayed at each threshold value and the sound that was shown to achieve over 80% EMG had the side effect of increasing their motivation. Some participants reported that they unexpectedly exerted maximum intensity to try to display many particles.
Discussion
In this study, we developed the simple and versatile strength training system using EMG measurements. The results of this study show that the system can be used on almost any muscle, regardless of muscle size. However, as a future challenge, we need to consider how much muscle strength can be improved after long-term use of our training system.
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EFFECT OF INTERNAL AND EXTERNAL TRAINING LOAD ON MATCH ACTIVITIES AND SUBJECTIVE MARKERS IN PROFESSIONAL FOOTBALL.

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UNIVERSITÉ RENNES 2

INTRODUCTION:

The ability to perform high intensity efforts is an important factor of performance in football. On the other hand, these efforts can cause muscular damages. For this, sport scientist and conditioning coaches has developed techniques to manage these efforts during training, to lead player to performance and to decrease injurie risk. So, there are a lot of studies regarding the monitoring of external (EWL) and internal (IWL) workload (WL). However, there was a lack of study in football on the effects of WL on the match. The purpose of this study is to test the hypothesis that EWL and IWL of pre-match training weeks have effects on matches day wellness, internal matches WL and matches activity.
METHODS:
All in-season training weeks (TW) and matches (M) of 21 professional football was recorded. EWL was observed by using distance covered at high intensity running (>5.5m/s: dHIR), acceleration (dHIA: >3m/s²), deceleration (dHID: <-3m/s²) and metabolic power (dHIMP: >20W/kg). IWL was recorded by morning wellness ratings previous training sessions and match [fatigue (F), sleep quality (SQ), stress (ST) and muscles soreness (MS)]. The sum of these four topics gives the wellness score (WS) and ratings of perceived exertion following each session to calculate overall session WL (RPE-WL). To individualize WL, we have standardised all values by Z-score. We test the correlation with the Spearman's test.
RESULTS:
Significant correlations were found between training and match. TW-dHIR was significantly correlated to M-SQ, F, ST, MS and WS (r=-.2 p<.01; r=.23 p<.001; r=.29 p<.001; r=23 p<.001; r=.18 p<.01). TW-dHIA was significantly linked to M-SQ, F, ST, MS and WS (r=-.19 p<.01; r=.23 p<.001; r=.29 p<.001; r=22 p<.001; r=.19 p<.01). TW-dHID was significantly linked to M-SQ, F, ST, MS and WS (r=-.2 p<.01; r=.24 p<.001; r=.28 p<.001; r=24 p<.001; r=.21 p<.01). There were also significant correlations between TW-dHIMP and M-F, ST, MS (r=-.16 p<.05; r=-.2 p<.01; r=.14 p<.05). For TW-IWL, significant correlations were found between TW-RPE-tl and M-RPE-tl (r=.38 p<.001) like for TW-F with M-F and MS (r=.14 p<.05 and r=-.13 p<.05). TW-MS was correlated with M-SQ, F, ST, MS (r=-.13 p<.05; r=.15 p<.05; r=.17 p<.01; r=18 p<.01). To finish, TW-WS was correlated with M-SQ, F, ST, MS, WS (r=.15 p<.05; r=.17 p<.01; r=.18 p<.01; r=15 p<.05; r=.15 p<.05).
CONCLUSION:
Although we had significant correlation, these were too poor to valid our hypothesis. We must choose other variables or analyse pre-match WL on a longer duration.

EFFECTS OF A SINGLE BOUT OF A NEUROMUSCULAR WARM-UP ON POTENTIAL REINJURY RISK FACTORS ASSOCIATED WITH UNANTICIPATED JUMP LANDINGS AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A CROSSOVER TRIAL.

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GOETHE UNIVERSITY

INTRODUCTION:
Unanticipated movements may expose anterior cruciate ligament (ACL)-reconstructed individuals to a high (re)injury risk during sports participation. This trial investigated the acute effects of a single bout of a football specific neuromuscular ACL injury preventive warm-up programme on potential ACL reinjury risk factors during anticipated and unanticipated jump-landings.
METHODS:
Fourteen (14) participants with ACL-reconstructed knees (all autologous (12 hamstrings, 2 quadriceps) grafts, 6-24 months after reconstruction) performed a single bout of a football specific neuromuscular ACL injury preventive warm-up programme (Prevent Injury and Enhance Performance (PEP): strengthening, flexibility, plyometry and agility) and a standard warm-up (bicycle ergometer) in a randomised sequence. Washout phase was one week. After each warm-up, countermovement jumps with anticipated (n = 4; stimulus indicating landing side and equally distributed shown prior to jump) and unanticipated (n = 6; stimulus shown during jump; ~0.4 s prior to ground contact) single-leg landings (peak ground reaction force, centre of pressure, time to stabilization and number of standing errors) were assessed. Decision making quality was measured by means of landing error count (i.e. landing on wrong leg).
RESULTS:
No carry-over effects occurred ($p > 0.05$). The unanticipated task resulted in significantly higher peak ground reaction forces (Δ+4%, $F(11) = 3.46$, $p < 0.001$, $eta2 = 0.21$) irrespective of the preceding warm-up protocol. After the PEP warm-up, significantly higher peak ground reaction forces and a lower number of errors (decision and cumulated errors) were recorded during the unanticipated condition compared to the ergometer warm-up ($p < 0.05$). Both protocols did not differ significantly in terms of between-condition differences ($p > 0.05$).
CONCLUSION:
The observed higher peak ground reaction forces during the unanticipated task may put athletes at an elevated risk for knee injury. Thus, evaluating an athletes' unanticipated jump landing ability prior to return to sports clearance may help prevent secondary injuries. The PEP warm-up may be superior to an ergometer warm-up at improving unanticipated decision making quality among athletes cleared to return to sports within 2 years of anterior cruciate ligament reconstruction.
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ACUTE EFFECTS OF AEROBIC AND ANAEROBIC EXERCISES AND TRAINING EXPERIENCE ON CELL FREE DNA CONCENTRATIONS IN BLOOD PLASMA

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INTRODUCTION:
Soft tissue injuries are one of the key determinants of effectiveness in the training process. While exercise has both – acute and chronic effects on the immune system, it is crucial to find reliable biomarkers indicating immunological response. Recent years brought the era of

circulating cell-free DNA (cfDNA) as a potential biomarker of the inflammation, tissue injury and muscle damage [1]. We aimed to identify the response of free plasma DNA to different types of exercise, linked to exercise insensitivity as a potential marker of exercise load.
METHODS:
50 volunteers (25 athlete's and 25 physical active man) were assigned to the study and performed maximal aerobic (Bruce test; MAE) and anaerobic (WanT test; MAnE) test in a week apart. Before experimental testing, each individual completed a standardised warm-up on the cycloergometer (five min at 60 rpm, 1 W/kg). Each participant (for WanT test) was required to pedal with maximum effort for a period of 30s against a fixed resistive load of 75 g/kg of total body mass according to Bar-Or. The Bruce protocol was performed on a treadmill and composed of six stages, with beginning at 1.7 mph at an inclination percentage of 10% degree. Blood samples were collected in 4 time-points: before (T0), 2-5 minutes (T1), 30 minutes (T2) and 3 hours (T3) after each type of physical activity. cfDNA was isolated using NucleoSpin cfDNA XS kit and fluorescently measured.
RESULTS:
In the athletes after MAnE, we observed the greatest increase in cfDNA concentration immediately after exercise as compared to the baseline values and the last blood collection, while after MAE only slight increase in cfDNA concentration was observed in T1 and the level of plasma cfDNA remained at a similar level up to T3. However in the control group, we observed a gradual decrease, with the highest cfDNA level prior to MAnE, probably due to psychological stress [2] prior to the first maximal physical effort. While after MAE, cfDNA level increased up to T2 and then decreased ($p<0.05$).
CONCLUSION:
Our analysis presents differential response depending on the intensity and duration of exercise. Among endurance athletes, cfDNA may be a predictor of adaptation for anaerobic exercise but not for MAE. Maximal aerobic and anaerobic exercise significantly increases plasma levels of cfDNA, possibly at an early stage of tissue inflammation. These observations imply that formation of cfDNA is associated with occurrences of maximal physical activity. Observed changes in cfDNA concentration may be a potential marker for athletic overtraining.
The project is financed by the National Science Centre, Poland (2018/29/N/NZ7/02800).
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CP-MH02 Orthopedics

SELF-REPORTED SEVERE GASTROINTESTINAL SYMPTOMS ARE NOT PREVALENT IN ELITE FEMALE SOCCER PLAYERS

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PEPSICO

INTRODUCTION:
Gastrointestinal (GI) symptoms during exercise are common in female athletes (Parnell et al, 2020). The prevalence and severity of symptoms varies between athletes, but common symptoms can negatively impact performance and exercise completion. Pre- during- and post-exercise nutritional intake may be altered in an attempt to reduce GI symptoms and prevent performance detriments (Parnell et al, 2020). However, most research has been conducted in female endurance athletes, there is limited data in team sport athletes. Therefore, the aim of this study was to identify the prevalence and severity of GI symptoms, and nutrition habits, in elite female soccer players.
METHODS:
In this cross-sectional study, elite female soccer players (n= 106) from English, Spanish, and Italian leagues (n= 23, 73, 10 respectively) completed a GI symptom prevalence and nutrition habit questionnaire. Players rated the number and severity (1 (very mild) to 10 (extremely severe)) of GI symptoms experienced during soccer training and matches. Any symptom rated >4 was classified as severe. Questions on pre-exercise nutrition habits and food/drink avoidance were also included. Chi-square tests were used to determine relationships between nutrition habits and number of GI symptoms.
RESULTS:
During training and matches, 20% and 13% of players experienced one GI symptom, and 8% and 12% of players reported experiencing two GI symptoms, respectively. Five players (5%) reported experiencing three or more symptoms during both training and matches. During training, flatulence (n=12), bloating (n=12), heartburn (n=11) and belching (n=11) were the most common symptoms. Eight players ranked the severity of the symptom as severe. During matches, bloating (n=15), flatulence (n=8), defecation (loose stool) (n=7) and stomach pain (n=6) were the most common symptoms. Ten players ranked the severity of the symptom as severe. A total of 28% and 35% of players reported regularly avoiding certain foods/drinks to prevent GI symptoms; this was most commonly high fat foods. Caffeine was frequently ingested prior to both training and matches but was not associated with the number or severity of GI symptoms experienced ($X2(8,n=110)=8.9$, $P=0.350$).
CONCLUSION:
Most (70%) elite female soccer players do not experience GI symptoms during training and/or matches. The severity of GI symptoms experienced during training and matches was generally low but highly individual. The impact of mild GI symptoms on soccer specific performance warrants further investigation.
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SUPERVISED EXERCISE FOR PEOPLE WITH DIFFERENT CHRONIC DISEASES: THE EFIKRONIK RANDOMIZED CLINICAL TRIAL

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INTRODUCTION:
Exercise can reduce the side effect of treatments, improve prognosis and increase survival of people with chronic diseases, which create a vicious circle of weakness, fatigability and sarcopenia with a huge negative impact on physical fitness and quality of life. Therefore, we hypothesized that a tailored exercise prescription, supervised by primary care nurses and exercise physiologist (EfiKroniK), could improve prognostic factors such as functional capacity, aerobic capacity and strength on a variety of chronic diseases.

METHODS:
This randomized clinical trial included 32 patients with schizophrenia, 41 patients with hematologic stem-cell transplant and 18 patients with phase IV metastatic cancer. Randomly assigned to one of two parallel groups: 46 to the EfiKroniK supervised exercise program and 45 to home-based non-supervised exercise. All of them received a personalized exercise prescription, educative materials and a physical activity and health promotion plan. Aditionally, the EfiKroniK program includes three supervised resistance and aerobic training sessions a week.
Participants were assessed at baseline, before starting the program and 3 months later, after finishing the EfiKroniK program. Main outcomes were functional capacity using the 400-m walking test; aerobic fitness measured by lactate thresholds and strength using the handgrip test (1).
RESULTS:
Although no statistical differences were found between groups, at 3 months, all the participants achieved significant improvement ($p<0.01$) in all tests. For the 400 m walk and lactate threshold tests the improvement was significantly higher ($p<0.01$) in patients with hematological cancer than in patients with solid cancer or schizophrenia.
CONCLUSION:
In this preliminary analysis, both groups achieved improvements in functional capacity, handgrip strength and aerobic capacity, independently of the intervention: the EfiKroniK supervised exercise program or the guidelines given to the control group. Future analysis will provide more information on the effect of both groups 6 and 12 months after the initial evaluation, the adherence to the supervised exercise prescription and the objective weekly physical activity dose measured by accelerometers.

MORPHOLOGICAL RECOVERY OF PARASPINAL MUSCLE CROSS SECTIONAL AREA AND REDUCTION OF FAT INFILTRATION AFTER AN ILEX BASED REHABILITATION PROGRAM – A CASE STUDY

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ORTHOPAEDIC SPINE CENTER DR. ALFEN

INTRODUCTION:
Studies have shown there is atrophy and local fat infiltration in the paraspinal extensor muscle (PM) (m. erector spinae/ m. multifidus) for patients with chronic low back pain (LBP) (Steele et al. 2015). Heavy loaded Isolated Lumbar Extension Resistance Exercise (ILEX) using a restraint system for pelvic fixation has shown good clinical outcome (Steele et al. 2015). However, it is unclear if this clinical improvement is accompanied by a recovery of muscle size and composition.
METHODS:
This case report represents a male patient (49 years) who suffered from chronic pain in the lumbar spine region for ten years (2009 -2019). In June 2019, the patient visited our spine center and was examined by an experienced orthopaedic consultant. Magnetic resonance imaging (MRI) showed progressive facet joint arthritis, osteochondrosis and four lumbar disc protrusions (L2/L3-L5/S1). He underwent a rehabilitation program including one set of ILEX with a diagnosis based limited range of motion (ROM). Furthermore, an additional strength training program (cable pull and reverse butterfly) was applied. The whole program consisted of three consecutive phases: initial phase for nine weeks (2x/week), stabilisation phase I for eight weeks (1x/week), and stabilisation phase II for two months (1x/month). Numeric rating scale (NRS) measures for current pain (PC), pain within the last 10 days (P10), impact on mental health (IMH) were taken (scale 0-10; 0=no pain/no impact on mental health; 10=severe pain/highly negative impact on mental health), and isometric extensor strength was taken before and after the initial rehabilitation program. MRI images were available from before and after the therapy program (June 2019 and February 2020). Muscle cross sectional area (CSA, in cm2), lean muscle mass (LM, in cm2) and fat fraction (FF, in %) were quantified (mean of both PM sides) and compared with an MRI image taken 10 years before the rehabilitation program (2009).
RESULTS:
Scores for PC decreased from 7 to 4 and for P10 from 9 to 4 while IMH score decreased from 7 to 2. Furthermore, quantitative comparison of MRI images (2009/2019/2020) showed an increase in CSA (29,3/26,2/28,8 cm2) and in LM (25,4/21,4/24,8 cm2) and a decrease in FF (13,2/18,2/13,9 %) after the rehabilitation program (2020) compared to before the treatment (2019). For all quantified values levels from 2009 were almost regained indicating a recovery of muscle size and composition. Additionally, the patient's isometric extensor strength increased by 54,7%.
CONCLUSION:
Heavy loaded ILEX can not only lead to a reduction in symptoms in patients with LBP, but can also restore paraspinal extensor muscle in quantity and quality by regaining lean muscle mass and reducing fat infiltration simultaneously. Future studies in bigger cohorts have to be designed.
Steele et al. A review of the clinical value of isolated lumbar extension resistance training for chronic low back pain. PM R. 2015 Feb;7(2):169-87.

GROWTH AND MATURITY STATUS OF FEMALE SOCCER PLAYERS

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1: LUSÓFONA UNIVERSITY, 2: UNIVERSITY OF COIMBRA, 3: MINISTRY OF EDUCATION, 4: POLISH ACADEMY OF SCIENCES, 5: UNIVERSITY OF TEXAS.

INTRODUCTION:
Given the increased popularity of soccer among girls and the selectivity of sport and competition for potentially talented players at relatively young ages, the purpose of this narrative review is to evaluate the growth and maturity status of female youth soccer players. Studies reporting heights and weights spanned 1992 through 2020, and, except fora study in 1981, studies reporting maturity indicators spanned 1995 through 2020.
METHODS:
Reported mean ages, heights and weights of female soccer players aged <19 years in 161 studies spanning the years 1992–2020 were extracted from the literature or calculated from data available to the authors; 35 studies spanning the years 1981–2020 also included an indicator of biological maturation. Heights and weights were plotted relative to U.S. reference data. Preece–Baines Model 1 was fitted to moving averages to estimate ages at peak velocity. Maturity indicators included skeletal age, pubertal status, age at menarche, percentage of predicted adult height and predicted maturity offset.

RESULTS:
Heights and weights showed negligible secular variation across the time interval. Heights were slightly above or approximated the reference medians through 14 years old and then varied between the medians and 75th percentiles through 18 years old. Weights were above the reference medians from 9 to 18 years old. Mean ages at menarche ranged from 12.7 to 13.0 years.
CONCLUSION:
The trend in heights and weights suggested the persistence and/or selection of taller and heavier players during adolescence, while estimated age at peak height velocity (PHV) and ages at menarche were within the range of mean ages in European and North American samples. Data for skeletal and sexual maturity status were limited; predicted maturity offset increased linearly with mean ages and heights at prediction.

IMMEDIATE EFFECTS OF HEAVY LOADED ISOLATED LUMBAR EXTENSION RESISTANCE EXERCISE ON SPINAL POSTURE AND FLEXIBILITY MEASURED BY A SKIN-SURFACE DEVICE

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INTRODUCTION:
Isolated lumbar extension resistance exercise (ILEX) has shown good clinical results for patients with chronic low back pain [1]. Observations from clinical practice indicate there is often an immediate temporary reduction of symptoms after an ILEX session. However, little is known on the precise underlying physiological mechanisms that contribute to this clinical short- and long-term revcovery. The aim of this study was therefore to examine immediate effects of ILEX on spinal posture and flexibility.
METHODS:
Thirty-two healthy individuals (16 men, 16 women) with a mean age of 29.1 ±6.8 years and no history of back and neck related pain episodes performed one set of ILEX exercise leading to full muscle exhaustion after 12-15 repetitions within a range of motion of 12°-42°. The exercise device includes a restraint system that aims to increase lumbar extensor activity and to decrease the contribution of gluteal and harmstring muscles. Before and immediately after the exercise a standardized measurement of spinal posture and flexibility was performed using a skin-surface device (IDIAG M360). Standing sacral angle, lumbar lordosis, thoracic kyphosis, and range of flexion (ROF) of the thoracic and lumbar spine and of the sacrum was measured. Furthermore, values of flexibility for each segment between Th1-S1 were analyzed.
RESULTS:
After the ILEX intervention there was a significant reduction in thoracic kyphosis from 40.2°±10.3 to 38.8°±10.5 ($p<0.001$) and a reduction of lumbar lordosis from -29.0°±7.9 to -27.0°±38.0 ($p<0.001$). Furthermore, ROF in the lumbar spine decreased from 58.1°±8.9 to 56.3°±8.3 ($p<0.01$) and ROF in the sacrum increased from 58.1°±12.9 to 62.3°±12.1 ($p<0.001$). For the analyzed segments there was only a significant difference in L2 flexibility decreasing from 11.9°±2.5 to 11.2°±2.6 ($p<0.01$).
CONCLUSION:
The results indicate that there is an immediate effect on spinal posture and flexibility after one set of heavy loaded ILEX training. This knowledge can help understanding the underlying mechanisms behind the clinical outcomes of ILEX based rehabilitation programs. Future studies need to evaluate long-term outcomes of ILEX based therapies on spinal posture and flexibility.
1. Steele J, Bruce-Low S, Smith D. A review of the clinical value of isolated lumbar extension resistance training for chronic low back pain. PM R. 2015;7(2):169-87.

COMPARATIVE EXPERIMENT ON THE REHABILITATION EFFECT OF THREE-DIMENSIONAL BREATHING AND LUMBAR STABILIZATION EXERCISES IN THE PATIENTS WITH LUMBAR DISC HERNIATION

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INTRODUCTION:
The purpose of this study is to compare the efficacy of three-dimensional breathing (TDB) and lumbar stabilization exercises (LSE) in improving the efficacy of in patients with lumbar disc herniation(LDH).
METHODS:
Sixty-eight male patients with lumbar disc herniation were randomly divided into three-dimensional breathing and lumbar stabilization exercises groups. The training cycle of the 2 groups was 10 weeks, and the training frequency was 3 times a week.The clinical symptoms, functional parameters of lumbar vertebrae and deep muscle strength were collected and measured before and after training in the 2 groups.
RESULTS:
There was no statistical difference in all indexes between the two groups before the experiment.After 10 weeks of intervention, the parameters of the 2 groups showed the following changes:①The clinical symptoms were significantly improved in LSE group and TDB group ($P < 0.001$).②Compared with LSE group, the improvement effect of anxiety and the degree of lumbago in TDB group was better ($P < 0.05$).③The retraction of intervertebral disc herniation increased significantly in LSE and TDB groups ($P < 0.001$),it is related to the muscle strength of the diaphragm（$P<0.05$,$r=0.625$） and the lower transverse abdominal muscle（$P<0.05$,$r=0.457$）;There is a correlation between lumbar posterior stability（$P<0.05$,$r=0.649$）, lumbar joint function（$P<0.05$，$r=0.637$）, lumbar lateral stability（$P<0.05$,$r=0.479$） and retraction of lumbar disc herniation.④the retraction effect of intervertebral disc herniation in TDB group was better than that in LSE group（$P<0.05$）.
CONCLUSION:
Lumbar stabilization exercises and three-dimensional breathing pattern improve clinical symptoms and increase lumbar disc deformation in patients with lumbar disc herniation. However, the retraction effect of disc herniation was better in the three-dimensional breathing group, which is related to the muscle strength of the diaphragm and the lower transverse abdominal muscle, as well as the lateral and posterior stability of the lumbar spine.

THE EFFECT OF THE SMILE EXERCISE ON THE BONE STRENGTH AND GAIT ABILITY IN OLDER ADULTS

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HIROSHIMA UNIVERSITY

INTRODUCTION:
Physical training can prevent gait ability and gait ability declines in older adults. We recently showed that the SMILE exercise, which was designed to apply mechanical loads and vibration to the bones of the foot, improved bone strength and gait speed in older adults with activities of daily living disability [1]. However, it remains unknown that this exercise improves bone strength and gait ability in older adults with better physical function since training-induced improvements in physical function were smaller in older adults with better physical function than in those with worse physical function [2]. Thus, the present study investigated whether the SMILE exercise could improve bone strength and gait ability in older adults with better physical function.
METHODS:
This study was a 1-year randomized controlled trial. Fifty-eight Japanese older adults participated in this study. Participants were randomly allocated to either the intervention group (n=28) or the control group (n=30). The intervention group underwent the SMILE exercise for 60 min once a week over the course of 1 year. The exercise was designed to apply mechanical loads and vibration to the bones of lower limbs and performed through group training. The speed of sound (SOS) at the right calcaneus, muscle hardness at the gastrocnemius, muscle strength of the toe plantar flexor, hip adduction and hip abduction, gait speed, and immunoglobulin A (IgA) were measured before (Pre) and after (Post) the 1-year training.
RESULTS:
Physical characteristics and all measures at the Pre did not differ between groups. In the control group, the SOS, muscle hardness at the gastrocnemius, and muscle strength of the toe plantar flexor and hip adduction at the Post were significantly worsen compared to at the Pre ($p<0.05$). However, in the intervention group, the SOS, muscle hardness at the gastrocnemius, muscle strength of the toe plantar flexor, hip adduction and hip abduction, gait speed at the Post significantly improved by 0.70%, 3.44%, 6.63%, 5.04%, 15.77%, 11.92%, respectively, compared to at the Pre ($p<0.05$).
CONCLUSION:
The main finding in the present study was the SMILE exercise for 60 min once a week over the course of 1 year improved the bone strength and gait ability. The magnitude of improvement in the gait speed in the present study was similar in that in the previous study in which multi-component physical training was used (14% [2]). Moreover, the improvement of the SOS is important for preventing non-spine fractures in older Japanese adults [3]. Thus, the SMILE exercise is recommended for Japanese older adults with better physical function to improve bone strength and gait ability.
References:
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STUDY IN EFFECTS OF DIFFERENT PERIODS OF INTERVENTIONS WITH ELECTRICAL STIMULATION ON STRUCTURAL CHANGES OF TIBIAL ARTICULAR CARTILAGE INDUCED BY HIND-LIMB SUSPENSION IN RATS

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INTRODUCTION:
Recently, a treatment method for Osteoarthritis using a vector potential (VP) has been developed and is drawing attention. The method is characterized by an extremely low burden on the body because the electrical stimulations aren't directly given to body. Although VP may contribute as a therapy for OA, the effect of VP on the articular cartilage of OA has not been examined histologically.The purpose of this study was, using tail-suspended rats, to morphologically compare and investigate the effects of electrical stimulation with VP on structural changes of the tibial articular cartilage caused by mechanical unloading.

METHODS:
One hundred and eight male rats (wistar strain, 7-week-old) were used as materials and they were divided into HS, VP and CO, and moreover, each group subdivided, by experiment periods, into HS1, HS2, HS3, VP1, VP2, VP3, CO1, CO2, and CO3. CO1, CO2 and CO3 were normally bred in the cages for 1, 2 or 3 weeks, respectively. Tails of HS1, HS2, HS3, VP1, VP2 and VP3 were suspended in cages for 1, 2 and 3 weeks, respectively. The experiment was conducted under anesthesia using a VP generator (Sumida Denki Co., Ltd.). The conditions of electrical stimulation of VP were 67V, 20kHz, 0.13mA AC, and were set to 30 minutes / day, 5 days / week. After the experimental period, knee Joint in each group was excised and was analyzed histologically.
RESULTS:
The thickness of the cartilage calcified layer was significantly higher in HS than in CO, and that of VP was likely to CO. The difference between such groups became remarkable with an experiment period advancing. The stainability of safranin O tends to be low in the articular cartilage of HS, and in HS3 in particular, the stainability of the superficial and intermediate layers of articular cartilage has almost disappeared. The results of immunostaining of MMP-3 showed positive reactions only in the HS group, and those reactions localized from superficial to intermediate layers of HS3. However, for CO and VP, those reactions were no longer observed from the CO1 and VP1 stages.
CONCLUSION:
In this study, the calcified layer of the articular cartilage in HS was significantly thicker than that of the other groups, and it is supposed that this is suggesting that OA-like condition was induced by the hindlimb suspension. From the results of the stainability of Safranin O and the immunostaining of MMP-3, it is considered that the suspension of the hindlimbs caused the substrate destruction of the articular cartilage and then the elevation of the calcified layer but those changes were suppressed from the early stage by VP-electrical stimulation.
It was suggested that the substrate destruction and the increase in the calcified layer of the articular cartilage induced by mechanical unloading could be suppressed from the initial stage of energization stimulation by VP.

CP-MH03 Physiotherapy

IS AN EXERCISE PROGRAM FOR PEDIATRIC CANCER PATIENTS IN PALLIATIVE CARE FEASIBLE? – A CASE STUDY

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INTRODUCTION:
Growing evidence indicates benefits through exercise programs on physical performance and psychological well-being in pediatric oncology. Based on these findings, young patients should have access to exercise programs during all phases of treatment including palliative care. Only very limited data in this setting is available for AYA patients, but not for younger adolescents or children with cancer. This pilot study analyzes the feasibility of an exercise programs offered during hospital and home-based care.
METHODS:
Exercise program consisted of individual and 1:1 supervised resource-oriented interventions supplemented by home-based activities at least once a week each lasting 30-60 min during palliative care. It comprised a combination of strength, endurance, coordination, body awareness and mobility training. Data collection of psychological (Health-Related Quality of Life [HRQoL], fatigue) and physical capacity-related endpoints (muscular endurance/leg strength [sit-to-stand], isometric maximum force/handgrip strength [maxforce], functional mobility [TUG], and body composition) was intended to be every 4-6 weeks. A 13-yr-old girl with relapsed alveolar rhabdomyosarcoma in a palliative care setting participated.
RESULTS:
Exercise program was feasible and well tolerated with 69% adherence throughout 16 weeks of participation including n=7 interventions at home, n=7 inpatient and n=2 outpatient. HRQoL increased slightly with a slight decrease at the last measurement (T0:41.7, T1:43.8, T2:46.7, T3:45.8). Although Physical health score was generally low and decreased at the end (T0:20, T1:25, T2:30, T3:20), Psychosocial health increased (T0:57.1, T1:57.1, T2:55, T3:64.3). Fatigue decreased until T2 and then increased at T3 again to baseline level.
Exercise parameters such as maxforce (T0:24.6kg, T1:24.5kg, T2:23.4kg, T3:22.3kg) decreased, whereas TUG (T1:4.79, T2:4.97, T3:5.09) did not differ. Leg strength increased (T0:9.65, T1:7.26, T2:6.05, T3: 7.06 s in sit-to-stand) over time. Body cell mass (T0:13kg, T1:14.1kg, T2:12.2kg, T3:11.6kg) decreased, extracellular mass (T0:23.3kg, T1:22.6kg, T2:24.3kg, T3:24.9kg) increased, whereas bodyweight did not differ. Phase angle (T0:3.5°, T1:3.9°, T2:3.2°, T3:3.1°) decreased over time. The girl participated in the exercise program until one week before her death.
CONCLUSION:
The individually adapted exercise program for this advanced pediatric cancer patient was feasible, well accepted, and might have served as a supportive tool to reduce overall burden. The interventions at home were gladly accepted if the general health allowed it and children's and parent's needs were respected. On a psychosocial and physical level, the patient seems to have benefited from this exercise program. More research needs to be done about effects on health status.

RATE OF FORCE DEVELOPMENT AND RELAXATION IN A LGMDR1 YOUNG FEMALE PATIENT: A CASE STUDY PRELIMINARY RESULTS AFTER 6 WEEKS OF RESISTANCE TRAINING

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INTRODUCTION:
The slope gathered from the relationship between several submaximal peak forces and their relative peak of Rate of Force Development (RFD: maximal Δforce in any given 100ms during each contraction) is referred as RFD scaling factor (RFD-SF) while this slope obtained from the relationship between the same peak forces and their peak of Rate of Force Relaxation (RFR) is named as RFR-SF. Impaired RFD and RFR ability, showed as a reduced slope in the RDF-SF/RFR-SF linear regressions in several pathologic conditions (1), negatively influences postural control and increases risk of falls (2). The present study aims to a) evaluate the impact of LGMDR1 on the RFD and RFR ability and b) to assess the neural capacity to improve them in the early stages of a resistance training (RT) program.
METHODS:
After an introductory macrocycle to physical exercise, and before moving into a RT program, the 23-year-old woman suffering from LGMDR1 selected for this study was assessed for Maximal Voluntary Contraction (MVC) in the knee extension (Multi-Joint System 4 –850-000 dynamometer from Biodex medical systems). She was asked to perform between 2 and 5 maximal repetitions with each knee. 2 weeks into the program, it was safe and relevant to assess the quick contraction/relaxation capacities by means of the RFD-SF/RFR-SF protocol, in which the participant performed 1-minute-bouts of contractions (one every 2 seconds) for a total of 30 repetitions per bout. A total of 350 contractions (60 at each intensity: 20, 30, 40, 50, 60, 70, 80% of the MVC) were recorded and analysed. One month later, RFD-SF/RFR-SR and MCV test were repeated. The study met the ethical standards (H1057_1534342).
RESULTS:
RDF and RFR slopes increased from 4.86 to 9.83 and from -4.57 to -7.52, respectively for the most affected leg. Six weeks of RT promoted an increment in MVC baseline values for knee extension in the most affected leg (from 48.7 to 52.3 Nm; Δ+7.4%), with no changes in the less affected.
CONCLUSION:
Our preliminary findings suggest that despite being contraindicated for so many years, RT appear to be beneficial in this LGMDR1 young female. Since both, maximal effort, and quick contractions, are required to successfully complete daily activities and reduce risk of falling, RDF and RFR scaling factor protocols are seen as a useful part of the screening process in different pathologies. In addition, in contrast to what has been previously seen in pathologies that directly affect the nervous system, the neural adaptative response may be preserved in patients suffering from LGMDR1. Customized training programmes my prevent the functional deterioration linked to inactivity in this population, enhancing their functionality and Quality of Live.
REFERENCES:
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A PRAGMATIC EXERCISE PROGRAM (MATCH) DURING HOSPITALIZATION IN OLDER ADULTS TO COUNTERACT FUNCTIONAL IATROGENIC DECLINE: A FEASIBILITY STUDY

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INTRODUCTION:
Hospitalization leads to iatrogenic decline, which increase health disorders and healthcare needs (falls, frailty, more services). Even if physical activity (PA) is known as a potential solution, it is poorly integrated into usual care due to non-available pragmatic intervention. Assess the feasibility, acceptability and effects of a pragmatic systematic, prescribed, specific and unsupervised daily adapted PA training (MATCH) in geriatric care unit.
METHODS:
Feasibility study using a co-creation process. Of 37 eligible and hospitalized older adults (>65yrs), 26 consented and were randomized into two groups: MATCH (n=13) or Control (n=13). MATCH-participants received one of the five PA programs (3exercises; 3times/day) according to their mobility score obtained through a decisional tree. Feasibility and acceptability were assessed through prescription rate, adherence, feedback and questionnaires (system usability, Likert-scales). Physical performance (balance, gait/walk parameters, muscle strength, muscular capacity) was evaluated at admission (T0) and discharge (T1). Length-of-stay and rehabilitation care were also recorded.
RESULTS:
MATCH-participants trained in average 2sessions/day and reported high level enjoyment (100%) and satisfaction (80%). MATCH implementation occurred within 3days. Physician provided feedbacks in 90% of the time. Healthcare professionals found MATCH adequate (90%). MATCH-group increased more the sit-to-stand performance than control-group (MATCH: T0: 24.1 ± 10.5; T1:18.3 ± 4.8 vs. CONTROL: T0:19.8 ± 7.4; T1:18.8 ± 5.6sec; p=0.040). MATCH reduce rehabilitation treatment (n; MATCH: 2.1 ± 1.7 vs. CONTROL: 7.3 ± 5.5; p=0.012) during hospitalization and tend to decrease the length of stay (days; MATCH: 22.5 vs CONTROL : 24.5).
CONCLUSION:
MATCH could be integrated as pragmatic PA intervention into usual care to counteract iatrogenic decline. Further RCT studies implementing MATCH are needed to confirm results.

CP-MH04 Disabilities

THE RELATIONSHIP BETWEEN SELF-DETERMINED MOTIVATION AND PHYSICAL ACTIVITY LEVELS IN PEOPLE WITH SEVERE MENTAL ILLNESS. THE PSYCHIACTIVE PROJECT.

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INTRODUCTION:
Physical activity (PA) is a key risk factor for the prevention and treatment of severe mental illness (SMI). However, this population reported low levels of PA and poor adherence to exercise interventions [1], an aspect that can limit the positive effects of exercise on health. Physical activity and adherence are affected by several factors that could be controlled and modified by researchers. Understanding the motivating factors towards PA for people with SMI would help to maximize exercise participation. The aim was to study the relationship between levels of PA and different types of motivation in people with SMI.
METHODS:
A cross-sectional study was carried out in 59 adults (= 13, 20-60 years) with SMI. Participants completed The Behavior Regulation Exercise Questionnaire 3 (BREQ-3) and the International Physical Activity Questionnaire Brief Form (IPAQ-SF). The BREQ-3 comprises 23 items related to six motivational regulation constructs, each item is measured on a five-point Likert scale, from 0 ("Not true for me") to 4 ("Very true for me"). The mean of the 6 subscales is calculated on a five-point scale to score each type of motivation. The IPAQ-SF uses a recovery period of 7 days and the data are summarized in METs of walking, moderate, vigorous, and total PA per week. The relationship between variables was explored with Spearman's rho correlation with a significance level of P <0.01.
RESULTS:
Integrated motivation was significantly associated with moderate (r= 0.37; 95% CI 0.13, 0.57), vigorous (r= 0.44; 95% CI 0.21, 0.63), and total PA (r= 0.56; 95% CI 0.36, 0.72). Besides, amotivation was negatively correlated with total PA (r= -0.44; 95% CI -0.62, -0.21). Finally, sedentary time measured with IPAQ-SF correlates positively with BMI (weight [kg]/ height [m]2) and amotivation with age in people with SMI. No other significant associations were found.
CONCLUSION:
Current findings suggest that amotivation and integrated motivation may play a key role in the adoption and maintenance of regular PA in people with SMI. Control and modify these variables can reduce the dropout and improve adherence to exercise programs, enhancing the positive effects on health.
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COMPARING THE EFFECTIVENESS OF COGNITIVE AND NON-COGNITIVE ENGAGING EXERCISE ON COGNITIVE FUNCTIONS IN CHILDREN WITH AUTISM

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INTRODUCTION:
Executive dysfunction has been widely reported in children with autism spectrum disorder (ASD). While studies have clearly documented the cognitive benefits of physical exercise on cognition in children, similar studies in children with ASD are scarce. The purpose of this study

was to compare the impact of cognitively engaging exercise and non-cognitively engaging exercise on executive function in children with ASD.
METHODS:
Sixty-two children diagnosed with ASD (50 males and 12 females, Mage = 9.89±1.53 yr, Mheight = 1.43 ± 0.15 m, and Mweight = 44.69 ± 11.96kg) were randomly assigned into three groups: learning to ride a bicycle (n = 22), stationary cycling (n = 20) and control (n = 20). Four executive function components (planning, working memory, flexibility and inhibition) were assessed.
RESULTS:
Results revealed significant improvements in all executive function components in the learning to ride a bicycle group (ps <.05) but not in the other two groups after controlling for age and IQ.
CONCLUSION:
Our findings highlight the value of cognitive engagement in exercise programs designed to improve cognition in children with ASD.

CARDIORESPIRATORY FITNESS AND CAROTID-INTIMA MEDIA THICKNESS IN SENIORS WITH INTELLECTUAL DISABILITY

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FPCEE BLANQUERNA

INTRODUCTION:
Older adults with intellectual disabilities (ID) have decreased physical fitness compared to their peers without ID, which might be the key for life expectancy rates, where less cardiorespiratory fitness (CRF) is related to lower life-expectancy (1). Co-morbidities present in this population create a burden that need to be cared of. One of these is cardiovascular risk, which can be predicted with carotid intima-media thickness measuring (2). There is a lack of literature reporting CRF related with carotid-intima media thickness (cIMT) in older adults with ID. The aim of this study was to determine the relationship between CRF and cIMT in elderly with ID. Further, we aimed to determine if differences exist for cIMT and CRF between sex.
METHODS:
28 adults (14 females, 49 ± 8 yrs and 14 males, 50 ± 8 yrs) with mild to moderate ID were recruited from occupational day centers for people with ID. CRF was obtained through a metabolic cycloergometry test; cIMT assessments were performed on the right common carotid, using a high-resolution B-mode ultrasound machine equipped with an 11-MHz frequency linear probe, 1-2 cm proximal to the carotid bifurcation. cIMT was quantified using edge detection software (Cardiovascular Suite, QUIPU, Pisa, Italy), where a 10 mm segment of the artery was identified with calipers placed on the far vessel wall. cIMT was measured over the entire 10 mm segment during 10 s providing average cIMT of the segment. Descriptive for all variables were obtained. Independent t-tests were applied to analyze between-sex differences. Correlations were performed (Pearson's r) to analyze relationships between cIMT, CRF and anthropometric variables. Finally, a multivariate linear regression analysis was used to evaluate factors contributing to cIMT.
RESULTS:
cIMT was correlated with relative VO2 peak (r = -0.46; p = 0.015), heart rate (r = -0.46; p = 0.014) and weight (r = 0.43; p = 0.022). VO2 peak was correlated with distensibility (r = -0.56; p = 0.002), stiffness (r = 0.48; p = 0.008) and young's modulus (r = 0.52; p = 0.005). Sex differences were no statistically different in cIMT (women: 0.57 ± 0.09 mm vs men: 0.62 ± 0.12 mm). However, women presented lower VT (t = -3.66; p = 0.001), lower VO2 peak (t = -2.07; p = 0.049), and lower relative VO2 peak (t = -3; p = 0.006) compared to men. Multivariate linear regression showed that height and relative VO2 peak contribute to cIMT in seniors with ID (R2 = 0.41).
CONCLUSION:
We found negative correlation between cIMT and CRF, which indicates that higher CRF is a protective factor in this population with ID. Besides, cIMT has shown to have CRF contributions. Thus, it is recommended that seniors with ID follow exercise programs, both to improve CRF and cIMT.

TELE-EXERCISE DURING COVID-19 FOR AN ITALIAN UNIVERSITY STUDENT LIVING WITH PARAPLEGIA: EFFECTS AND USABILITY.

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INTRODUCTION:
In Italy, the Covid-19 pandemic imposed gyms stop; young people living with disabilities were most penalized by this situation. The University of Pavia, with the "Abili si diventa" project, gave students with disabilities the opportunity to follow a tele-exercise program (TEP) to reduce the sense of abandonment and promote biopsychosocial well-being. The aim of the study was to evaluate the functional effects of a TEP and the perceived usefulness and ease of use of the technology on a female student living with paraplegia.
METHODS:
From April to June 2020, a 27-years-old student with paraplegia, due to T10 spinal cord injury, with a reduced trunk control and no lower limbs' motor and sensitive functions, participated in a TEP of two supervised 1-hour week sessions carried out with a device with integrated video-call (Kari, Euleria srl, Trento, Italy). Sessions included aerobic, resistance, functional and stretching exercises. In order to make the resistance exercises more effective, a kit of resistance bands (Matrix Italia, Ascoli Piceno, Italy) was sent to participants.
Tests of resistance strength, identified in the literature and feasible online, were administered at the beginning (T0) and at the end of the intervention (T1). Aerobic capacity, flexibility and wheelchair management were not evaluated because of the online situation and the need to ensure safe conditions during tests.
Tests, performed on students wheelchair, were Dip (D) and Chest Press with resistance band (C). Maximum number of repetitions performed (reps) were evaluated.
At T1 was also administered the Technology Acceptance Model (TAM) to evaluate perceived usefulness and ease of use of the technology employed for online exercise.
RESULTS:
Compared to T0, the number of reps at T1 increased in both tests: D (73 vs 40), C (110 vs 40).
Total TAM score was 25.6/28. Single areas' scores were: perceived ease of use 7/7, perceived usefulness 7/7, attitude towards use 4.6/7, intention to use 7/7.
CONCLUSION:

The results showed an improvement in upper body strength and subject reported an increase in her trunk control, postural transfer and wheelchair handling skills during the activities of daily living. The online training technology employed in the study, was perceived as easy and useful. In conclusion, a TEP can be an effective training mode for people living with paraplegia, when the face-to-face modality is not possible.

EFFECT OF A STRENGTH EXERCISE PROGRAM ON FUNCTIONAL MUSCLE CAPACITY AND GUT AND LUNG MICROBIOTA IN CHILDREN WITH CYSTIC FIBROSIS

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INTRODUCTION:
Digestive alterations are characteristic in patients with Cystic Fibrosis (CF), which has important implications on intestinal microbiota (1). Gastrointestinal (GI) and pulmonary tract bacterial communities are heterogeneous (1). There is a link between certain taxa of de GI microbiota and the progression of pulmonary disease in CF (2-7). Exercise produces beneficial effects in this population, in part because of the possible modification of GI and lung microbiota (8).
OBJECTIVE: To assess the effect of a strength exercise program on muscular capacity, alpha and beta diversity of intestinal and lung microbiota on children with CF with mild-moderate pulmonary involvement and good physical condition.
METHODS:
Randomized controlled trial design on children with CF diagnose from 7 to 19 years with mild-moderate pulmonary involvement and good physical condition. Patients were divided into two groups: control (CON) and exercise (EX). The EX group completed an individualized and guided strength training program (60-80% of 5RM) during 16 weeks (2 days/week;/ 60min/day) and the CON group followed the physical activity recommendations of their pediatrician.
There were analyzed leg press (LP) and chest press (CP), alpha and beta diversity of intestinal and lung microbiota.
RESULTS:
Twenty four children (CON=9, EX=15) aged 12.63±2.95 were included. Forced expiratory volume 1 (FEV1) z-score was -1.42±1.53 and peak oxygen consumption (VO2peak) 43.63±7.90mL.Kg-1.min-1. There was a significant effect on the time*group interaction in the LP and CP with a large effect size, ($F[1,22]=21,831$; $p<0.05$; $\eta 2p=0,498$) and ($F[1,22]=17,116$; $p<0.05$; $\eta 2p=0,438$) respectively.
Exercise did not modify the alpha diversity of intestinal or lung microbiota. A positive correlation was observed between the lung alpha diversity and the FEV1 z-score. A beta diversity variation of the intestinal and lung microbiota was observed in the longitudinal study between CON and EX groups, taking into account the abundance of species without considering phylogeny (Bray-Curtis). However, there were no significant differences on the microbiota composition related to the exercise program.
CONCLUSION:
The strength training program in children with CF with mild-moderate pulmonary involvement and good physical condition achieved significant improvements in muscular condition of upper and lower limbs. It induced a variation in the beta diversity of intestinal and lung microbiota, however, it failed to produce significant changes in alpha diversity as well as composition of intestinal and lung microbiota.

CP-MH05 Motor learning and mental health

MOTOR COORDINATION IN SICILIAN CHILDREN AGED 6-13 YEARS OLD: A FOCUS ON AGE, GENDER, AND WEIGHT STATUS

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INTRODUCTION:
An adequate level of motor coordination (MC) should be achieved during childhood in order to develop several health-related benefits. Although different research groups have investigated the influence of body weight status (BWS) on MC, no studies have examined the interrelationship between age, gender, and BWS in a large sample of Sicilian children.
METHODS:
In this cross-sectional study 647 children (328 boys, 319 girls) were recruited from primary and middle schools in Sicily. Participants, stratified in three age groups (6-7, 8-10, 11-13 yrs) and two BWS categories [underweight and normal weight (UW-NW), overweight and obese (OW-OB)], were administered the Körperkoordinationstest für Kinder (KTK) that allow to measure MC expressed as motor quotient (MQ). The KTK included four subtests: 1) walking backward on a balance beam of decreasing widths; 2) two-legged jumping sideways from side to side over a beam for 15s; 3) one-legged hopping for height over a foam obstacle of increasing height; 4) moving sideways on the floor in 20s. The MQ, standardized for age and gender, was computed by adding the score of the four subtests. The one-way ANOVA for each age group was performed separately to detect any difference on MQ between: 1) BWS categories; 2) gender of the same BWS category; 3) BWS categories of the same gender. The one-way ANOVA was also carried out separately to analyse any difference on MQ between: 4) age groups of the same BWS category in relation to the gender.
RESULTS:
Our results showed: 1) higher significant MQ in UW-NW than OW-OB for each age group ($p<0.001$ both in 6-7, 8-10, and 11-13 yrs); 2) higher significant MQ in boys than girls of the same BWS category for each age group ($p<0.001$ in UW-NW of 6-7 yrs, OW-OB of 6-7 yrs, and UW-NW of 8-10 yrs; $p=0.02$ in OW-OB of 8-10 yrs; $p=0.003$ in UW-NW of 11-13 yrs); 3) higher significant MQ in UW-NW than OW-OB both in boys and in girls for each age group ($p<0.001$ both in girls of 6-7 yrs, boys of 8-10 yrs, and boys of 11-13 yrs; $p=0.004$ in girls of 8-10 yrs; $p=0.03$ in girls of 11-13 yrs); 4) higher significant MQ in the 6-7 year age group than 8-10 and 11-13 for each BWS category both in boys and girls ($p=0.02$, $p=0.002$, $p<0.001$, and $p=0.009$ in UW-NW boys, UW-NW girls, OW-OB boys, and OW-OB girls, respectively).
CONCLUSION:
Our findings showed a negative relationship between MC and higher BWS in children regardless of age and gender, and it could be related to the existing inverse relationship between BWS and skills that require effort to counteract the force of gravity. Moreover, we revealed higher MC levels in boys than girls belonging to the same BWS category and age group, and this difference could be explained by the usual PA level and the type of sport practiced by boys. Furthermore, we detected an inversely proportional trend between age and MC with younger children showing higher MC levels, and it could be due to the intermittent developmental process during childhood.

SIX WEEKS OF COORDINATIVE ACTIVITY BREAKS IN THE OFFICE RESULT IN AN INCREASE OF BALANCE AND FINE MOTOR SKILLS IN ADULTS – PRELIMINARY RESULTS.

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INTRODUCTION:
Physical activity as part of health promotion plays an important role, especially during the Corona pandemic, when physical activity opportunities are rare. Furthermore, motor fitness seems to have a positive association with cognitive functioning [1]. Therefore, an online-tutored coordinative activity break was offered to the staff at the University of Graz. Besides the health promotion for the participants, the project aimed to evaluate the effects of the training on cognitive function, brain structure, and motor function. Here we present preliminary results on balance, fine motor skills, and participant's motivation.
METHODS:
Participants performed the training, which consisted of juggling and balance tasks, for 15 minutes two times per week for six weeks. Two men and 13 women (43,00±8,67 years) participated in the study. To assess the motor fitness, we tested the participants before and after the training period. We assessed balance, manual dexterity and bimanual coordination, and reaction time with the Y-Balance test, the Purdue Pegboard test, and the fall stick test, respectively. During the intervention, the participants documented how much they enjoyed the active break on a scale from 5 (I did enjoy a lot) to 1 (I did not enjoy) . Paired t-tests were used to analyze the data.
RESULTS:
For the Y-Balance test, the relative distance in the right anterior direction (PRE: 61,19±3,67%; POST: 62,56±4,30%), the right (PRE: 94,41±9,09%; POST: 98,50±8,80%) and left (94,27±8,80%; POST: 97,65±8,02%) posterior lateral directions increased significantly after six weeks. In addition, bimanual coordination (PRE: 11,95±1,18; POST: 12,68±1,47) increased significantly in the Purdue Pegboard test, while no other significant effects of the other measured parameters were observed. More than 90% of the participants enjoyed the active break (5:68,95%; 4: 23,57%; 3: 1,68%; 2: 5,88%; 1: 0,77%).
CONCLUSION:
DISCUSSION:
We conclude that an online-tutored activity program is motivating for office staff and that even a short period of juggling and balance training induces an improvement in motor fitness. However, we suppose that a longer intervention time is necessary to also increase the reaction time.
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MONITORING THE BRAIN HEALTH OF FORMER PROFESSIONAL ATHLETES ONLINE: AN ACCEPTABILITY STUDY

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Introduction:
The SCORES (Screening Cognitive Outcomes after Repetitive head impact Exposure in Sport) study, launched in 2020, investigates brain health of former elite athletes who have participated in contact sport compared with non-contact sport athletes. Previously, the FIELD study (1) examined medical records and retrospective data to demonstrate that male former professional football players were at an increased risk of developing dementia by 3.5 fold. Prospective, longitudinal evidence from studies of both male and female athletes is now needed to understand the link between contact sport and dementia risk. The SCORES study is an online longitudinal study monitoring signs of prodromal dementia at 6-month intervals for at least 10 years. This acceptability study explored taking part from the perspective of participants after one round of testing to maximise future engagement with the study.
Methods:
From 130 participants, 98 registered interest to be interviewed. Eight participants were selected from this group based on age, sex and sporting history (mean age: 65.8, 6 males). Semi-structured interviews were designed using Sekhon's multi-construct theoretical framework for assessing acceptability of participation (2). Topics explored included the experience of participation, ethicality of studying mental health and behaviour, and the best process for participants to receive their brain health results. Responses were organised by topic and coded to generate themes.
Results:
Participant motivations were altruistic including giving back to the sporting community and monitoring their own brain health. Participants suggested an optimal time of 30 minutes every three months to be low burden, and they suggested improvements for the online setting to enable greater technological ease. All participants wanted to receive their test results, but opinion on the ethicality of the process of giving feedback in terms of invasiveness and requirements of duty of care varied.
Conclusion:
The purpose of this study was to understand perceptions of online long-term study participation to reduce potential attrition in the SCORES study. Our findings directly led to the development of a process for giving personalised results to participants so that they can monitor their own brain health and a regular newsletter to keep them updated. We also limited testing to 30 minutes, re-ordered the sequence of tests, and improved participant facing information. Findings from this study will be used in the planned expansion of the project into Europe.
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MENTAL FATIGUE AND SPORT-SPECIFIC PSYCHOMOTOR PERFORMANCE: A SYSTEMATIC REVIEW

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INTRODUCTION:
Mental fatigue (MF) is a psychobiological state that arises during prolonged demanding cognitive activity and results in an acute feeling of tiredness and/or a decreased performance capacity[1]. Research shows that MF negatively influences both cognitive (e.g. attention) and

physical (e.g. endurance) performance[1]. Recently, multiple studies have indicated that MF could also impair sport-specific psychomotor performance[2] (SSPP; i.e. highly complex motor behaviour that results from the cognitive processing of sensory and perceptual information in a sport-specific context). SSPP encompasses outcomes such as reaction time and accuracy, which are important predictors of performance in a variety of sports. Nevertheless, a systematic overview detailing the effects of MF on SSPP is currently lacking.
METHODS:
PubMed (MEDLINE), Web of Science, PsycINFO and SPORTDiscus were searched (5th of November 2020). Studies were eligible when study outcomes encompassed any form of SSPP skill, the intervention was targeted to induce MF, and the population included healthy individuals. The presence of a manipulation check, to indicate the successful induction of MF, was obligatory for inclusion. Secondary outcomes were all outcomes (either physiological or psychological) that could explain the underlying mechanisms of the effect of MF on SSPP.
RESULTS:
In total, 21 papers were included. MF was successfully induced in all but two studies, which were excluded from further analysis. 17 out of the 19 analysed studies displayed a negative effect of MF on a myriad of SSPP outcome types, including decision-making, reaction time and accuracy. No changes in physiological outcomes, that could underlie the effect of MF, were reported. Subjectively, only ratings of perceived of exertion (RPE) increased due to MF in some studies.
CONCLUSION:
Overall, it is clear that MF can impact important aspects of SSPP, which is especially important for coaches employed in sports where SSPP determines a large part of total athletes' performance. This systematic review enables the relevant stakeholders to make better decisions about which performance outcomes to monitor in relation to MF and potentially counter MF.
Most secondary outcomes remained uninfluenced due to MF. Only RPE changed, which could be connected to adenosine accumulation in the brain, raising the perceived effort of the physical task and negatively influencing performance. However, these suggestions have been made before, and a clear confirmation of this theory using objective brain measurements is still lacking. Therefore, the brain should be the main focus of future studies to finally understand the effect of MF on human performance.
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COMBINED EFFECTS OF ELECTRICAL MUSCLE STIMULATION AND ARM CRANKING ON COGNITIVE PERFORMANCE

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INTRODUCTION:
It is well established that physical activity or regular exercise can improve cognitive function [1]. Electrical muscle stimulation (EMS) is an alternative modality of exercise. However, it is currently unclear if the combination of EMS and voluntary exercise impacts cognitive performance. Therefore, the purpose of this study was to examine the effects of EMS combined with low-intensity arm cranking on cognitive performance.
METHODS:
Twenty-two healthy males performed a Go/No-Go task before and after two separate interventions: EMS combined with low-intensity arm cranking (EMS+EX) and EMS combined with no-load arm cranking (Control). The frequency of EMS was set at 4 Hz in both conditions and the stimulation intensity was gradually increased until to a maximal tolerable level. In the EMS+EX condition, the intensity of arm cranking was adjusted such that heart rate (HR) was maintained at approximately 120 beats/min (bpm) during EMS combined with arm cranking. Reaction time (RT, ms) and accuracy (%) of the Go/No-Go task were expressed as median (IQR).
RESULTS:
Mean HRs were 121.1 ± 6.6 bpm in the EMS+EX condition and 90.4 ± 9.3 bpm in the Control condition. RT decreased in the EMS+EX condition (313 (301-324) vs. 298 (290-322), P = 0.003). In contrast, RT did not change in the Control condition (309 (295-341) vs. 314 (303-327), P = 0.60). Accuracy did not change in the EMS+EX (100 (99.6-100) vs. 100 (99.6-100), P = 0.86) and Control (100 (98.3-100) vs. 100 (99.6-100), P = 0.56) conditions.
CONCLUSION:
These findings suggest that the combination of EMS and arm cranking improves reaction time of this response inhibition task in an effort-dependent manner. These data may provide some insight into the potential benefits of the combination of EMS and voluntary exercise on cognitive health in various populations.
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PREFRONTAL CORTEX ACTIVITY IN GENERAL AND (SPORT-) SPECIFIC COGNITIVE TASKS IN SOCCER PLAYERS

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INTRODUCTION: The importance of both sport-specific and general perceptual-cognitive abilities in the performance of elite team athletes was shown in several studies (Heppe et al., 2016; Chen et al., 2020). However, the underlying cortical processes in sport-specific and general perceptual-cognitive tasks in the prefrontal cortex (PFC) of soccer players have not been clarified yet. The aim of the present study was to analyse the prefrontal activation of soccer players in general and sport-specific perceptual-cognitive tasks.
METHODS: 39 semi-professional male soccer players from the 4th to 6th highest German Soccer-League (24.8 ± 4 yrs, age range 18 to 33) performed two cognitive tasks requiring selective attention and decision-making skills. They were conducted as computer-based tests (Vienna Test System Determination Test (DT) and self-developed video-based Soccer Test) and involved a general cognitive and a soccer-specific cognitive task to distinguish the associated underlying processes. Meanwhile, the cortical activity in the PFC was measured by functional near infrared spectroscopy (fNIRS) (NIRx NIRSport, NIRx Medical Technologies LLC, NY, USA). Differences of cortical activation in sport-specific and general cognitive tasks were analysed using a paired t-test.
RESULTS: Significant differences of the prefrontal activation (oxyhemoglobin) between the sport-specific and general cognitive computer-based task were found in seven out of eight channels (Ch. 1: p=0.02, Ch. 2: p<0.01, Ch. 3: p<0.01, Ch. 4: p=0.99, Ch. 5: p=0.02, Ch. 6:

p<0.01, Ch. 7: p<0.01, Ch. 8: p=0.02). The mean activation changes between resting state (baseline) and the tasks indicated an increased activation during the general cognitive task compared to the sport-specific task.
CONCLUSION: Our study indicates that the prefrontal cortex is less activated during the processing of sport-specific cognitive demands compared to general perceptual-cognitive tasks in computer-based tests. This might be due to higher neural efficiency of soccer experts in soccer specific tasks. This seems in line with earlier research indicating that higher expertise is associated with relatively lower oxygenation (Bunce et al., 2011). However, further research is needed to clarify the spatial involvement of the PFC in the processing of these cognitive demands in experts.
LITERATURE:
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COGNITIVE TASK PRIOR TO BALLISTIC CONTRACTION TASK REDUCES RATE OF TORQUE DEVELOPMENT

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INTRODUCTION:
Since better performance in sports involved ballistic movements, e.g., acceleration of sprinting, dunk shot, long shoot etc., requires greater rate of torque development. Therefore, clarification of a factor affecting rate of torque development would be important to improve sports performance. In addition to peripheral factors, central factors including motor cortex excitability are known to regulate force generation capacity (Gandevia 2001). While recent studies demonstrated that cognitive tasks, which induces central fatigue reduces the subsequent endurance performance (Macmahon et al. 2014), it is not clear if cognitive tasks affect the performance of the subsequent ballistic contractions. Because the number of spectators in the stadium has been still limited to prevent the spread of COVID-19, the sports performance of the athletes may be influenced owing to smaller cheering (i.e., verbal encouragement) (Tilp et al. 2020). The purpose of this study was to clarify the effect of cognitive tasks on the subsequent ballistic contractions conducted with and without verbal encouragement.
METHODS:
The 12 participants (4 females) increased isometric knee extension torque of the right-leg as fast as possible (ballistic task) before (Pre), immediately after (Post0), and 20-min (Post20) after the cognitive task (15-min incongruent Stroop task, ST) and quite sitting (15-min quiet sitting, QS). Participants performed the ballistic tasks with and without verbal encouragement. These interventions were conducted randomly on a different day. The rate of torque development (RTD) was assessed as the maximal value of the first derivative of the filtered torque during ballistic task.
RESULTS:
With respect to RTD with verbal encouragement, there was an interaction between time and interventions ($P < 0.05$). Post-hoc test revealed that RTD was smaller in Post0 and Post20 than Pre ($P < 0.05$) in ST while there was no significant change in QS ($P > 0.05$). In contrast, with respect to RTD without verbal encouragement, there were no interaction and main effects ($P < 0.05$).
CONCLUSION:
RTD with verbal encouragement was reduced after cognitive task while RTD without verbal encouragement was not affected by prior cognitive task. RTD is linearly correlated with amplitude of movement related cortical potential in the sensorimotor cortex and supplementary motor area, which reflects neural processes involved in preparing the motor command (Shibasaki et al. 1980). Based on this, it seems that the reduction in RTD with encouragement after cognitive task is due to that cognitive task reduce the preparatory brain activity that was originally enhanced by the verbal encouragement. No change in RTD without encouragement after cognitive task may support this notion. These results indicate that cognitive task reduce the subsequent ballistic performance even conducted with verbal encouragement.

CP-MH06 Physical activity promotion I - Covid 19

OCCUPATIONAL ACTIVITY, WORK MODE, AND PERCEPTION OF MENTAL HEALTH DURING COVID-19 PANDEMIC QUARANTINE: A SURVEY STUDY IN CHILEAN ADULTS

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INTRODUCTION:
The confinement of the population during the COVID-19 pandemic has led to decreased daily physical activity (1), causing more prevalence and risk of mental illnesses and well-being (2). The changes adopted by people in terms of how they work, mainly by performing predominantly online work, can impact mental health (3) and, consequently, their perception. This study aimed to analyze the differences according to the occupational sitting and physical activity questionnaire (OSPAQ) questionnaire concerning the mode of work and the perception of mental health in adults during a quarantine period in Chile.
METHODS:
Two hundred twenty-one subjects (age 37.3±12.7; 68.6% women), mainly from the Biobío Region in Chile, participated during the quarantine period between March and April 2021. OSPAQ and an ad-hoc survey with Likert scale questions regarding the perception of mental health compared to the three months before the beginning of the arrival of the COVID-19 pandemic in the country were applied. Sociodemographic questions concerning the type of work or study, family income, and educational level also were asked. The ANOVA and the Bonferroni posthoc test were applied to determine differences between the modes of time spent sitting at work or study with the modalities of such activities and the perception of mental health.
RESULTS:
Those who worked or studied in on-site mode reported more weekly walking time than those subjects whose regime was a hybrid ($p<.001$) or online ($p<.001$). In addition, subjects with on-site activity presented more weekly heavy work time compared with those in hybrid modality ($p<.05$) or online ($p<.01$). As for mental health, this was better perceived in people working or studying on-site than those who had

hybrid or online mode (p<.05). Also, those who reported having better mental health than before the pandemic performed more heavy work than those who mentioned having the same or worse mental health (p<.05).
CONCLUSION:
These findings suggest that working in an online mode may affect health perception, which could be linked to pathologies and mental issues suffered in the short term. Quarantine confinement seems to impact how people view their health according to the time spent walking or performing strenuous activity during work or study hours. Thus, it is necessary to promote strategies related to reducing inactivity and sedentary lifestyles during work or study time, especially among those who work online.
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HEALTHY HABITS: THE STATUS OF MIDDLE-AGED AND OLDER ADULT SPANISH POPULATION 1 YEAR POST THE COVID19 PANDEMIC

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UNIVERSITY OF GREENWICH

The CoVid-19 Pandemic, lockdown period and mobility restrictions have led to an unfortunate state of worldwide society. Consequently, a wide volume of the population has been unable to undertake their common daily activities and habits (e.g., physical activity, physical exercise, nutritional habits and sleeping time). This situation has impacted health status and self-perceived wellbeing. We aimed to investigate the impact of the restrictions imposed during the lockdown and limited mobility on healthy habits, self-perceived status and wellbeing of CoVid-19 Pandemic restrictions on middle-aged and older adult (40-70 years old) Spanish population.
A new multi-factorial questionnaire was designed based on specific questions from the Food Choice Questionnaire (FCQ) (Jáuregui-Lobera & Bolaños Ríos, 2011), the Self-Regulation of Eating Behaviour Questionnaire (SREBQ) (Kliemann, Beeken, Wardle, & Johnson, 2016), Health and Emotional Motivations from the People's Food Choices Determinants Questionnaire (FCD) (Ferrão et al., 2017), and the Warwick–Edinburgh Mental Well-being Scale (WEMWBS) (Castellví et al., 2014).
This questionnaire was distributed online via Qualtrics. Every participant joining the inclusion criteria (be 40 years or older, Spanish living in Spain during the entire period of confinement and the subsequent year of restrictions, have signed the consent form, answered at least body measurement parameters such as height and body weight) were selected for further analysis.
Seven hundred and eighty-eight responses (302 males; 486 females; mean age: 51.6±8.1 y.o.) were included in the sample for further analysis. Self-perceived Health Status (SP-H) did not show significant differences between sexes, while Food Quality modifications after one year (p=0.004) and daily steps walked (p=0.001) showed significant differences in favour of male group. Chi-square test showed a non-significant difference between sexes in weekly Physical Exercise (p=0.215) nor Resistance Training (p=0.506) practice, but a difference in supplement consumption favoured women (9.173; p=0.002) with a higher preference of vitamins (21.5% vs 32.7%). Conversely, protein supplementation was more predominant in men (10.3% vs 5.5%). Independent samples T-test revealed a significant difference between sexes in Body Mass Index (BMI) (2.87±0.27, 95%CI [2.35,3.40], t(787)=10.7,p<0.001), and WEMWBS (0.77±0.28, 95%CI [0.217,1.313], t(753)=2.74,p=0.006) in favour of men (overweight), but FCD (-0.62±0.18, 95%CI [-0.978,-0.266], t(787)=-3.43,p=0.001) favouring womens group (normal weight).
Our findings suggest that after 1 year of CoVid19 Pandemic, healthy habits are determined by WEMWBS but not by BMI in Spanish middle-aged and older women but not in men. Overall, a positive influence of exercise practice and physical activity (step walked) was observed in SP-H and SP-DQ. However, more studies are needed to determine the influence of these variables in long-term healthy habits adherence.

UNIVERSITY STAFF SITTING TIME DURING WORKING HOURS

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INTRODUCTION:
Recently, awareness of health disorders caused by prolonged sitting has been increasing. It has been pointed out that prolonged sitting is closely related to the risk of death from cardiovascular diseases, and is a risk factor for obesity and various metabolic diseases. In this study, we measured the physical activity of the staff of the university and were intended to clarify those current situations.
METHODS:
Healthy university employees (n=17, 25-57yrs) were recruited as subjects, and physical activity during work was measured for two weeks (10days) using an accelerometer (Lifecorder Suzuken Co.). The physical activity intensities 0 and 0.5 (max=9) that can be measured by an accelerometer were defined as the physical activity intensity of the sedentary behavior, and their continuous hours were defined as the continuous hours of the sedentary behavior.
RESULTS:
The average working time was 570.4±88.3 minutes per day. The average continuous sitting time was 11.5 ± 3.9 min. The continuous sitting time for one sitting was not long, but the total sitting time in the working hours per day was 67±8%. Previous studies show that adults spend for sitting 55-60% of their time per each day. The results of this study indicate that the percentage of sitting behavior in working hours during the day was greater than in previous studies.
CONCLUSION:
The university staff took up sitting time for about 70% during working hours, and it was clear that they sat for 6 hours 30 minutes per day while working. In the future, it is necessary to consider the characteristics of the department to which they belong and consider ideas for reducing sitting behavior.

„INCLUSION THROUGH SPORT- APPLYING A SPORTCOACH FOR ADVISING, ACCOMPANYING AND MEDIATING OF PERSONS WITH OCCUPATIONAL DISEASES INTO SPORT AND AN ACTIVE LIFESTYLE" (2018-2022)

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INTRODUCTION:

The project „Inclusion through Sport- applying a sportcoach for advising, accompanying and mediating of persons with occupational diseases into sport and an active lifestyle“ focuses on the achievement and the sustainment of participation in daily social and working life of persons with occupational diseases through sporting activities and participation in sport clubs. The project's aim is that they will be allocated with a sportcoach, who advises, accompanies and mediates them into an individually desired sports program at the end of their medical rehabilitation. The selection of these sports programs are based on various factors, such as distance to home and personal sport preferences. The project is funded and organized by the German social accident insurance institution for the health and welfare services (BGW).
METHODS:
Participants go through an 18 months intervention time within four measurement periods in total. The research project uses a mixed-methods study design and participants were included from five regions, which are set by the BGWs regional distribution, throughout Germany. At each measurement period, the participants will be questioned about their sports program (e.g. satisfaction, progress, etc.) and have to fill out several questionnaires regarding their self-efficacy, strength, quality of life and employability. In addition, a network mapping with four partitions (e.g. “friends”; “family”; “occupation” & “health care professionals”) reflecting their development to establish a personal sport-orientated social network, is used.
RESULTS:
First results show that 74 participants were included in the study. Further participants may be included over time, since participants can take part until first of July 2021.
Interviews were also analysed and first results show that the participants increased their sporting activity, became member at local sports clubs and experienced additional motivation from the sportcoach meetings to carry on with their sport program(s).
CONCLUSION:
Preliminary results have shown that the sportcoach has an influence on the social life of persons with occupational diseases. Next, it can be seen that the usage of the sportcoach's services for persons suffering from occupational diseases at the end of the rehabilitation process, provides additional cognitive and physical training. Furthermore, this training initiates the purpose of maintaining the health and the stimulation of personal skills.
Until the congress, further data will be collected and a more in-depth analysis towards the influence of the sportcoach on persons suffering from occupational diseases will be present.

EFFECTS OF VIRTUAL “CHILDREN IN MOTION” CAMPS ON THE HEALTH-RELATED QUALITY OF LIFE AMONG CHILDREN DURING COVID-19 PANDEMIC

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INTRODUCTION:
Due to the current lockdown situation in Bavaria, Germany, it is very difficult or even not possible for children to take part in organized activities and leisure activities.
The consequences are lack of exercise, unhealthy diet, a reduced quality of life and less social contacts from which many children and their family members suffer. To create a balance, kidsTUMove has established an active virtual “children in motion” camp (VIM) giving children the opportunity to recharge themselves from homeschooling and pandemic isolation. VIM provides target group-specific exercise offers for different age groups, resilience-enhancing resources to strengthen and increase self-confidence by doing handicrafts, knowledge fun games on nutrition, the environment and team building. Thereby VIM motivates participants to be active in their daily life, strengthening their self-esteem and lack of social contacts.
The aim of this study is to analyze the current state of QoL in children and the effect of a virtual online camps.
METHODS:
The physical and mental state of children in the lockdown period of February/March 2021 was evaluated before and after a 2 weeks KidsTUMove VIM camps by a self-reported online survey. Questionnaire items are physical activity behavior, use of media, nutrition behavior (KIGGS), health related quality of life (KINDL®) and wellbeing (WHO-Five Well-Being Index).
RESULTS:
Children attending the survey: pre n=66, ♀ n=32und ♂ n=34; age 7.97 ± 2.73)/post n=26, ♀ n=12 und ♂ n=14; 7.15±2.49 years (Kindergarten 24.4%, primary school 53%).
Qol during lockdown was significantly lower before attending the VIM camps (pre 74.5%±11.34 vs. post 80.13%±9.57; $p<0.05$).
Mental wellbeing during lockdown was also significantly lower before than after the VIM camps (pre 74.53%±14.68 vs. post 82.45%±12.25, $p<0.05$). Regarding the item wellbeing in school and kindergarten during homeschooling and special daycare situation, there is also a significantly lower value before attending the VIM camps (pre 73.67±22.56 vs. post 83.41±17.13, $p<0.05$).
CONCLUSION:
VIM camps in lockdown periods specially designed for children with the aim of compensating missing offers (like sports, social and family support offers from clubs and schools and cultural activities) seem to raise children´s QoL. Virtual child-friendly contents and applications in health-related programs seem to affect the children's balance and wellbeing in periods of homeschooling and special daycare situation in kindergarten. The need for such VICs becomes evident in special situations such as the Covid 19 pandemic.

DEVELOPMENT OF THE THEORY- AND WEB-BASED PARENTAL AUTONOMY-SUPPORTIVE INTERVENTION TO INCREASE OUT-OF-SCHOOL PHYSICAL ACTIVITY AMONG SECONDARY SCHOOL STUDENTS

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UNIVERSITY OF TARTU

Introduction
Although the benefits of physical activity (PA) are well-known, PA levels among youth are low worldwide (Aubert et al 2018). Research indicates that PA levels during late childhood and early adolescence decline sharply. Since physical inactivity has adverse health effects in later life, it is essential to intervene before this decline to maintain adequate PA levels in children. Autonomy-supportive (AS) interventions have proven to be effective in the classroom, but children spend a considerable amount of time under parental care, so it is equally important to educate parents to use AS techniques. The aim of the project is to develop a theory- and web-based AS intervention for parents to help them support their children's autonomous motivation towards out-of-school PA. We target the intervention to parents of Grade 6 students' and expect increased out-of-school PA of children as a result.

Methods
The content of intervention will be based on the classification of Motivation and Behavior Change Techniques (MBCTs) that are derived from three basic psychological needs of autonomy, relatedness, and competence (Teixeira et al 2020). Parents will be provided with educational materials and short videos about the techniques. A smartphone application will be developed to help parents monitor the presence vs absence of need-supportive communication during their interaction with children. Parents are expected to put the techniques into practice and the primary outcome measure of the intervention is children's daily PA measured by accelerometers.
Results
Feedback to the preliminary videos regarding their understandability, effectiveness, and usability was asked from a test group of parents (N = 12). A 5-point Likert scale (1 = strongly disagree and 5 = strongly agree) was used for evaluation and the results revealed high scores on understandability (M = 4.86 ± 0.12), effectiveness (M = 4.41 ± 0.34), usability (M = 4.29 ± 0.41).
Discussion
The study will contribute to the literature by developing a theory- and web-based intervention delivered by parents with an aim to increase the students' PA levels in an out-of-school context. Feedback to the preliminary videos revealed that parents find the techniques understandable, effective, and usable. If the web-based parental AS intervention augmented with the smartphone application shows promising results, a practical tool would be available for parents who want to help their children be physically more active.
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CP-MH07 Health and fitness I - Age and mixed

EFFECTS OF EXERCISE HABIT TO THE CONDITION CHANGES IN THE SPORT SPECTATORS UNDER A HOT ENVIRONMENT

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INTRODUCTION:
Recently, it has been found that the spectators of sport games may develop the risk of heat stroke as well as athletes. Our previous reports suggested that it is possibility the spectators who may have heat stroke because their urinary electrolyte significantly decreases during the watch of a game under the heat environment. It became necessary to exermine the difference in sweating function and getting used to the heat environment dependent on exercise habit. Therefore, the aim of this study was to investigate the influence of with or without a exercise habit on the condition changes in the spectators of high school baseball in Japan.
METHODS:
Sixteen healthy Japanese young men volunteered to this investigation. The subjects watched the high school baseball game for two hours under a hot environment (August, 2019). We set the two groups; group of exercise (E group) were under hot environment more than 4 days a week (n=8, age: 21 ± 1 years, weight: 81.7 ± 15.5 kg, height: 177.1 ± 6.6 cm, BMI: 25.9 ± 3.5) and group of not actively exercise (NE group) under hot environment (n=8. Age: 22 ± 2 years, weight: 58.3 ± 5.9 kg, height: 171.6 ± 5.0 cm, BMI: 19.8 ± 1.7). The measurements were meteorological conditions, volume of the intake, body weight, thermal sensation, thirsty sensation and feeling of fatigue.
RESULTS:
Meteorological conditions (atomospheric temperatures: 35.0 ± 1.2 ℃, relative humidity: 40.1 ± 6.1%, WBGT (Wet-Bulb Glove Temperature): 31.2 ± 1.1 ℃) during watching games were considered summer specific. The sweat loss (1,158 ± 235 ml) and the dehydration rate (0.46 ± 0.36 %) of E group were significantly higher than thats of NE group (829 ± 200 ml, -0.26 ± 0.50 %). Additionaly, the degrees of hydration (fluid intake volume/sweat loss) of E group (75.7 ± 21.5 %) was significantly lower than NE group (120.4 ± 28.8 %).
CONCLUSION:
Although no difference was observed in thirsty sensation between the two groups, it was not enough hydration for E Group. Because E group also had less feeling of fatigue during watch the game, it is assumed that getting used to the heat environment is probably involved in a little volume intake. Therefore, it was suggested that need to encourage active hydration considering species of drink, intake timing, taste perception and preference, even at sitting watch the game. However, it is also possible that the sweat loss increased due to the influence of body composition because BMI of the E group was high. Our results suggested that habitual exerciser at heat environment is high dehydration rate and low hydration rate during watch the game. However, it is necessary to examine about the body composition, heat acclimation and issue of hydration (taste perception etc), in this summer.

AGE-RELATED CHANGES IN PHYSICAL PERFORMANCE - A THREE YEAR FOLLOW-UP STUDY IN KOSOVO

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INTRODUCTION:
Physical performance limitations increase with age, resulting in progressive decline in performing the activities of daily life, morbidity and mortality [1]. Therefore, the aim of this present study was to examine the change in physical performance of community-dwelling adults of Kosovo, a developing lower-middle income country.
METHODS:
In 2016/2017, 308 Kosovan adults (age: 39.8 – 90.8 yrs, 51.9% females) took part in the initial measurements. Out of these138 participants (age: 43.9 – 93.2 yrs, 52.2% females) took part also in 2019/2020. At both time points, self-reported data on general health, anthropometry, isometric handgrip strength (HG), and physical performance [30-s chair stand (CST), timed up and go (TUG), and 6 minutes walking test] were assessed. Population- and equipment-specific test-retest reliability was assessed for those parameters and reported to be acceptable [2]. Differences between time points were assessed by dependent t-test (continuous variables) and Chi² test (frequencies). Significance levels were set to $p < 0.05$.
RESULTS:

Participants were characterized with high BMI levels (29.6 ± 4.9 and 30.0 ± 4.8 kg/m² at the baseline and follow-up respectively). While height was significantly decreasing (-1.0 ± 0.02 cm; p<0.001), weight remained stable (0.1 ± 4.1 kg; p = 0.855), leading to a slight increase in BMI (+0.39 ± 1.62 kg/m²; p = 0.006). Isometric handgrip strength was not significantly altered (-0.6 ± 5.2 kg (p = 0.173). Similarly, aerobic capacity was not affected (-6.5 ± 88.7; p = 0.390). However, physical performance for CST and TUG worsened by -1 ± 3 reps (p = 0.001) and 0.98 ± 2.18 s (p<0.001), respectively. Separating by gender revealed that the decline was more pronounced in females. When correlating the changes between the two time points and age, we did not identify age at baseline as a modifying factor (p>0.05).
CONCLUSION:
This study evidenced the lower extremities strength (endurance) decline with ageing, as the primary detectable outcome within functional performance in our study group. Chair stand presents a proxy measurement recommended to be used for strength of leg muscles in addition to handgrip strength for sarcopenia as suggested by the revised European Working Group in Sarcopenia for Older People [3].
It has to be mentioned that life expectancy in Kosovo is the lowest in Europe which might explain the low attention on age-associated conditions within the public health sector. Our data support the need for considering this issue in the country's future health policies.
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THE DOSE-EFFECT RELATIONSHIPS BETWEEN PHYSICAL ACTIVITIES AND QUALITY OF LIFE IN OLDER ADULTS: A CROSS-SECTIONAL STUDY IN BEIJING, CHINA

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INTRODUCTION:
Studies have shown diverse strength of evidence for the associations between physical activities and quality of life in older adults. The objective of our study is to analyze the dose-effect relationship between physical activities and quality of life in the elderly.
METHODS:
We included in our study 105 older adults (≥60 years old) from three community in Beijing, China. The characteristics of study population (including gender, age, educational attainment and marriage status) were investigated by a self-designed questionnaire. Physical activities were assessed using the physical activity survey for the elderly (PASE). Quality of life was measured by the Medical Outcome Study 36-item short form health survey (SF-36). Multivariable linear regression was used to explore the dose-effect relationships between physical activities and quality of life.
RESULTS:
Female gender and age were found to be negatively related with physical component summary (the corresponding standardized regression coefficient were -0.256 and -0.188, respectively). Compared with the lowest quartile of physical activities volume, the third quartile and the highest quartile volumes of physical activities were associated positively with physical component summary (Standardized regression coefficients were 0.264 and 0.313, respectively) except for the second quartile of physical activities volume. However, no association was found between physical activities and mental component summary (P>0.05), after controlling the potential confounders.
CONCLUSION:
Compared with gender and age, the effect of physical activities on physical health of older adults in Beijing was the largest. Of note, a dose-effect relationship was found between the physical activities volume and the physical health in older adults. Elderly population with higher physical activities volumes could gain larger benefits in physical health. However, no associations were found between physical activities and mental health.

BIOELECTRICAL PHASE ANGLE IS ASSOCIATED WITH AEROBIC CAPACITY, COMPLEX GAIT ABILITY AND TOTAL FITNESS SCORE

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INTRODUCTION:
This study aimed to examine the association between whole-body or segmental phase angle (PhA) based on bioelectrical impedance analysis (BIA) and aerobic capacity (endurance), complex gait ability, and total fitness age score (FAS).
METHODS:
A total of 426 community-dwelling older adults (332 women and 94 men) aged 60 to 93 years participated in this study. PhA and appendicular skeletal mass index (ASMI) were obtained by an eight-electrode standing BIA. Aerobic capacity was assessed using the shuttle stamina walk test (SSTw); complex gait ability, using the timed-up-and-go test (TUG). FAS was obtained using the previously validated multidimensional equations based on 7-year longitudinal data. SSTw, TUG, and FAS were compared between the low PhA (<4.4° for women and <5.2° for men) and normal PhA groups. Pearsons correlation between PhA and SSTw, TUG, and FAS was determined. Multiple linear regression analysis was conducted using SSTw, TUG, and FAS as dependent variables. Age, sex, height, body mass index (BMI), ASMI, and PhA were entered into the linear model.
RESULTS:
SSTw and TUG results and FAS were significantly lower in the low PhA group (P < 0.05). PhA was significantly correlated with SSTw, TUG, and FAS (P < 0.001), and leg PhA showed a stronger correlation than whole-body or arm PhA. PhA at 50 kHz had higher correlation coefficients with SSTw, TUG, or FAS compared with PhA at 5 or 250 kHz. Multiple regression analyses indicated that leg PhA at 50 kHz was a significant predictor of SSTw, TUG, and FAS, independent of age, sex, height, BMI, and ASMI.
CONCLUSION:
Our results indicate that leg PhA is associated with multi-dimensional physical fitness in community-dwelling older adults. PhA is a highly informative biomarker of skeletal muscle and exercise physiology in clinical settings.

THE EFFECT OF VIBRATION AMPLITUDE ON THE OXYGEN CONSUMPTION OF SQUAT WITH DIFFERENT EXTERNAL LOADS

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INTRODUCTION:
The significant increase in oxygen consumption (VO2) induced by whole body vibration training (WBVT) means that WBVT may be an effective method for increasing aerobic energy expenditure and endurance capacity. Therefore, many studies began to research how to maximize the effect of WBVT on VO2 by changing vibration frequency, amplitude and external load. However, most of these studies employed only one level of external load and mainly focused on the effect of vibration frequency, it is still unclear whether a dose-response exists between vibration amplitude (VA) and VO2 under different loads. Thus, the aim of this study was to investigate the relationships between VA, external load and VO2.
METHODS:
Eight male college students (24.1±2.0 years) with strength training experience (1RM squat: 154.3±22.7 kg) volunteered to do 6 sets of 10 squats with different loads (weight: no weight (NW), 20% body weight (LW), 40% body weight (HW)) and vibration amplitudes (no vibration (NV), 30Hz 2mm (LV), 30Hz 4mm (HV). Data were collected during different stages (rest, six 30s sets of squatting, and recovery).

RESULTS:
VA-load interaction effect for VO2 and excess post oxygen consumption (EPOC) was not significant($P<0.05$), but VA effect is significant for VO2 and EPOC ($P=0.023$; $P=0.002$). After pairwise comparison, LV and HV was significantly higher than NV (VO2: $P=0.762$ EPOC: $P=0.07$; $P=0.003$), but there was no significant difference between LV and HV (VO2: $P=0.762$ EPOC: $P=0.857$). However, the sample size of LV and HV was different. Cohen's d in NW: HV was higher than LV (VO2: 0.62 VS 0.49; EPOC: 0.58 VS 1.30). Cohen's d in LW: HV VS LV (VO2: 0.32 VS 0.63; EPOC: 0.53 VS 0.48). Cohen's d in HW: HV VS LV (VO2: 1.09 VS 1.06; EPOC: 1.00 VS 1.52)
CONCLUSION:
The intervention of vibration stimulation can effectively improve VO2 and EPOC of squatting under different external loads. According to the result of effect size, VA effect was different for different external loads. For unloaded squat, the effect of 4mm-VA on increasing VO2 and EPOC is better than 2mm-VA. For LW, 2mm-VA was more effectively than 4mm-VA on increasing VO2 during exercise. For HW, 4mm-VA can induce higher EPOC than 2mm-VA.

PREFRONTAL CORTEX OXYGENATION DURING ENDURANCE PERFORMANCE: A SYSTEMATIC REVIEW OF FUNCTIONAL NEAR INFRARED SPECTROSCOPY (FNIRS) STUDIES

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INTRODUCTION:
During whole-body endurance performance, important decisions that impact performance are taken consciously and unconsciously, suggesting an important role for the brain (e.g. 'Am I totally exhausted, and do I have to stop this exercise?'). A promising hypothesis is a role for prefrontal cortex (PFC) oxygenation, since this brain region is thought to be crucial in decision making, planning, attention and is known for its executive function.
METHODS:
Three electronic databases Pubmed, Web of Science and Cochrane Library were searched (until 29 April 2021) for studies assessing prefrontal oxygenation (POx) through Near Infrared Spectroscopy (NIRS) during whole-body endurance performances. Studies using short (<75s), static and/or muscle endurance where excluded from this review. Primary outcome measures were Oxygenated- ([HbO2)]) and deoxygenated- ([HHb]) hemoglobin concentrations to express prefrontal oxygenation prior and during exercise performance and during post-exercise rest.
RESULTS:
In total, 27 articles were included, 9 assessing POx during a maximal incremental test (MIT) and 18 using endurance tasks at workloads ranging from low- to supramaximal intensities. Within the MIT-studies an increase in [HbO2] was found until the respiratory compensation point (RCP). After this point, HbO2 decreased in 4 studies, reached a steady state in 4 other studies and increased in 1 study, all until exhaustion. Moreover, all studies found a decrease or steady state in [HHb] from the start until RCP and an increase until exhaustion. Within the 18 endurance studies, a general increase in POx was found during exercise at low-, moderate- and up to vigorous intensities, at which a steady state was reached. Throughout endurance tasks at near to maximal intensities, the increase in oxygenation and maintenance of the steady state could not be retained, resulting in prefrontal deoxygenation.
CONCLUSION:
The systematic screening of the literature shows that PFC oxygenation is affected in a similar way in both MIT and endurance exercise. Maximal incremental exercise studies show that a certain cerebral oxygenation threshold is present at the level of the RCP, which occurs at the verge of vigorous to near maximal intensities. The MIT-studies show that POx increases until this threshold, whereafter, steady state was reached or [HbO2] declined, reinforcing Rooks et al. (2010)[1].
During endurance exercise, [HbO2] increases throughout low- and moderate intensity-exercise until vigorous intensities, where after it reaches a steady state. Furthermore, the cerebral oxygenation threshold can be found at the verge between vigorous and near maximal intensity. During endurance exercise at near to maximal intensities or higher, POx increases until exceeding this threshold, resulting in a decrease in POx until the cessation of exercise. These findings reinforce and expand the knowledge on cerebral oxygenation during whole-body endurance exercise

CP-MH08 Health and fitness II - Disease

PHYSICAL ACTIVITY LEVELS IN WOMEN WITH BRCA 1/2 MUTATIONS

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INTRODUCTION:

The BRCA 1/2 mutations are the most known typologies of hereditary breast cancer (BC). Studies have provided among women carrying these mutations preliminary evidence of a protective role of PA against BC, particularly during adolescence or early adulthood. Data from the German LIBRE study confirmed a significantly lower BC prevalence in women who reported higher PA during their adolescence [1, 2]. In addition, the WISER trial on healthy pre-menopausal women at high risk of BC showed that exercise raised adiponectin and lowered leptin, controlling for a change in body fat and suggesting the importance of adipokines in BRCA penetrance [3]. Aim of the present study was to investigate the role of PA on BC risk factors in women carrying BRCA 1/2 mutations.
METHODS:
Data analysis involved 63 women (47.6±12.4yrs) with BRCA 1/2 mutations in care at Fondazione IRCCS Istituto Nazionale dei Tumori, Milan. The participants filled in Godin-Shepard Leisure-Time Physical Activity Questionnaire for the evaluation of the PA levels. Moreover, they underwent to anthropometric, metabolic, and blood sample evaluations. Data were analyzed with SPSS version 27.
RESULTS:
The women were classified as active (n=22) and inactive (n=41). Insulin levels were found significantly lower in active women compared to the inactive group ($p<.05$); there were no differences for the other variables analyzed.
The correlation analysis on the entire sample showed that higher PA levels are significantly correlated with a lower weight ($r2=-0.26$, $p<.05$), lower BMI ($r2=-0.30$, $p<.05$), lower hip circumference ($r2=-0.30$, $p<.05$), lower triglycerides ($r2=-0.28$, $p<.05$), lower fat mass in % ($r2=-0.31$, $p<.05$) and lower fat mass in kg ($r2=-0.28$, $p<.05$).
CONCLUSION:
These findings suggest that higher levels of PA can play an important and protective role against BC. Structured PA interventions are useful for developing new strategies that could provide a tool for modulate the penetrance of hereditary BC.
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ACUTE AND LONG-TERM EFFECTS OF RESISTANCE TRAINING ON ARTERIAL STIFFNESS IN HEALTHY PARTICIPANTS: A META-ANALYSIS

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UNIVERSITY OF ALMERÍA

INTRODUCTION:
Arterial stiffness (AS) may predict cardiovascular health-related outcomes [1]. The influence of aerobic training on AS is well known [2]. However, the effects of resistance training (RT) on AS in healthy people are unclear [3,4]. This meta-analysis aimed to assess both the acute and long-term (≥8 weeks) effects of RT on AS in healthy people.
METHODS:
A systematic search was conducted in PubMed, SportDiscus, Medline and Endbase electronic databases, for randomized-controlled trials published until October 2020. Nineteen studies were included, with 12.58±0.82 methodological quality points (from a total 15 points). The 19 studies included a total of 626 participants.
RESULTS:
No significant long-term effect was noted for RT on AS (ES = -0.07; 95% CI = -0.59 to 0.45; $p = 0.789$). However, RT induced a significant acute increase in AS (ES = 1.07; 95% CI = 1.55 to 0.59; $p < 0.001$). No moderator factor (i.e., age; gender; AS measurement; upper- vs lower-body RT; training intensity; duration; frequency) had significant effect on AS, for acute and long-term interventions.
CONCLUSION:
Although RT induces acute AS increase, this effect has no long-term impact on AS, irrespective of participant's age, sex, or RT programming factors such as intensity. However, the clinical implications of acute AS increase after RT are unknown.
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GENDER DIFFERENCE IN MODERATE TO VIGOROUS INTENSITY PHYSICAL ACTIVITY TIME INFLUENCES ON ARTERIAL STIFFNESS IN YOUNG ADULTS

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INTRODUCTION:
Regular physical activity decreases arterial stiffness, an independent risk factor of cardiovascular disease. The current physical activity guidelines recommend moderate to vigorous intensity physical activity (MVPA) to pursue cardiovascular benefits in various populations. Previous findings demonstrated that there are gender differences in both MVPA participation and arterial stiffness. However, it is hard to discover previous studies to investigate the relationship between physical activity and arterial stiffness with gender differences. Therefore, the purpose of this study was to investigate the relationship between MVPA participation and arterial stiffness based on gender difference.
METHODS:

Forty-six young adults (23.2 ± 0.4 years) participated in this cross-sectional study. Physical activity level was measured for 7 days using the wGT3X-BT accelerometers. To assess arterial stiffness, both aortic pulse wave velocity (AorPWV) and augmentation index adjusted at 75 beats per minute of heart rate (AIx@75) were measured by SphygmoCor Xcel System.
RESULTS:
We confirmed that there is a significant gender difference in MVPA time ($p < 0.001$). Thus, we classified participants into four groups by gender and MVPA time; high MVPA male (HighM), low MVPA male (LowM), high MVPA female (HighF), and low MVPA female (LowF). HighM showed significantly higher MVPA time than LowM and the rest female groups ($p < 0.001$). HighF showed significantly higher MVPA time than LowF. Female participants' AorPWV was lower than male participants, but there was no significant difference in AorPWV among the four groups. HighM presented significantly lower AIx@75 compared with LowM and LowF. In the whole group, MVPA time was negatively associated with AIx@75 ($r = -0.428$, $p = 0.003$).
CONCLUSION:
In conclusion, MVPA time in young men is higher than young women, but central artery stiffness is superior in young women compared to young men. Augmented MVPA time contributes to decreased wave reflection, an indirect measure of arterial stiffness, even in healthy young adults.

PHYSICAL ACTIVITY LEVEL IS ASSOCIATED WITH ARTERIAL STIFFNESS AND AUTONOMIC FUNCTION IN HEALTHY YOUNG ADULTS

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INTRODUCTION:
Physical inactivity is one of the modifiable risk factors for cardiovascular disease (CVD) and associated with stiffened arteries. Arterial stiffness, an independent risk factor for CVD, is positively associated with the incidence of future CVD even in healthy young adults. Imbalance of autonomic function is associated with cardiovascular events and mortality. Regular physical activity can reduce arterial stiffness by decreasing sympathetic and increasing parasympathetic nervous activities. However, the research findings on the relationship of physical activity level with arterial stiffness and autonomic function in heathy young adult remain unclear. Therefore, the purpose of this study was to investigate the relationship of physical activity level with arterial stiffness and autonomic function in healthy young adults.
METHODS:
We recruited sixty-six participants (24.1 ± 0.3 yrs) and measured physical activity level by using the wGT3X-BT accelerometers for consecutive 7 days. Carotid-femoral pulse wave velocity (cfPWV) and augmentation index (AIx) were measured by SphygmoCor Xcel system. Autonomic function was assessed via heart rate variability by using VitalScan HW10A.
RESULTS:
The group with the highest tertile of vigorous-intensity physical activity time had significantly lower AIx adjusted for the heart rate at 75 beats per minute (AIx@75) than the group with the lowest tertile (-2.57 ± 1.83 % vs. 5.64 ± 2.15 %, $P = 0.02$). Furthermore, the quantity of total physical activity was negatively related to AIx@75 ($r = - 0.26$, $P = 0.03$). The highest tertile group with total physical activity quantity presented higher RMSSD than the lowest tertile group (3.54 ± 0.11 ms vs. 3.86 ± 0.07 ms, $P = 0.03$). Additionally, rate pressure product (RPP) was lower in the group with the highest tertile of moderate-vigorous physical activity time compared with the lowest tertile group (62.96 ± 1.47 mmHg*beat/100 vs. 71.46 ± 2.74 mmHg*beat/100, $P = 0.03$).
CONCLUSION:
In conclusion, increased total physical activity quantity was associated with decreased arterial stiffness and increased activation of the parasympathetic nervous system. Moreover, increasing vigorous-intensity physical activity time may give additional benefits to cardiovascular health by reducing arterial stiffness and myocardial workload.

RELATIONSHIP BETWEEN DIET, VASCULAR ENDOTHELIAL FUNCTION AND BONE MINERAL CONTENT IN WOMEN

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INTRODUCTION:
Lifestyle-related diseases such as hyperlipidaemia, diabetes and hypertension would be reduced by changing the living environment. These lifestyle-related diseases are closely linked to atherosclerosis. Vascular endothelial dysfunction is one of causes of arteriosclerosis and the development of atherosclerotic conditions, including hardening of the arterial walls. Patients with low bone mineral content (BMC) are at significantly greater risk of developing cardiovascular disease (Caffarelli, 2017). The primary aim of this study was to identify the relationship between diet and vascular endothelial function (FMD) in young and post-menopausal middle-aged women. The second aim is to clarify the relationship between FMD and BMC in postmenopausal middle-aged women.
METHODS:
Thirty-five postmenopausal middle-aged regular swimmers and Nordic walkers, and 61 healthy female university students were participated for our cross-sectional study. All FMD measurements were performed by one operator using the UNEXEF 38G (UNEX, Japan). Participants completed weighted food records over consecutive 3 days: 2 weekdays and 1 weekend day. The diets were analysed by software (Eiyoukun, Japan) that is based on a standard food database by one nationally registered dietitian. DXA (DCS 600EX, Aroka, Japan) measured BMC at the distal radius were operated by one nationally registered radiologist.
RESULTS:
The postmenopausal middle-aged women group (66.1yeas,156.5cm,52.1kg) had significantly greater %FMD (6.2vs8.3%) and intakes of protein, lipid, carbohydrate, calcium, vitamin D, vitamin K and salt than the young healthy women group (21.2yeas, 157.3cm, 51.9kg). Only the vitamin D was significantly correlated with the %FMD in both groups. Twenty-nine postmenopausal middle-aged women who were able to measured FMD at the same day as BMC were divided into two groups; namely FMD normal group (n=17:≧6.0%) and FMD deteriorated group (n=18:<6.0%). The FMD deteriorated group was significantly older than the FMD normal group. It was not statistically significant, BMC at distal radius for both sides (p=0.071~0.201) were greater in the FMD normal group than the FMD deteriorated group. Fat and salt intake were greater in the FMD deteriorated group, although the differences were not statistically significant (p=0.050 and 0.128).
CONCLUSION:
The postmenopausal group had greater %FMD, intakes of protein, lipids, carbohydrate, calcium, vitamin D&K, and salt than the young healthy group. Only the vitamin D was significantly correlated with the %FMD in both groups. DXA-measured BMC showed that the FMD-

deteriorated group had lower values than the FMD-normal group, although without statistical significance, in postmenopausal middle-aged women. Fat-rich and high-salt meals could significantly suppress brachial artery FMD within a relatively short time. Fat and salt intake also may relate to the deterioration of FMD in relatively active postmenopausal women.
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CP-MH09 Health and fitness III - Sleep and mixed

INFLUENCE OF BEHAVIORAL RESTRICTIONS DUE TO CORONAVIRUS DISEASE ON SLEEP PATTERNS AND MENTAL HEALTH IN JAPANESE UNIVERSITY STUDENTS

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INTRODUCTION:
On March 11, 2020, the World Health Organization declared coronavirus disease (COVID-19) a global pandemic. This infectious disease is not only a severe public health issue, but it also significantly impacts health, educational, and social aspects. It can be easily inferred that COVID-19 has a great influence on the physical activity, sleep habits, and mental health of university students. Thus, we examined the influence of behavioral restrictions due to COVID-19 on sleep patterns and mental health in first-year university students.
METHODS:
Four hundred and twenty-two first-year university students (253 males and 169 females; age, 18.7 ± 1.0 y) participated in our questionnaire study. Under the behavioral restrictions condition due to COVID-19, 193 students (127 males and 66 females) responded to the questionnaire online from home. They did not visit the university during this period. The data acquired the year before the COVID-19 pandemic (2018 and 2019) were used as the control data (126 male and 103 female). The questionnaire consisted of the following four sections: 1) demographic and lifestyle variables, 2) the Pittsburgh Sleep Quality Index (PSQI) [1], 3) the Japanese version of the Epworth Sleepiness Scale (JESS) [2], and 4) the Patient Health Questionnaire-9 (PHQ-9) [3].
RESULTS:
Under the behavioral restrictions condition, the PHQ-9, JESS, and PSQI scores were significantly higher than those under the normal condition. Furthermore, these results were similar for both male and female students. The results of this study indicated that university students had better mental health and sleep patterns under behavioral restrictions due to COVID-19.
CONCLUSION:
Our results, unlike the results of many previous studies, show that mental health and sleep patterns are improved under behavioral restrictions due to COVID-19 in Japanese university students. It can be inferred that physical activity at night, part-time work, and long commuting times under the normal environment have an effect on these results.
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THE ACTIV-PROJECT: SELF-RATED EXERCISE INTENSITY OF 86,514 FEMALE AND MALE RUNNERS AGED 18-64 YRS

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INTRODUCTION:
Training induces adaptations and improvements of health and physical performance. It counteracts negative changes caused by lifestyle and certain impairments in consequence of biological ageing (1). Changes restricting performance often begin as early as young adulthood (2). Training parameters like volume and intensity are key indicators for the adaptive outcome. The survey of regularly trained runners examines health factors, training habits, and analyses associations to subjective ratings of training intensity (3).
METHODS:
The nationwide survey (www.dshs-koeln.de/activ) gathers data from runners registering for running events organized in the GRR e.V. Survey data are obtained by a scaled questionnaire covering i. a. health and anthropometric parameters, life-style indications, and normative data of training. Subjects quantified how often they push themselves to physical limits while training (“exercise intensity”) by using a 10-point-Likert-scale ranging from one (“almost never”) to ten (“almost always”). A subsample of 86,514 cases from more than 190,000 complete datasets was extracted. Selection criterions were: (1) age from 18 to 64 years, (2) experience of regular running training of at least two years, and (3) a minimal weekly training volume of 10 km.
RESULTS:
Data of 56,247 male (m) and 30,267 female (f) runners (age: 42.6 ± 10.7 vs. 39.1 ± 10.8 years; training volume 34.6 ± 17.9 vs. 29.1 ± 15.0 km/week; years of running training: 9.2 ± 8.9 vs. 7.2 ± 7.0) were analyzed. Two-way ANOVA exposes linearly sinking exercise intensity between age groups from 18 to 64 years from 6.8 ± 12.7 to 4,9 ± 16.8 units ($F(46, 86,232) = 81$; $p<0.001$) and also a minor sex-related difference: 5.75 ± 1.9 (m) vs. 5.55 ± 1.9 (f) ($F(1, 86,232) = 400$; $p<0.001$). Regression analyses of intensity confirmed age (standardized beta: -0.20; $p<0.001$) as main independent predictor followed by sex and marathon experience (each beta: -0.08, $p<0.001$) as weaker factors. No effective association exists with health resp. medical risk factors (beta: -0.02; $p<0.001$).
CONCLUSION:
The interpretation of these results and all drawn conclusions are subject to the well-known constraints of cross-sectional approaches concerning causality. However, the clear association between self-rated exercise intensity and age suggests that ability and readiness to realize high loads and to tolerate strain in runners consistently sink with age and the process begins early in life. Age- or biologic-related intrinsic factors may slowly attenuate the affinity, initial drive and motivation for high intensity activities. Therefore, the specific application of high-intensity loads (e.g. HIIT, cross-fit©) is recommended to maintain willingness to achieve and for the prevention of premature loss of physical performance.
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EFFECT OF A DIGITAL AWARENESS PROGRAM ON HEALTHY HABITS ON THE PHYSICAL HEALTH OF WORKERS

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Effect of a digital awareness program on healthy habits on the physical health of workers
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Introduction: The high levels of stress as a new way of working have brought, are assuming an increase in risk factors derived from this marked sedentary lifestyle and physical inactivity and a generally poor quality diet, being associated with physiological, cardiovascular, metabolic and psycho-emotional diseases. Therefore, our main objective was to study the effect of a digital healthy lifestyle promotion program (HLPP) based on 12-week educational awareness pills on body composition profile (BCP) and physical capacity (PC) in a sample of workers.
Methods: An experimental longitudinal study was carried out based on the measurement and comparison of response variables before and after the intervention, where the BCP was measured through electrical bioimpedance, the PC through manual grip with dynamometry and jump variables with counter movement jump (CMJ) with the APP My Jump; as well as self-perception through questionnaire.
Results: The intervention significantly improved the variables associated with self-perception of HLPP and those associated with the inclusion of day-to-day habits. These improvements appear to have a positive and significant effect on PC, improving CMJ height and speed. However, the indicators related to the BCP did not improve significantly with the intervention carried out.
Discussion: The main objective of the study was achieved, which was to improve awareness in HLPP. However, the 12-week intervention with digital pills that educate on the improvement of life habits does not prove to be sufficient with respect to the overall improvement of physical health in the group defined by the BCP and the PC.

CP-PN01 Muscle

BODY COMPOSITION AND CARDIORESPIRATORY FITNESS ACCOUNT FOR SEX DIFFERENCES IN ANGIOTENSIN-CONVERTING ENZYME 2 (SARS-COV-2 RECEPTOR) EXPRESSION IN HUMAN SKELETAL MUSCLE

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INTRODUCTION:
Severe acute respiratory syndrome virus 2 (SARS-CoV-2) utilizes angiotensin-converting enzyme 2 (ACE2) to penetrate human cells. The severity and mortality of SARS-CoV-2 are larger in men than women and increase with age and co-morbidities. Previous studies indicate that the level of ACE2 expression may be a critical factor for the development of the disease and its severity. ACE2 is a crucial enzyme that opposes the classical renin-angiotensin system (RAS). Thus, this study aimed to determine the levels of ACE2 protein expression in human skeletal muscle and ascertain whether ACE2 protein expression in human skeletal muscle is associated with adiposity and cardiorespiratory fitness in men and women.
METHODS:
Skeletal muscle biopsies from the m. vastus lateralis obtained from 170 men (age: 29±10 yo, weight: 87±17 kg, BMI:28±5) and 69 women (age: 33±11 yo, weight: 82±17 kg, BMI:30±6) were analysed (WB) in duplicate to determine ACE2 protein expression levels. In all subjects, VO2max was determined by ergospirometry with an incremental exercise to exhaustion, and body composition was assessed in the fasted state by DXA. Statistics: ANCOVA, bivariate correlations and multiple linear regression with interaction.
RESULTS:
Women had a higher fat %, and lower VO2max than men even expressed per kg of leg lean mass (VO2max.LLM-1). A negative association was observed between VO2max expressed per kg of body weight and ACE2 ($r=-0.24$, $p<0.001$, $N=215$). ACE2 protein expression was 1.8-fold higher in women than men ($p=0.001$, $N=239$). However, this sex difference disappeared after accounting for fat % ($p=0.66$), VO2max.LLM-1 ($p=0.16$), fat % and VO2max.LLM-1 ($p=0.49$), or fat %, VO2max.LLM-1 and age ($p=0.39$) as covariates. ACE2 protein expression was positively associated with fat % in both sexes ($r=0.19$ and 0.37, $p=0.03$ and 0.002, in men and women, respectively). In the whole group of subjects, multiple regression analysis showed that the fat % ($\beta=0.49$) was the main predictor of ACE2 protein expression in skeletal muscle, explaining 6.9 % of the variance. VO2max.LLM-1 had less predictive value ($\beta=0.10$), i.e., 1/5 that of fat %. There was a significant fat % by VO2max.LLM-1 interaction, such that for subjects with low fat %, VO2max was positively associated with ACE2 expression. In contrast, as fat % increased, the positive association between VO2max and ACE2 was attenuated.
CONCLUSION:
Premenopausal women express higher amounts of ACE2 in their skeletal muscles than men of similar age. This sexual dimorphism is mainly explained by sex differences in the percentage of body fat. ACE2 protein expression is positively associated with adiposity. These findings may help to understand the pathophysiology of COVID-19. Further research is needed to verify whether the observation made in skeletal muscle also extends to other tissues and how acute and chronic exercise influences ACE2 protein expression levels in skeletal muscle and other tissues.
Grants: DEP2017-86409-C2-1-P; COVID 19-06

SHORT-TERM STEP REDUCTION DOES NOT ALTER SKELETAL MUSCLE MARKERS OF OXIDATIVE METABOLISM OR INSULIN-MEDIATED SIGNALING IN YOUNG MALES DESPITE REDUCTIONS IN WHOLE-BODY INSULIN SENSITIVITY.

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INTRODUCTION:
Mitochondria are critical to muscle contractile function (1). Alterations in mitochondrial metabolism accompany muscle atrophy and insulin resistance in response to musculoskeletal disuse (2). However, whilst a short-term period of step reduction (SR) elicits alterations in muscle protein turnover, the effects of this model of reduced ambulation on muscle oxidative metabolism and insulin-mediated signalling are unclear. Therefore, we tested the hypothesis that the protein expression of key skeletal muscle markers of mitochondrial/oxidative metabolism and insulin-mediated signalling would be altered over 7d of SR in young healthy males.
METHODS:
Eleven, healthy, recreationally active males (Mean±SD, age: 22±2.2 years, BMI: 23.4±2.4 kg.m2) underwent a 7d period of SR. Immediately prior to and following SR, fasted-state muscle biopsy samples were acquired before participants underwent an oral glucose tolerance test with serial blood sampling. Muscle biopsies were analysed for the protein expression of key markers of mitochondrial/oxidative metabolism (e.g. ACC, Citrate Synthase, OXPHOS, AMPKα, PGC1α, DRP1, FIS1, MFF, OPA1, MFN2, ULK1, NOS, mnSOD) and insulin-mediated signaling (e.g. GS, GS3Kαβ, Insulin Receptor, AKT, IRS1, PI3K, AKT, GLUT4).
RESULTS:
Daily step count was significantly reduced during the SR intervention (13054±2763 to 1192±330 steps.d-1, P<0.001). Following SR, there was a significant increase in fasting plasma [insulin] and postprandial plasma [insulin] area under the curve (AUC; Pre:4590±1817 vs. Post:6287±1363 µIU·120 min·mL-1, P<0.05) as well as an associated decline in the Matsuda index (Pre:6.5±1.8 vs. Post:4.5±0.7, P<0.01). There was no significant change in fasting [glucose] or postprandial [glucose] AUC (all P>0.05). Furthermore, following SR there was a significant increase in the protein expression of p-glycogen synthase (P-GSS641; Fold change: 1.46±0.46, P<0.05). No significant differences were observed in the protein expression of other key markers of insulin-mediated signalling, oxidative metabolism, mitochondrial function or mitochondrial dynamics (all P>0.05).
CONCLUSION:
Short-term SR did not alter skeletal muscle insulin-signalling or oxidative metabolism in young males despite a reduction in whole-body insulin sensitivity. Accordingly, these results suggest that a reduction in whole-body insulin sensitivity following short-term SR precedes alterations in the protein expression of key markers of skeletal muscle mitochondrial metabolism and insulin signaling.
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NEAR-INFRARED SPECTROSCOPY AS A COMPLEMENTARY METHOD FOR ASSESSING LOCAL SKELETAL MUSCLE MITOCHONDRIAL OXIDATIVE CAPACITY IN-VIVO

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INTRODUCTION:
Skeletal muscle mitochondrial oxidative function and dysfunction are linked to exercise performance and several pathological conditions. Therefore, non-invasive methods (e.g. near-infrared spectroscopy (NIRS)) to assess indices of mitochondrial oxidative capacity are of great interest. The aims of this study were to assess the NIRS measured index of mitochondrial oxidative capacity, its relationship with peak oxygen uptake (VO2peak) and its between-day variability in a group of highly-trained (HT) and physically active (PA) men.
METHODS:
Nine HT and ten PA subjects visited the laboratory on three occasions within 14 days. A graded ramp-exercise test (GXT) to assess VO2peak was conducted during the first visit. Mitochondrial oxidative capacity was determined during the second and third visit. GXTs were performed on road bikes mounted on a Cyclus 2 ergometer (RBM Electronics, GER). Gas exchange and pulmonary ventilation were measured with a gas analyser (MetaMax 3B, Cortex Biophysik, GER). VO2peak was calculated as the highest 30s average VO2 throughout the GXT. Mitochondrial oxidative capacity was assessed in a supine position with the continuous-wave NIRS probe (PortaMon, Artinins, NL) taped on the belly of the right vastus lateralis. A blood pressure cuff (Ulrich medical, GER) attached to a cuff inflator (TH-AC 300/20, Einhell, GER) was placed proximally of the probe. Participants performed 1-min of isometric knee extension exercises followed by a series of arterial occlusions. The deoxy[heme] signal was collected at 10Hz, corrected for blood volume changes and the slope of each arterial occlusion was resolved by linear regression to receive muscular oxygen uptake (mVO2). The post exercise mVO2 values were fit to an exponential function, where the time constant (Tc) represents an index of mitochondrial oxidative capacity. A Welch's t-test and a Pearson's correlation were used to investigate mean Tc differences between the HT and PA individuals and the relationship between Tc and VO2peak, respectively. Typical error (TE) and intraclass correlation coefficient (ICC) were used to assess between-day variability. The level of statistical significance was set at p<0.05.
RESULTS:
Tc was faster in the HT (24.6±6.1s) vs. PA (51.0±14.7s) individuals (p<0.05) and showed a strong negative relationship with VO2peak (r=-0.87, p<0.05). With a mean Tc of 38.5±17.6s the between-day variability averaged 2.6s (95% CI: 1.9-3.8s) or 7.9% (95% CI: 5.9-11.9%). The ICC of 0.98 (95% CI: 0.94-0.99) revealed an excellent between-day reproducibility.
CONCLUSION:
Tc indicates a ~2-fold higher mitochondrial oxidative capacity in the HT group. The relationship between Tc and VO2peak suggests a strong link between local mitochondrial oxidative and whole-body aerobic capacity. TE and ICC indicate a good to excellent day-to-day reproducibility for Tc. Therefore, we suggest that NIRS may be considered as supplementary method to non-invasively determine an index of mitochondrial oxidative capacity in-vivo.

AGE-RELATED DECLINE IN RESPIRATORY FUNCTION AND RESPIRATORY MUSCLES STRENGTH IN MASTER TRACK CYCLISTS

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INTRODUCTION:
The function of the respiratory system declines with ageing. However, regular physical activity, such as that seen in master track cyclists, may attenuate the age-related decline in respiratory function and respiratory muscle strength. Therefore, this study was conducted to assess the age-related rate of decline in respiratory function, respiratory muscle strength and hand grip strength in master cyclists.
METHODS:
Sixty-one (47 men: mean age 61±11; 14 women: mean age 50±11 years) master cyclists were recruited during the World Masters Track Cycling Championship 2019 event held in Manchester. Respiratory function and respiratory muscle strength were determined using spirometry and measurement of maximal inspiratory and expiratory mouth pressure, respectively. Handgrip strength was measured with a hand-held dynamometer.
RESULTS:
The forced expiratory volume in the first second (FEV1; 15.0%) forced vital capacity (FVC; 12.7%), peak expiratory flow (PEF; 27.5%), maximal inspiratory (MIP; 21.1%) and expiratory (MEP; 17.8%) pressures, and handgrip strength (7.0%) were all higher in men than women ($p<0.05$). The FEV1 (-7.1%/year), FVC (-5.9%), PEF (-4.9%), MIP (-4.8%) and MEP (-4.1%) pressures, and handgrip strength (-7.3%) correlated negatively with age, with no significant differences between the parameters in the annual rate of decline ($p<0.05$). There was, however, no correlation between and maximal sniff nasal inspiratory pressure and FEV1/FVC ($p>0.05$). Sex had no significant effect on the age-related rate of decline in any of the parameters ($p>0.05$).
CONCLUSION:
High levels of physical activity do not prevent the age-related decline in ventilatory function.

NEUROMUSCULAR CHARACTERISTICS OF ECCENTRIC, CONCENTRIC AND ISOMETRIC CONTRACTIONS OF THE KNEE EXTENSORS

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INTRODUCTION:
Muscles can generate greater force despite lower muscle activation during eccentric (ECC) when compared to isometric (ISO) and concentric (CON) muscle contractions (1, 2). However, the neuromuscular mechanisms underpinning the greater force production in ECC contractions are not fully understood. The present study compared transcranial magnetic stimulation (TMS) responses and voluntary drive between ECC, ISO and CON muscle contractions of the knee extensors.
METHODS:
Sixteen participants (20-33 y) performed ISO and isokinetic (30˚/s) CON and ECC knee extensor contractions, while electromyographic (EMG) activity was recorded from vastus lateralis. Supramaximal femoral nerve stimulation was delivered during and after ISO, CON and ECC maximal voluntary contractions (MVCs), and the superimposed (ST) and resting twitches (RT) were used to calculate voluntary activation (VA). During 30% ISO, CON and ECC MVCs, single- and paired-pulse TMS elicited motor evoked potentials (MEPs) and short-interval intracortical inhibition (SICI), and maximal M-waves (Mmax) were also recorded. All stimuli were delivered at 75° of knee flexion. Neuromuscular variables were compared between ECC, CON and ISO with a one-way repeated measures ANOVA. In an exploratory analysis, participants were divided into two groups: 1) ECC torque >8% greater than ISO torque (high, n=10) and 2) ECC torque <7% greater than ISO torque (low, n=6). Neuromuscular variables were compared between groups by a two-way ANOVA with contraction type as a repeated measures factor.
RESULTS:
MVC torque was greater ($P<0.01$) during ECC (302.6±90.0 Nm) than ISO (269.8±81.5 Nm) and CON (235.4±78.6 Nm). EMG normalised to torque during MVC was lower ($P<0.01$) for ECC (1.9±1.1 μV/Nm) than ISO (2.2±1.2 μV/Nm) and CON (2.7±1.6 μV/Nm). VA was lower ($P<0.01$) for ECC (68.4±14.9%) than ISO (78.3±13.1%) and CON (80.7±15.4%). During 30% MVCs, EMG per torque was lower ($P<0.01$) for ECC (3.2±2.6 μV/Nm) than ISO (4.1±3.2 μV/Nm) and CON (4.9±3.7 μV/Nm), but MEP/Mmax and SICI showed no differences among contraction types ($p>0.05$). No significant ($p>0.05$) differences between the high and low groups were evident for any of the variables.
CONCLUSION:
MVC torque was greater during ECC than CON and ISO, despite lower voluntary drive to the muscle in ECC. However, reduced muscle activation during ECC was not explained by increased intracortical inhibition or reduced corticospinal excitability. Potentially, inhibition mainly at a spinal rather than cortical level may underlie the reduced voluntary drive (3). Greater ECC than CON and ISO MVC torque may be related to mechanical factors at the level of the cross-bridges. Hence, further studies are required to examine the possible spinal and peripheral mechanisms allowing greater torque production during ECC than CON and ISO muscle contractions.
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UPREGULATION OF SKELETAL MUSCLE ACE2 PROTEIN EXPRESSION (SARS-COV-2 RECEPTOR) BY ACUTE EXERCISE AND POST-EXERCISE ISCHAEMIA IN MEN AND WOMEN.

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INTRODUCTION:
The angiotensin-converting enzyme 2 (ACE2) is a transmembrane protein counteracting the renin-angiotensin system. In mice, increased ACE2 has been associated to skeletal muscle (SM) wasting and myocardial injury. In humans, increased ACE2 mRNA has been reported in ischaemic heart disease and associated with more severe COVID-19 in case of infection. ACE2 protein expression has not been measured in

human SM. The aim was to ascertain if ACE2 protein expression is increased by incremental exercise to exhaustion (IE) and postexercise ischaemia and the molecular mechanisms involved. We hypothesised that low PO2 or metabolite accumulation stimulates ACE2 protein expression via ROS or Ca2+ signalling.
METHODS:
In study 1 (S1), 11 men performed an IE in normoxia and hypoxia (Hyp, PIO2: 73 mmHg). At exhaustion, the circulation of one leg was instantly occluded (300mmHg) for 1min. Muscle metabolites were measured in vastus lateralis biopsies taken before (PRE), 10s after (POST, occluded leg), and 1min after IE in the occluded (OC1M) and non-occluded (nOC1M) legs. In study 2 (S2), 23 volunteers (17M; 6W) performed IE, followed by unilateral leg occlusion for 60s. Upon cuff release, subjects sprinted maximally (Wingate, 30s), and the same leg unilaterally occluded for 90s. Biopsies were taken at baseline (PRE), 10s after IE (POST, occluded leg) and 10s after Wingate (OCW, occluded leg); and from the occluded and non-occluded leg at 90s (OC90, and nOC90) and 30min post-Wingate (OC30m and nOC30m). ACE2 protein expression was determined in duplicate (231 biopsies, WB). Statistics: repeated-measures ANOVA.
RESULTS:
At POST, ACE2 expression was increased 2.3 and 1.5-fold (S1 and S2 respectively, ANOVA time effect $p<0.05$). After the Wingate (S2), ACE2 was further increased (2.2-fold above PRE, $p<0.05$), remaining elevated at OC1M (S1), OC90 and OC30m (S2). These effects were attenuated by free circulation recovery (nOC1M, S1; nOC90 and nOC30m, S2) ($p<0.05$ occluded vs free circulation in all bilateral biopsies). ACE2 expression was 44% higher in women than in men and similarly upregulated by intense exercise regardless of PIO2 and sex, and coincident with augmented CaMKII and STAT3 phosphorylation.
CONCLUSION:
Exercise to exhaustion increases SM ACE2 protein expression in men and women similarly, despite a higher basal expression in women. The exercise-induced increase of ACE2 expression is not exacerbated by severe acute hypoxia, likely due to a similar metabolite accumulation at the end of IE in Hyp and Nx. Eliciting a greater metabolite accumulation and muscle deoxygenation with either sprint exercise at exhaustion or ischaemia exacerbates this upregulation similarly in men and women. This study reveals that ACE2 behaves as an acute stress-response protein in human SM. Since ACE2 is the SARS-CoV-2 receptor, these findings could have implications for athletes in the context of the COVID-19 pandemic.
Grants: DEP2017-86409-C2-1-P; COVID 19-06

CP-PN02 Gender

SEX DIFFERENCES IN METABOREFLEX ACTIVATION AND FUNCTIONAL RESERVE DURING EXERCISE TO EXHAUSTION REVEALED BY POST-EXERCISE ISCHAEMIA AND REPEATED SUPRAMAXIMAL EXERCISE

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INTRODUCTION:
During whole-body high-intensity (HI) exercise to exhaustion task failure occurs despite the presence of a functional reserve or capacity to produce power at the same level or higher than reached at exhaustion. Women have lower fatigability than men during single limb isometric and dynamic contractions, and experiments eliciting metaboreflex in the forearm muscles show that men may have a higher metaboreflex sensitivity, but whether sex-differences exist during HI whole-body exercise remains unknown. We aimed to determine whether the differences in fatigability between men and women following supramaximal exercise could be explained by differences in metaboreflex responses.
METHODS:
Physically active women (n=18) and men (n=18) performed two sessions, each of them consisting of three bouts of supramaximal constant power at 120% of VO2max (120%CP) until exhaustion, interspersed with 20s recovery periods. In one of the sessions, the circulation of both legs was instantly occluded (300mmHg) during recovery, while the other session included free circulation recovery. In both sessions, performance, cardiorespiratory variables, O2 debt and brain oxygenation (NIRS) were assessed. Body composition was determined by DEXA. ANOVA repeated-measures.
RESULTS:
No sex differences were observed in VO2max by kg of leg lean mass (LLM), time to exhaustion (best 120%CP), but women reached lower PETCO2 and brain oxygenation during the bouts. In the bouts preceded by occlusion (2nd and 3rd), times to exhaustion were on average 43.7% lower ($P<0.001$), being similar in men and women ($P=0.54$). During the bouts after ischemia, endurance time, work/kg.LLM, LLM-normalized accumulated O2 consumption, accumulated O2 deficit and glycolytic rates were almost identical in men and women. During recovery, occlusion significantly reduced VO2 (24%), VCO2 (14.4%) and HR (mean 5.7 beats)($P<0.001$), while VE remained unchanged ($P=0.26$), with similar responses regardless of sex. The legs´ O2 debt after the 1st and 2nd bouts was similar in men and women. The contribution of the legs´ O2 debt represented 24.1% of the total O2 debt during the 1st 20s, regardless of sex ($P=0.63$).
CONCLUSION:
This study demonstrates that men and women respond in a remarkably similar manner to repeated supramaximal whole-body exercise and that at task failure a large functional reserve which depends on the glycolytic component of substrate-level phosphorylation, which is influenced by occlusion but almost identical in both sexes. With a novel methodological approach using post-exercise ischaemia, we have shown that metaboreflex activation (indicated by VE and HR responses), and the O2 debt per kg of active lean mass during recovery are also similar between sexes, indicating a similar muscle metabolism after exhaustion in men and women. PETCO2 and brain oxygenation are lower in women than men, without apparent negative repercussion on performance. Women had no faster recovery of performance after accounting for sex differences in lean mass. Grants: DEP2015-71171-R; DEP2017-86409-C2-1-P

MOLECULAR AND PHYSIOLOGICAL DETERMINANTS ASSOCIATED WITH SPRINT PERFORMANCE IN MEN AND WOMEN

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INTRODUCTION:
Sprint exercise performance produces remarkably high-power outputs through an intense activation of substrate-level phosphorylation and oxidative phosphorylation. Although it is known that several biochemical factors influence sprint capacity, little scientific data exist regarding what factors are predominant in humans. Furthermore, despite the lower anaerobic capacity in women than men, no clear answer exists regarding the principal determinants driving such sex differences. Thus, we aimed at investigating the role of several key metabolic enzymes on sprint performance in men and women.
METHODS:
52 male (22.7±2.9 y, 74±8.6 kg, VO2max=48.8±6.7 ml/kg/min) and 13 females (22.2±1.5 y, 59.9±11.6 kg, VO2max=39.9±3.5 ml/kg/min) performed a 30s isokinetic Wingate test at 80rpm. VO2max (Vyntus CPX) and body composition (DEXA) were assessed, and O2 deficit in the Wingate test calculated. Muscle biopsies (VL) were taken at rest, and protein expression (WB) of mitochondrial proteins, Serca 1, Citrate Synthase (CS), and Phosphofructokinase (PFK) measured in duplicate, and MHCs by SDS-PAGE. Statistics: One-way ANOVA, Pearson´s r, and multiple linear regression.
RESULTS:
Men had higher VO2max than women even when normalized to the legs' lean mass (LLM) (8.5%; P=0.04). Absolute mean (MPO) and peak power output (PPO) (1s) were higher in men than women (32.2%, p=0.001), but sex differences disappeared after accounting for LLM. Absolute O2 deficit was 39.9% lower in women, but no sex differences were observed after accounting for LLM (p=0.07). Women had more MHC-I (41%) and less MHC-IIa (-23.0%) than men (p<0.05). Protein expression was similar in both sexes except for PFK (16.9% lower in women, p=0.03). Linear regression analysis showed a positive association (r2=0.13, p=0.02) between Serca1 and MPO/LLM (both sexes analyzed conjointly) when all proteins and VO2max were included as predictors. This model also showed an inverse relationship (r2=0.13, p=0.01) between CS and PPO/LLM in both sexes. Significant Pearson´s r in the whole sample (n=65): MHC-I with SHDB (r=0.37), MHC-I with Serca 1 (r=-0.53), MHC-IIx with Serca 1 (r=0.38), MHC-I+ MHC-IIa with SDHB (r=0.43), VO2max/LLM with Serca 1 (r=-0.50). Significant Pearson´s r in women (n=13): PFK with MHC-IIx (r=0.88) and Serca 1 with MHC-IIx (r=0.73).
CONCLUSION:
This study shows that although men have a higher glycolytic capacity (~17% more PFK) than women, power in the Wingate test is similar when normalized to LLM. This may imply that lower glycolytic capacity in women is not a limiting factor for performance during maximal sprints lasting 30s. Despite a lower proportion of MHC-II and higher MHC-I in women, MPO/LLM and PPO/LLM were similar in both sexes, indicating that other factors should compensate for sex differences in genotype. The strong correlation between Serca 1, MHC-IIx and MPO suggests that this protein emerges as a potential determinant of sprint performance in both sexes.
Grant: DEP2017-86409-C2-1-P

MENSTRUATION HAS NO EFFECT ON HEART RATE VARIABILITY AND SUBJECTIVE SLEEP QUALITY OF PHYSICALLY ACTIVE WOMEN

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INTRODUCTION:
Subjective sleep quality may decrease during menstruation, although the duration and composition of sleep remains relatively stable across the menstrual cycle (MC) (1). Recording heart rate variability (HRV) is a tool to monitor the autonomic nervous system and recovery of the body. Meta-analytical data has not revealed significant changes in HRV from the early follicular phase (menses) to the mid-follicular phase (2). However, reduced HRV-values were observed during menses compared to follicular phase in women with pain during menses (dysmenorrhea) (3). Only a few studies have examined effects of the MC on nocturnal HRV. The aim of this study was to investigate how menses and associated pain affects nocturnal HRV and subjective sleep quality.
METHODS:
Participants included 14 healthy, physically active women, who did not use hormonal contraception. During one MC, participants completed a diary of sleep, MC and related symptoms. HRV was registered every night (Bodyguard 2, Firstbeat Technologies Ltd., Finland). HRV-data (RMSSD and LF/HF-ratio) were analyzed for two nights after a blood sample and over a four-hour period beginning 30 min after bedtime. Only the menses (M) and mid-follicular phases (FP) are used in this study. Blood samples (estradiol, E2, and progesterone, P4) were collected during M (day 2-3 of the MC) and FP (day 7-10) to ensure normal hormonal function associated with the MC (4).
RESULTS:
E2 was higher (p=0.012) during FP (267±150 pmol/L) compared to M (143±88 pmol/L), but P4 remained stable (p=0.103). Mean heart rate (HRmean) was higher during M (54±8 beats/min) compared to FP (52±7 beats/min, p=0.022). However, HRV-variables did not differ between M and FP (RMSSD: 76.7±34.5 to 77.3±27.0 ms, p=0.872; LF/HF: 1.416±1.380 to 1.273±0.769, p=0.826). Subjectively-assessed sleep quality remained unchanged between M and FP (p=0.349). The change in RMSSD and HRmean between M and FP did not differ (RMSSD: p=0.728; HRmean: p=0.149) between participants with and without menstrual pains.
CONCLUSION:
Menses has no effect on nocturnal HRV and subjective sleep quality of physically active women, though the higher nocturnal HRmean during M may indicate decreased recovery during menses.
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MULTIVARIATE MODELLING OF THE RECOVERY PATTERN AND ITS SEX DEPENDENCE AFTER A GRADED RUN

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INTRODUCTION:
Endurance running exercises are known to induce in men a biphasic recovery, with acute and delayed functional decrements attributed to metabolic fatigue and inflammatory process respectively (1). However, most studies have focused on the acute recovery phase and only a few on its potential influence on the delayed phase (1,2). Our recent study of a 20 km (~400 m) graded run revealed sex- and test-dependent acute and delayed recovery patterns (3). Using a statistical approach called RV coefficient (4), the present study aims to investigate the potential relationships between recovery phases, tests and their sex sensitivity.
METHODS:
Eighteen healthy runners (32±7 yrs), 10 women (W) and 8 men (M), completed the race. The protocol included 5 testing sessions: a week before (PRE), 35±15 min after (POST) as well as at 2h, 2 and 4 days (2D & 4D). Each session included maximal isometric voluntary contractions of the knee extensors (KE MVCs), a squat jump (SJ) and a drop jump (DJ) tests. Muscle soreness was assessed using a visual analogic scale. In case of significant decrease in performance, the functional changes as compared to PRE were centred, reduced and added to multivariate models. RV coefficients (4), from 0 to 1, were used to test the similarity between the sets of variables defined for the same individuals from each test and session.
RESULTS:
Regardless of sex, the SJ did not reveal any significant decrease in performance. Inter-session relationships were found for both KE MVC and DJ between the fatigue-induced changes at POST and 2h (RV=0.67 and 0.71, $p<0.001$) as well as at 2D and 4D (RV=0.54, $p<0.05$; RV=0.62, $p<0.001$). The DJ changes at POST and 2h were also related to those at 2D (RV=0.70 and 0.64, $p<0.001$), and for men only between POST and 4D (RV=0.64, $p<0.05$). Inter-test relationships were found only for men between the KE MVC and DJ changes at POST (RV=0.67, $p<0.05$). Muscle pain was not significantly correlated with functional changes.
CONCLUSION:
Multivariate analyses confirmed, for all tests and regardless of sex, relationships between functional changes occurring within the acute (POST and 2h) or delayed (2D and 4D) recovery phase. As expected, no relationship was found with muscle soreness (1,3). It is noteworthy that only the DJ test revealed similarities between its acute and 2D-delayed changes with fatigue, and only for men up to 4D. Acute indices of reduced resistance to stretch may thus predict a delayed recovery in men as well as in women. Finally, the limited number of inter-test relationships highlights the importance of using a battery of tests rather than specific tests.
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DEFINING ELITE: WHY ARE FEMALE FOOTBALLERS STILL NOT INCLUDED IN RESEARCH?

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A growing body of research investigates the long-term effects of exposure to repetitive sport-related concussive and subconcussive injuries on neurological health. We are now seeing early onset dementia in some footballers in their 40s. However, female athletes have largely been excluded in this body of research (1), despite evidence that females are more likely to suffer from dementia (2), to sustain a concussion (3), and to have longer and more severe symptoms than do males (4).
Most studies focus on male professional footballers because there are not as many females classified as professionals who are old enough to show prodromal signs of dementia. Whilst this is true on the surface, the categorisation of “professional” excludes a considerable cohort of females who have played at the elite level but without pay. In the few studies where females have been included, definitions of elite women have often been the same as for elite men, without considering the contemporary nature of women’s football development in the last 50 years. If sporting level is to be used as a proxy for level of exposure to injury, then categories must be appropriate to allow comparison between males and females irrespective of pay. We also need to consider the development trajectory of women’s football in general. In the United Kingdom, women have been playing organised football at an elite level since 1972 (5), suggesting that a considerable cohort of females, many of whom are now in their 60s, have been exposed to repetitive subconcussive/concussive injury. We may see more variance in this cohort in terms of entrance age, career lengths, and frequency of participation because of the development of women’s football compared with men. It is therefore critical not to exclude female athletes from this field of study.
The present study explores how influences including professionalisation, physical education curricula, and attitudes towards women’s sport may have affected participation in women’s football within the UK. This study offers a proposed guide to classifying elite women’s football based on development in the UK, including where and when participants played their highest level of football. The framework offers three definitions of elite women’s football based on key milestones in the professionalisation of the women’s game. Based on this framework, we can define three specific time periods of development in the UK as <2000, 2000-2010, and >2010. This framework has been designed such that it can be translated to an international research setting and therefore used as a critical factor for level of exposure to injury.
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CP-PN03 Metabolism and nutrition

TESTOSTERONE THERAPY AUGMENTS RESISTANCE EXERCISE-INDUCED IMPROVEMENTS IN GLYCAEMIC CONTROL IN OLDER AGED MEN: A RANDOMIZED DOUBLE-BLIND PLACEBO-CONTROLLED TRIAL

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INTRODUCTION:
The andropause is associated with declines in serum testosterone (T), and associated loss of skeletal muscle mass (i.e. sarcopenia) and impaired glycaemic control. Two of the major interventions purported to offset sarcopenia and related anabolic resistance (e.g. insulin resistance) are T therapy and Resistance Exercise Training (RET). Nonetheless, the global physiological impacts and mechanisms of T therapy adjuvant to RET remain poorly defined in older individuals. The aim of this study was to determine the impacts of RET plus T (vs. placebo) on glycaemic control in older individuals.
METHODS:
Eighteen non-hypogonadal older men (65–75y, BMI≤30 kg.m-2, T>230 ng·dl-1) were assigned in a random double-blinded fashion to receive, bi-weekly placebo (P, saline, n=9) or T (Sustanon 250-mg, n=9) injections over 6-weeks whole-body-RET (3-sets of 8–10 repetitions at 80% one-repetition-maximum). Subjects underwent 75-g oral glucose tolerance testing (baseline, ~5 days after first injection and after 6-weeks RET) and Dual-energy X-ray Absorptiometry to assess glycaemic control and body composition, respectively. Vastus lateralis muscle biopsies were taken to quantify insulin-signalling proteins.
RESULTS:
T therapy augmented appendicular FFM (7.8±0.3 to 8.3±0.3 kg·m-2, P=0.001 vs. 7.9±0.3 to 8.0±0.3 kg·m-2, P=0.82) and decreased total fat mass (22.5±2.0 to 21.3±1.8 kg, P=0.02 vs. 24.7±2.8 to 24.5±2.7 kg, P>0.99). T up-regulated insulin sensitivity (Cederholm-index: 57.3±5.1 to 68.6±5.3 vs. 49.1±3.7 to 57.1±5.1 mg·L2·mmol·L−1·mU−1·min−1, P<0.05), decreased insulin area under the curve (-900 vs. -524 mU-1.2h-1, P=0.03) and increased plasma C-Peptide (601±46 vs. 830±77 ng·ml-1, P=0.02) during OGTT. Mechanistically, AKT/glycogen synthesis signalling (e.g. a trend in increase in AS160; 1.9±0.5, P=0.08 vs. 1.01±0.1-fold change, P>0.99), GS content (1.9±0.2, P=0.001 vs. 1.3±0.1-fold change, P=0.3) and mitochondrial citrate synthase activity (P=0.03) were augmented with T therapy.
CONCLUSION:
T therapy adjuvant to RET as a pre/re-habilitation intervention-may be of value to overcome the burgeoning trend of insulin resistance with ageing.

EFFECTS OF CAFFEINE INGESTION ON POST-EXERCISE GLYCEMIC REGULATION IN PREDIABETES

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INTRODUCTION:
Diabetes has become a widespread epidemic, primarily because of the increasing prevalence and incidence of type 2 diabetes, which accounts for 95% of all diabetes cases worldwide. Type 2 diabetes is characterized by insulin resistance and abnormal insulin secretion, resulting in a decrease in glucose disposal. Individuals with prediabetes would have higher risk of developing type 2 diabetes. It is well established that exercise improves blood glucose control and can prevent or delay type 2 diabetes. In contrast, there is some evidence showing that the ingestion of caffeine would have an adverse effect on blood glucose regulation. Hence, the purpose of this study was to investigate the effects of caffeine ingestion on glucose, insulin, and C-peptide responses after acute aerobic exercise in prediabetes.
METHODS:
Subjects were screened a standard 75g, 2-hour oral glucose tolerance tests (OGTT). Blood glucose was sampled at baseline and at 30-minute intervals during the OGTT. When meeting one or more criteria for prediabetes described were participants. Men (n=12) with prediabetes (age= 36 ± 6.5 yrs, body mass index, BMI= 24.2 ± 2.9 kg/m2) randomly underwent two different trials which were caffeine + exercise (CE, 3 mg/kg) and placebo + exercise (PE) one week apart in a counterbalanced and double-blinded design. Participants performed a 30-min running at 60% VO2max (maximal oxygen uptake) 30 min after caffeine/placebo ingestion in both trials. Blood glucose, insulin, and C-peptide concentrations were measured at pre-ingestion, pre-exercise, immediately after and 120 min after exercise. In addition, subjects received OGTT immediately after exercise, with blood glucose and insulin measured every 30 min during the tests. Area under the curve (AUC) of glucose and insulin were calculated by trapezoid method. A two-way ANOVA with repeated measures was used to compare the differences among trials and times, and paired samples t-test was calculated to quantify AUC differences between trials.
RESULTS:
The results showed that no significant trial × time interaction was observed in blood glucose ($p > .05$). Regarding the main values of trial factor, blood glucose, (133.87 ± 41.22 vs 127.04 ± 34.17 mg/dl) in the CE were higher than PE ($p < .05$). Then, there were statistically significant differences in insulin between trials and time points ($p = .010$). The simple main effect indicated that insulin of CE at post-exercise 30 and 120 (OGTT 30, 120) were significant higher than the PE. Moreover, there were statistically significant differences ($p < .05$) in blood glucose and insulin AUC between trials. That in CE was significant higher than the PE trial. In addition, there were no differences in C-peptide between CE and PE trials at all time points.
CONCLUSION:
Acute caffeine ingestion could increase blood glucose and insulin post aerobic exercise in prediabetes. Thus, caffeine ingestion, though combined with aerobic exercise, might have a negative impact on glycemic control among prediabetes.

DIETARY NITRATE IMPROVES MUSCLE CONTRACTILE PROPERTIES, SUBMAXIMAL SERCA ACTIVITY, AND THE FUNCTIONAL INTERACTION BETWEEN SERCA AND MITOCHONDRIA

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INTRODUCTION:
Rapid oscillations in cytosolic calcium (Ca2+) coordinate muscle contraction, relaxation, and ultimately physical movement. Intriguingly, dietary nitrate increases force production and cytosolic Ca2+, a response which would seemingly necessitate a greater ATP demand for sarcoplasmic reticulum Ca2+ ATPase (SERCA) to sequester Ca2+ within the SR during relaxation. As SERCA is highly regulated, we aimed to determine the effect of nitrate on SERCA enzymatic properties, rates of ATP hydrolysis, and the functional interaction between SERCA and mitochondrial oxidative phosphorylation.
METHODS:
Female C57Bl/6N mice consumed either standard drinking water or water supplemented with 1mM sodium nitrate (NO3) for 7 days. SERCA activity, contractile properties, and Ca2+ handling proteins were measured in soleus muscle. Mitochondrial respiration and protein content were measured in red gastrocnemius permeabilized muscle fibers (PmFb). Data were analyzed using Students t-tests (control vs NO3) and expressed as mean±SD.
RESULTS:
Following 7 days of NO3 consumption, serum nitrate+nitrite was increased ~4-fold, confirming the effectiveness of supplementation. While NO3 did not alter maximal force production, low-frequency force production was increased ~20%, and the rate of fatigue was attenuated, following NO3. In line with these functional contractile improvements, mice supplemented with NO3 displayed an ~25% increase in submaximal SERCA activity at three pCa values (4.9, 5.4, 5.7), without any differences in SERCA Vmax or Ca2+ sensitivity. Given the improvement in submaximal SERCA activity, we examined the SERCA-mitochondria high-energy phosphate interaction. In PmFb, the addition of Ca2+ in the presence of ATP generates ADP from SERCA to support mitochondrial respiration. As such, this readout of mitochondrial oxygen consumption is an indication of ATP hydrolysis from SERCA, and the coupling between SERCA and oxidative phosphorylation, in an intact cellular preparation. Using this approach, similar to submaximal SERCA activity, mitochondrial respiration supported by SERCA-derived ADP was increased ~20% following NO3 (272±45pmol/sec/mg control, n=13 vs 316±55pmol/sec/mg NO3, n=15, p=0.03), in the absence of changes in mitochondrial sensitivity to Ca2+. This effect was fully attenuated by the SERCA inhibitor cyclopiazonic acid and was not attributed to differences in mitochondrial oxidative capacity, global mitochondrial ADP sensitivity (ADP Km: 897±143µM control, n=13 vs 876±199µM NO3, n=15, p=0.75), or the content of mitochondrial and SERCA-related proteins.
CONCLUSION:
Dietary nitrate improved submaximal SERCA activity, which is linked to a functional increase in low-frequency force production, SERCA-supported mitochondrial respiration, and fatigue resistance. These findings suggest improvements in SERCA activity may represent a mechanism in which dietary NO3 enhances contractile properties, providing a mechanistic understanding for the ability of nitrate to influence exercise performance.

CP-PN04 Physiology I - Muscle

MUSCLE REOXYGENATION CAPACITY AFTER 6 WEEKS OF TWO VELOCITY-BASED RESISTANCE TRAINING PROGRAMS: 20 VS. 40% OF VELOCITY LOSS

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INTRODUCTION:
Barbell-back squat (SQ) resistance training program (RT-program) reaching a 20% of velocity loss (VL) in the set can preserve the IIx myosin heavy chain isoform, whereas 40% of VL promotes the reduction to more oxidative characteristics which could improve muscle oxygenation (1). To investigate this, we study the muscle oxygen dynamics adaptation of two different VL-based RT-programs (20 vs. 40%) in response to a 1 m·s−1 squat test using the tissue oxygenation index (TOI).
METHODS:
A total of 27 young men (21.4 ± 2.4 yrs) were randomly allocated into three groups: 20% of VL (20VL; n=9), 40% of VL (40VL; n=8) and control (CG; n=10). Participants performed a 6-week RT-program using SQ exercise twice per week. The 1m·s−1 load test was performed before and after intervention with the same absolute load. TOI was measured during 3 minutes of recovery after 1m·s−1 load test in Vastus Lateralis and Vastus Medialis muscle belly with a spatially resolved spectroscopy tissue oximeter (NIRO-200Nx). Minimum TOI (minTOI), maximum TOI (maxTOI) and the time elapsed to reach maxTOI (TmaxTOI) were evaluated during the recovery period. A repeated-measures ANOVA with Bonferroni post-hoc comparisons was performed.
RESULTS:
A significant main effect of time was found for maxTOI on Vastus Medialis and Vastus Lateralis ($p<0.05$) post-intervention in 20VL group (+ 3.763% for Vastus Medialis and +3.969% for Vastus Lateralis). No significant differences were found on 40VL neither CG after training program. Bonferroni post-hoc comparisons showed significant “time” x “group” interaction for minTOI on Vastus Medialis with lower values in 20VL than CG (-14.119%; $p<0.05$), but without differences regarding 40VL. No significant “time” x “group” interactions were found for Vastus Lateralis. No differences were found in TmaxTOI between groups .
CONCLUSION:
Despite achieving a lower minTOI than CG, 20VL increased their maxTOI with the same TmaxTOI, showing a better oxygenation restauration capacity. Given the fact that recovery rate of oxygen saturation can be used to assess mitochondrial function (2), we can speculate that 20VL experienced an augment in muscle oxidative capacity. Previous research has shown that barbell back squat RT-program using a 20% of VL enhancing expression of sarcolipin, which is a small protein that appears to be critical for mitochondrial biogenesis and fat

oxidation capacity in mice models (3). Although this fact can explain our results, the role of sarcolipin overexpression on human muscle oxidative capacity has not been demonstrated yet. Further studies are needed to clarify this relationship.

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INTRAMUSCULAR INJECTION OF MESENCHYMAL STEM CELLS ACTIVATES NOT ONLY MUSCLE PROTEIN ANABOLIC BUT ALSO CATABOLIC SYSTEM AFTER THREE SUCCESSIVE BOUTS OF RESISTANCE EXERCISE IN MOUSE

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INTRODUCTION:
Skeletal muscle mass is critical for activities of daily living and for maintaining good quality of life. Resistance exercise is a main counter-measure for the muscle atrophy, and there are growing strategies to maximize the training adaptation. Mesenchymal stem cells (MSCs) are multipotent cells and have been reported to have the capacity to secrete variety of growth factors (e.g., insulin like growth factor 1) which implicate MSCs' potency to enhance the anabolic effect of resistance exercise . The present study aimed to investigate the effect of intra-muscular injection of MSCs and three successive bouts of resistance exercise on muscle protein synthesis and related signals in mouse skeletal muscle.
METHODS:
Male C57BL/6J mice were divided into placebo group (N = 6) and MSC group (N = 6). All mice performed three bouts of RE (consists of 3s × 10 reps × 5 sets maximal isometric contraction, elicited by transcutaneous electrical stimulation) on the right gastrocnemius muscle every 48 hours. Immediately after the 1st bout, mice were intramuscularly injected either MSCs (2.0 × 106 cells suspended in 20 μL PBS) labeled with green fluorescence protein (GFP) or vehicle only placebo into right gastrocnemius muscle under isoflurane anesthesia. Left gas-trocnemius muscle in each group was kept as sedentary and served as the control. Seventy-two hours after the third exercise bout, muscle samples were collected, and muscle protein synthesis was measured by SUnSET method.
RESULTS:
GFP was expressed only in MSCs-injected muscles. The expression of phosphorylated p70S6K (Thr389), rpS6 (Ser240/244), 4EBP1 (Thr37/46) was increased in the exercised muscles in the MSC group and was higher than that in the exercised muscles in the PBS group ($P < 0.05$). Muscle protein synthesis was increased in the exercised muscles only in the MSC group ($P < 0.05$). On the other hand, the expres-sion of ubiquitinated proteins, a marker of protein catabolic system, was also increased in the exercised muscles only in the MSC group ($P < 0.05$).
CONCLUSION:
The present results suggest that the intramuscular injection of MSCs activated muscle protein anabolic system after three successive bouts of resistance exercise greater than that of exercise alone. On the contrary, the muscle protein catabolic system also activated simultane-ously.

DAILY REPEATED BLOOD FLOW RESTRICTION DOES NOT ATTENUATE THE REDUCTION IN SATELLITE CELL CONTENT DUR-ING TWO WEEKS OF BED REST IN HEALTHY, YOUNG MEN

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INTRODUCTION:
Skeletal muscle satellite cells (SC) are of key importance for muscle fiber regeneration, repair and remodeling. A prolonged period of bed rest results in a substantial loss of muscle mass, which is accompanied by a reduction in SC content. In resting skeletal muscle tissue, blood flow restriction (BFR) has been reported to stimulate myogenesis as well as muscle fiber hypertrophy in animals. However, whether BFR treatment can attenuate the decline in muscle fiber size and SC number during a period of bed rest in humans remains unknown. The present study assessed whether single-leg repeated daily BFR treatment attenuates the decline in muscle fiber size and SC content during 2 weeks of bed rest in healthy, young men.
METHODS:
Twelve healthy, non-obese men (age: 24±4 y; BMI: 23.7±3.1 kg/m²) were subjected to 2 weeks of bed rest, during which one leg was ex-posed to 3 times daily BFR, whereas the contralateral leg received sham treatment (CON). Before and immediately after the 2 weeks of bed rest, leg lean tissue mass was assessed by DXA-scan. Muscle biopsies were obtained from the vastus lateralis before and after the 2 weeks of bed rest from both the BFR and CON leg. Type I and type II muscle fiber size, myonuclear and SC content were assessed by immuno-histochemistry. Repeated measures ANOVA was used to evaluate the effect over time in both the BFR and CON leg.
RESULTS:
Leg lean mass decreased in response to 2 weeks of bed rest ($P<0.05$), with no differences between the BFR and CON leg ($P=0.62$). Type I and type II muscle fiber size tended ($P=0.06$) to decline following bed rest in the CON leg only. Myonuclear content remained unchanged over time in either leg. Type I and type II muscle SC content expressed per 100 fibers declined over time, with no differences between legs (main effect of time, $P<0.05$). SC density, expressed per millimeter squared, tended (main effect of time, $P=0.07$) to decline in response to bed rest in either leg.
CONCLUSION:
Daily blood flow restriction treatment does not attenuate the decline in leg lean mass or SC content during two weeks of bed rest in healthy, young men.

EFFECTS OF 32-WEEK DIFFERENT EXERCISE INTERVENTION ON MITOCHONDRIAL ENDOGENOUS APOPTOSIS RELATED PROTEINS IN SKELETAL MUSCLE OF AGING RATS

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INTRODUCTION:
Sarcopenia induced skeletal muscle dysfunction seriously affects the quality of life of older adults, the mitochondrial-mediated pathway in skeletal muscle plays an important role in the development of Sarcopenia. Observing the effects of 32 weeks of HIIT and resistance training on skeletal muscle related indexes and provide a theoretical basis for regulating the mitochondrial-mediated pathway to delay Sarcopenia.
METHODS:
135 male SD rats were divided into 3 groups. Control group (C, n=45), HIIT group (H, n=45), Resistance group (R, n=45). H participated in a 32-week HIIT (46 min/d, 3d/week, with 50%-65%-80% VO2max). R participated in a 32-week RT (46 min/d, 3d/week, with 30% maximum load on a treadmill with a slope of 35º, 15 m/min). Muscles were collected for analysis at baseline and every 8 weeks then exfoliated and weighed, and mitochondria were extracted. The body composition was measured by DXA, the morphology of soleus muscle was measured by hematoxylin-eosin staining, content of ROS was measured by ELISA. The expression of Bcl-2, Bax, cytochrome c, caspase-9 and caspase-3 tested by Western blot. Repeated measures analysis of variance and two-way analysis of variance was used to compare C, H and R.
RESULTS:
1. Compared with C, the skeletal muscle mass index increased after 12 weeks training ($P < 0.05$), the soleus index increased at 16 and 32 weeks training ($P < 0.05$), exercise could increase the cross-sectional area of soleus muscle except at 24th weeks ($P < 0.05$); compared with H, the soleus index and the cross-sectional area of soleus muscle of R increased after 32 weeks ($P < 0.05$);2. Compared with C, ROS in H decreased after 8 and 32 weeks ($P < 0.05$); ROS in R was lower than C at 8 weeks and was higher than H and C at 32 weeks ($P < 0.05$). 3. Bcl-2 in C decreased except for 16 weeks of aging ($P < 0.001$); Bcl-2 in H was higher than that in C and R at 24 and 32 weeks ($P < 0.001$); Bcl-2 in R was higher than that in C and H at 8 and 16 weeks ($P < 0.05$). 4. Bax of skeletal muscle in C decreased at 16 and 32 weeks ($P < 0.05$); compared with C, Bax increased after 32 weeks ($P < 0.05$); Bax in R was lower than C and H at 8 weeks, lower than H at 24 weeks ($P < 0.05$); 5. Cyt-C in H was lower than that in C at 16 weeks ($P < 0.05$); Cyt-C in R increased at 8 weeks and was higher than C, and was lower than C at 32 weeks ($P < 0.05$). 6. Caspase-9 in C decreased at 8 and 24 weeks; compared with C, Caspase-9 increased after 32 weeks exercise ($P < 0.05$) 7. Caspase-3 in C decreased at 8 weeks, H was higher than other groups at 8 weeks, R was higher than other groups at 16 weeks, compared with C, caspase-3 decreased after 32 weeks ($P < 0.001$).
CONCLUSION:
1. Continuous application of HIIT and resistance intervention during 32-week aging can effectively delay skeletal muscle loss. 2. The effect of 32-week HIIT on skeletal muscle apoptosis of aging rats is better than resistance training, which may be achieved by improving Bcl-2 and ROS.

EFFECTS OF ISCHEMIC PRECONDITIONING ON RESISTANCE EXERCISE-INDUCED MUSCLE DAMAGE AND MUSCLE PERFORMANCE IN COLLEGIATE ATHLETES

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INTRODUCTION:
The ischemic preconditioning (IPC), involves brief cycles of ischemia and reperfusion, could reduce metabolic stress and pro-inflammatory responses induced by ischemia and ischemia-reperfusion-injury during surgery [1]. It has been reported that IPC performed before a bout of eccentric exercise may attenuate exercise-induced muscle damage (EIMD) and muscle soreness in healthy adults [2]. This study examined the effects of IPC on EIMD and muscle performance in athletes.
METHODS:
Twenty-four male collegiate athletes were randomly assigned into IPC (3 × 5 min, 220 mmHg) or CON (control) group. One week after performing one repetition maximum (1RM) test, participants performed IPC at the upper thighs before a fatiguing resistance exercise bout consisting of 10 sets with 10 repetitions of back squats at 70%1RM with 3-minute rest between sets. Plasma creatine kinase (CK), thigh circumference (TC), range of motion (ROM) at knee joint, muscle soreness (visual analog scale, VAS), countermovement jump (CMJ), and isometric mid-thigh pull (IMTP) were measured before (baseline), immediately after (post-exercise), and 1 to 5 days (D1 to D5) after the exercise. In IPC group, IPC was administrated again immediately after muscle damage and performance tests on D1 and D2.
RESULTS:
No significant difference was found on total exercise volume (IPC vs. CON, 12.3 ± 3.4 vs. 12.7 ± 2.1 metric tons) between groups, and the CK levels at post-exercise was significant higher than that at baseline (from 248 ± 129 to 345 ± 190 IU, $P < 0.05$). The TC in both legs on D1 in IPC was significantly higher than that in CON (IPC vs. CON, +0.76 ± 0.72 vs. +0.07 ± 0.60%, $P < 0.05$). The ROM of knee extension in both legs at post-exercise, D1, and D2 in CON were significantly lower than the baseline, however, the ROM of knee extension only at post-exercise in IPC was significantly lower than the baseline. The VAS scores at post-exercise, D1, and D2 in IPC and CON were significantly higher than the baseline, and the VAS at D3 (3.15 ± 2.0) in CON was still significantly higher than the baseline (1.23 ± 1.56, $P < 0.05$). Changes in CMJ height at post-exercise in IPC was significantly lower than the baseline, nevertheless, changes in CMJ height at post-exercise and D1 in CON was significantly lower than the baseline. Changes in peak and mean force during IMTP test at post-exercise and D1 in IPC were significantly lower than the baseline, however, the changes in peak and mean force at post-exercise, D1, D2, D3, and D4 in CON were significantly lower than the baseline.
CONCLUSION:
The IPC could attenuate the EIMD and muscle soreness, and prevent the declines in muscular strength and explosive performance after a fatiguing resistance exercise in athletes. Supported by grants from Ministry of Science and Technology, Taiwan (MOST 108-2410-H-003-130-MY2). References: [1] Murry, et al. (1986). Circulation, 74(5), 1124–1136. [2] Franz, A., et al. (2018). Med Sci Sports Exerc, 50(1), 109–115. Contact: andescheng@ntnu.edu.tw

AEROBIC EXERCISE DECREASES AIRWAY SMOOTH MUSCLE CONTRACTION OF ASTHMATIC RATS THROUGH DOWN-REGULATION OF ORAIL1 CHANNELS BY INHIBITING IL-4 SECRETION

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INTRODUCTION:
Bronchial asthma is a chronic inflammatory disease characterized by variable airway obstruction and airway hyperresponsiveness (AHR). As is known, interleukin 4 (IL-4) plays an important role in the onset of asthma. Increasing evidence has shown that moderate-intensity aerobic exercise training reduces AHR in patients with asthma. However, the mechanisms underlying exercise-induced improvements in airway smooth muscle (ASM) contractility have not been fully elucidated. Evidence shows that intracellular calcium concentrations ([Ca2+]i) are elevated in ASM of subjects with asthma. Store-operated Ca2+ entry (SOCE) is one of the most important Ca2+ influx pathway of airway smooth muscle cells (ASMC). As a key pore-forming unit of store-operated Ca2+ channels, Orai1 has been demonstrated to play an indispensable role in functional regulation of ASM contraction. We tested the hypothesis that exercise down-regulated the expression of Orai1 in ASM through IL-4-mediated pathways and thus improved asthma symptoms.
METHODS:
Male Sprague-Dawley rats (10–12 weeks) were divided into control group, asthma group, and exercise plus asthma group (EA group) randomly. Chicken ovalbumin was used to stimulate asthma, normal saline was applied to the control group. The EA group received a moderate-intensity exercise training 5 times/week for 4 weeks. Bronchoalveolar lavage fluid (BALF) was collected, and IL-4 concentration in BALF was evaluated by ELISA. The rat tracheal tissues were taken and used for ASM cell culture experiments as well as in vitro tracheal ring tension experiments. Western-blot experiment was employed to identify the expression level of Orai1 proteins. [Ca2+]i measurement experiment was used to determine the relative Ca2+ level in ASM cells
RESULTS:
The contraction of rat airway smooth muscle induced by carbachol was significantly increased with asthma and exercise training reversed this alteration. Meanwhile, the blocker of Orai1 could significantly inhibit carbachol-stimulated ASM constriction. Furthermore, our data showed that asthma increased the carbachol-induced, SOCE-mediated ASM contraction, which was reversed in the EA group. Both of the IL-4 level in BALF and the expression level of Orai1 proteins in ASM of asthmatic rat were upregulated. However, aerobic exercise could down-regulate the IL-4 level and Orai1 protein expression of asthmatic rats. Moreover, we found that application of IL-4 could up-regulate the Orai1 protein expression and the carbachol-induced, SOCE-mediated ASM contraction in ASM cells.
CONCLUSION:
The present study revealed that aerobic exercise improved the function of asthmatic ASM by inhibiting IL-4 secretion, down-regulating the expression level of Orai1, and thus decreased the excessive ASM contraction of asthmatic rats.

THE CANCER-LIKE METABOLIC REPROGRAMMING OF GLUCOSE DURING SKELETAL MUSCLE GROWTH

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INTRODUCTION:
Resistance training represents an attractive and low-cost strategy to enhance/maintain muscle mass in the athlete and ageing population. Whilst we know much about how resistance-training increases skeletal muscle mass, we poorly understand the underlying mechanism of metabolic adaptations during muscle growth. We therefore assessed the effect of muscle growth stimulation by insulin-like growth factor (IGF)-1 on metabolic changes in differentiated murine C2C12 skeletal muscle stem cells in vitro.
METHODS:
C2C12 cells were cultured in Dulbecco's Modified Eagle's Media (DMEM) supplemented with 10% fetal bovine serum using standard tissue culture techniques. Differentiation into myotubes was induced when confluence was reached by changing to DMEM supplemented with 2% fetal bovine serum (DM). After three days, cells were cultured in DM supplemented with vehicle (control; VC), IGF-1 (100ng/mL; IGF) or IGF-1 and Rapamycin (10 ng/mL; RAP) for 48 h. After rapid quenching of the myotubes, methanolic extraction of samples for metabolite measurements was performed. Samples were analysed with liquid chromatography-tandem mass spectrometry measurements. All data were undergo various steps of quality control and were processed using XCMSViewer. For normalisation, protein quantification was assessed using Bradford assay, and we measured microscopically the thickness of the myotubes. Experimental results were analyzed using a one-way ANOVA for myotube thickness and a Student's t-test for metabolite concentration. False discovery rate (FDR<0.2) control was implemented to correct for multiple testing. All data are expressed as mean ± SEM.
RESULTS:
IGF (20.8 ± 2.31 μm) showed increased diameter of myotubes compared to VC (16.3 ± 0.54 μm) or RAP (14.3 ± 0.43 μm; $p<0.001$). Muscle growth stimulation increased lactic acid production in IGF compared to VC (6.8%; FDR=0.09) and RAP (19.1%; FDR=0.04). The pentose phosphate pathway (e.g. Ribose 5-phosphate) and five as well as 13 detected amino acids (AA) were elevated in IGF compared to VC and RAP (all FDR<0.2), respectively. Of the detected AAs, only serine showed a lower concentration in IGF compared to VC (FDR=0.12) and RAP (FDR=0.05).
CONCLUSION:
Our data suggest greater glucose consumption and increased abundance of glycolytic metabolites in IGF indicating increased glycolytic metabolic flux. This phenomenon is commonly a hallmark of cancer cells - known as the Warburg effect - that serves to provide glycolytic intermediates as precursors for anabolic reactions to build biomass. Although classified as a non-essential AA, serine might be metabolically indispensable, serving as an intermediate for many cellular processes (e.g. in the formation of glycine) during muscle growth. The results indicate that the cancer-like metabolic reprogramming is also a universal feature of skeletal muscle growth. This might have important implications for managing muscle mass in the athlete and ageing population.

CP-PN05 Physiology II - VO2 max

COMPARISON OF %VO2PEAK BETWEEN THE FRONT AND THE REAR RIDER IN A 2-HOUR ENDURANCE TANDEM-BICYCLE RIDE AFTER ENERGY SUPPLEMENTATION

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INTRODUCTION:
A tandem bicycle is a two-person bicycle wherein the front and rear riders work together to propel the bicycle. Previous research has found that exercise intensity for the front rider during tandem-bicycle exercise is larger than that for the rear rider. This is particularly true during uphill cycling. This study aimed to verify whether this would hold true when subjects were given energy supplement.
METHODS:
Four healthy Japanese adult males participated in a 2-hour endurance race held at OKAYAMA International Circuit (3.7km). The two pairs (pair A and B) of front and rear riders were chosen in different combinations according to age and peak oxygen uptake. The race was conducted in two different roads according to altitude difference (uphill road and downhill road). Location information was detected via GPS. During the ride, heart rate was measured using a heart rate monitor, while %V(・)O2max was measured after each completed circuit. Subjects had a short rest (7 min) and were supplemented with energy supplement (Jelly, 215 g) and isokinetic water (125ml) after 3 laps. Individual %V(・)O2peak was evaluated by the predetermined HR-V(・)O2 relationship for each subject. %V(・)O2peak was calculated using the peak oxygen uptake and average heart rate. All the obtained data are expressed as their means and standard deviations.
RESULTS:
Each pair cycled 12 laps around the 3.7km track for 2 hours. The average %V(・)O2peak of the front and rear riders on the uphill road were as follows. In pair A, the average %V(・)O2peak of the front rider was 79.6 ± 11.2%, while for the rear driver it was 68.4 ± 8.3%. In pair B, this was 78.3 ± 5.1% for the front rider and 41.1 ± 6.7% for the rear driver. The average %V(・)O2peak of the front and rear riders on the downhill road were as follows. In pair A, the average %V(・)O2peak of the front rider was 77.1 ± 12.3%, while for the rear driver it was 55.3 ± 14.9%. In pair B, this was 50.0 ± 5.3% for the front rider and 25.2 ± 5.8% for the rear driver. The front riders had higher average %V(・)O2peak than the rear riders, despite the energy supply. In the front rider, the difference in relative %V(・)O2peak was higher than that of the rear riders during both uphill and downhill rides. These tendencies were similar to a previous study, as well, thus supporting our results. The slope was 2% for the uphill road, and 3% for the downhill road. Therefore, the significant difference can be attributed to the change in slope. The handle, brake, and gear operations and wind pressure could have also influenced the differences between the front and rear riders. Our results confirm that the relative physiological stress of front riders is greater than that of rear riders during uphill ride.
CONCLUSION:
The relative exercise intensity of front riders is greater than that of rear riders during both uphill and downhill rides, even after energy supplementation.
Acknowledgement: This work was supported by JSPS KAHENHI Grant Number 17K10950.

THE RELATIONSHIP BETWEEN LEG ARTERIAL STIFFNESS AND MAXIMAL OXYGEN UPTAKE IN ENDURANCE ATHLETES

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INTRODUCTION:
Maximal oxygen uptake (VO2max) represents the maximum ability of an individual to extract oxygen from the atmosphere to be utilized by the working muscles, and is considered a physiological determinant of cardiopulmonary fitness. Arterial function influences cardiopulmonary function and peripheral blood flow during exercise. Increased aortic stiffness is associated with reduced VO2max via decreases in cardiac function in various age ranges. In contrast, no correlation exists between systemic arterial stiffness and VO2max in healthy young adults. Endurance training improves systemic arterial function, and greater peripheral arterial compliance increases cardiac output and blood flow in active limbs. During endurance exercises such as running and cycling, there is a large increase in blood flow and oxygen consumption in the working muscles. Leg arterial stiffness in endurance athletes may thus influence VO2max via increased blood flow in the working muscles. However, the relationship between leg arterial stiffness and VO2max remains unclear. This study investigated whether leg arterial stiffness is associated with VO2max in endurance athletes.
METHODS:
Twenty-one male, endurance-trained athletes (mean age: 20.0 ± 1.0 years; mean training time: 18.4 ± 8.0 h/week) and 12 non-athlete men (mean age: 21.2 ± 0.2 years; mean training time: 1.0 ± 1.1 h/week) participated in this study. All participants were normotensive (< 140/90 mmHg), non-obese, and apparently healthy, with no difference in body composition. Carotid-femoral pulse wave velocity (cfPWV) and femoral-ankle PWV (faPWV) were measured as indices of aortic and leg arterial stiffness at rest, respectively. After measurement of arterial stiffness, VO2max was determined using incremental cycle ergometer testing.
RESULTS:
Both cfPWV (athletes: 724.0 ± 85.9 cm/s vs. non-athletes: 801.1 ± 85.7 cm/s; P = 0.019) and faPWV (athletes: 820.9 ± 90.5 cm/s vs. non-athletes: 894.1 ± 82.8 cm/s; P = 0.028) were significantly lower in athletes than non-athletes. VO2max was greater in athletes (53.1 ± 3.8 mL/kg/min) than in non-athletes (41.9 ± 8.0 mL/kg/min; P < 0.001). Significant negative correlations were seen between VO2max and both cfPWV (r = -0.510; P = 0.018) and faPWV (r = -0.472; P = 0.031) in athletes. In contrast, no associations (P > 0.10) were seen between each PWV and VO2max in non-athletes (cfPWV: r = -0.306; faPWV: r = 0.065).
CONCLUSION:
Our findings indicated that lower aortic and leg arterial stiffnesses were both associated with higher VO2max in endurance athletes. These results suggest that decreased leg arterial stiffness due to endurance exercise training may influence VO2max in endurance athletes as with aortic stiffness.

EFFECT OF DATA PROCESSING ON VENTILATORY THRESHOLD DETERMINATION IN ATHLETES - A PILOT STUDY

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BRAZIL OLYMPIC COMMITTEE

INTRODUCTION:
Ventilatory thresholds (VT) are useful to predict endurance performance and determine training zones through maximal incremental testing. Digital filtering methods have been recommended for gas exchange data processing. However, the fixed time-average processing is widely used in research and sport science facilities. Still, to the extent of the authors' knowledge, the effect of data processing methods upon VT determination remains unclear. Therefore, the study aims to a) compare the effect of different filtering and sampling methods on VT determination and b) analyze the agreement between evaluators to determine the ventilatory thresholds within each method.
METHODS:
Seventeen male athletes performed a maximal incremental test on a Pulsar treadmill (H/p/cosmos, Nussdorf-Traunstein, Germany). The ramp protocol was finished at the subjects` volitional fatigue (~10 min). The oxygen uptake (L.min-1) was measured with the Quark CPET metabolic cart (Cosmed, Rome, Italy), previously calibrated for flow and known gas according to manufactures' instruction. The raw signal was processed with the strategies: a) 4th-order Low-pass Butterworth Filter (cut-off frequency of 0.04 Hz and a maximal Frequency of 1.5 Hz) (BTW) – adopted as the criterion method, b) Raw data averaged each 20s (FTA20), c) Smoothing of 15 data point (SMT15); and d) SMT15+FTA20. Final values of time-averaging and smoothing were aligned at the center of the data period. Digital signal processing was performed with the MATLAB 2019a software (Mathworks, Natick, USA), and time-average/smoothing were calculated with an Excel Spreadsheet (Microsoft, Redmond, USA). Two experienced evaluators independently determined the ventilatory thresholds in a blinded and random design. Shapiro-Wilk test was performed to assess the adherence of the data to a normal curve. A mixed two-way ANOVA was performed to compare the VO2 values for each VT (4 methods x 2 evaluators) followed by Bonferroni post-hoc test, when necessary. The agreement was calculated as a percentual mean difference between the two evaluators and compared using the Friedman test and Dunn's post-hoc test, when necessary. The significance was set at $p<0.05$ for all analyses.
RESULTS:
The Butterworth method yielded significantly higher VO2@VT1 ($F= 6.84$; $p=0.001$) compared to FTA20 and SMT15+FTA20 (mean difference of 189 and 160 mL.min-1, respectively). In contrast, no differences were found for VO2@VT2 among methods. Regarding the interrater difference, fixed average-based methods presented similar median differences (up to 7%) for VT1. For VT2 ($F= 12.1$; $p=0.01$), the FTA20 and SMT15+FTA20 methods provided a lower median difference (0-2%) (significantly lower than SMT15), whereas BTW and SMT15 yielded a median difference between 7 and 8%.
CONCLUSION:
The Butterworth method provides higher VO2 values only in the VT1. The fixed average-based methods seem to increase the probability of agreement between evaluators.

VALIDITY OF ISOLATED AND COMBINED TIME-AVERAGING/SMOOTHING STRATEGIES TO DETERMINE VO2MAX IN INCREMENTAL RAMP TESTING OF ELITE ATHLETES

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BRAZIL OLYMPIC COMMITTEE

INTRODUCTION:
Digital filtering methods are preferable for breath-by-breath oxygen uptake data processing during incremental ramp tests, but it requires data processing and mathematics skills [1]. Despite the known limitations, fixed averaging at a given time interval or a moving average (smoothing) of an array of breath data points are simpler methods, which can be quickly performed into the metabolic cart software. Therefore, this study aims to assess the concurrent validity of isolated and combined simpler processing strategies with digital filtering for VO2max determination.
METHODS:
Sixty male elite athletes from several Olympic disciplines (VO2max: 4235 ± 707 mL.min-1 / 57,0 ± 8,2 mL.kg-1.min-1) performed an incremental ramp test on a Pulsar treadmill (H/p/cosmos, Nussdorf-Traunstein, Germany). The ramp was programmed to last ~10 min, starting with 60% of the maximal predicted velocity, and finished at participants' volitional fatigue. The oxygen uptake was measured with the Quark CPET metabolic cart (Cosmed, Rome, Italy), previously calibrated. The raw signal was processed with the strategies: a) Raw data – no processing; b) Raw data averaged at a fixed time of 20s (FTA20), c) Smoothing (moving average) of 15 data points (SMT15); d) SMT15+FTA20; e) 4th-order Low-pass Butterworth Filter (cut-off frequency of 0.04 Hz and a maximal Frequency of 1.5 Hz) (BTW) – adopted as the criterion method, and f) BTW+FTA20. Final values of time-averaging and smoothing were aligned at the center of the array of data points. Digital signal processing was performed with the MATLAB 2019a software (Mathworks, Natick, USA), and time-average/smoothing were calculated with an Excel Spreadsheet (Microsoft, Redmond, USA). The highest value of oxygen uptake (L.min-1) attained during the test was determined as the VO2max for each strategy. A mixed two-way ANOVA was performed to compare the VO2max values (3 filters [Raw data/Smoothing/Butterworth] x 2 time-averaging conditions [yes/no]) with Bonferroni post-hoc testing when necessary. Additionally, the agreement statistics a) Intraclass correlation coefficient (ICC – Type 3,1), b) ICC-derived standard error of measurement, and c) bias were also calculated. The significance level was set at $p < 0.05$.
RESULTS:
There was a significant effect of both filtering, averaging, and interaction for all tests ($p < 0.001$). Smoothing was the only method that did not differ from gold-standard Butterworth ($p = 0.06$), regardless of averaging. SMT15+FTA20 yielded the highest agreement with BTW (CCI = 0.97; SEM = 122 mL.min-1 [2.9%]; bias -107 mL.min-1).
CONCLUSION:
15-points smoothing combined with 20s fixed time-averaging presented itself as a simple processing method with an acceptable error (<3.0%) for VO2max determination.
1. Robergs et al. Sports Medicine, 40(2), 95-111. 2010

TECHNICAL STABILITY OF THE COSMED K5 IN BREATH-BY-BREATH AND DYNAMIC MICRO MIXING CHAMBER MODE DURING 150 MIN.

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INTRODUCTION:
Validity and reliability of several portable metabolic analyzers have been evaluated in scientific studies. Noteworthy, the stability of the analyzers with potential technical drift is often disregarded, though of practical relevance when it comes to continuous and long-lasting measurements. Since stability might be influenced by the measurement approach of the analyzer, i.e. breath-by-breath (BBB) or dynamic micro mixing chamber (DMC), we aimed to test the stability of the COSMED K5 (COSMED, Rome, Italy) for a period of 150 min in BBB- and DMC-mode.
METHODS:
Two COSMED K5 metabolic analyzers operated simultaneously (one in BBB-, the other in DMC-mode) while exposed to a metabolic simulator (MS) that simulated ventilation (V̇E: 60 L/min) and gas exchange (oxygen uptake (V̇O2): 2.1 L/min, respiratory exchange ratio (RER): 1.01) in a precisely controlled manner. Six times, i.e. each 30 min of the 150-min procedure, both continuously operating K5s were connected to the MS and afterwards to a reference gas tank (16% of O2 5% of CO2) to evaluate any changes of the gas sensors. This setup allowed to measure the technical stability of the complete system and the gas sensors separately. Calibration of flow and gas sensors (2.0 calibration) were conducted manually before the test and automatically for gas sensors (1.0 calibration) each 30 min, as suggested by the manufacturer. Technical stability was calculated as the coefficient of variation (CV) between all six measurements. Technical drift was expressed as the percentage slope of the regression between changes in O2, CO2, V̇E, V̇O2 and RER vs. time.
RESULTS:
CVs for the stability for O2, CO2, V̇E, V̇O2 and RER amounted to 0.12, 0.36, 0.05, 0.56 and 0.45% in BBB-mode, and 0.10, 0.25, 0.05, 0.38 and 0.82% in DMC-mode, respectively. Slopes of the drift ranged -0.018 to 0.002% (R^2 0.079-0.280) for BBB-mode and -0.021 to 0.001% (R^2 0.089-0.476) in DMC-mode. There were no significant differences of the slopes to zero (p>0.05) found.
CONCLUSION:
The COSMED K5 in BBB- and DMC-mode demonstrated a high technical stability and low drift over 150 min with six repeated measurements, as indicated by a low CV ≤0.69% and non-significant slopes ≤ 0.021%. However, while stability tended to be superior for V̇O2 in the DMC- vs. BBB-mode, this was vice versa for RER due to lower stability of V̇CO2 in DMC-mode. These data provide clear evidence that the K5 showing no substantial technical drift during long lasting experiments. Of note, only one constant metabolic rate and dry gas concentrations at room temperature were used in this study. Since human breathing is characterized by changes in each of these variables, further research mimicking human breathing is warranted.

PHYSIOLOGICAL DEMANDS OF EXERGAMES IN OLDER ADULTS: A SYSTEMATIC REVIEW.

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INSTITUTE OF SPORT SCIENCE

INTRODUCTION:
The population is rapidly aging, and there is a longer life expectancy than ever before. With advancing age and related lifestyle changes, there is also an increased risk for non-communicable diseases. Sufficient physical activity and low levels of sedentary behaviour positively impact health and reduce the risk for non-communicable diseases in older adults [1]. Therefore, new approaches to promote everyday physical activity tailored to the interests and abilities of older adults are recommended. Exergames – video games that require physical exertion or movement – could be an innovative approach and are easily adaptable to different levels of ability [2]. However, the physiological effects of Exergames for older adults is unclear. The aim of this study was to review the current literature addressing the physiological demands of Exergames in older adults above the age of 65 years.
METHODS:
A systematic database search (Pubmed, Sport Discus, Cinahl, Cochrane, Psychinfo, Web of Science, Surf, Scopus) was conducted in October 2020. Inclusion criteria were: participants aged > 65 years; Exergaming Intervention; compared to rest, control group, or other interventions (such as common training interventions); and analyzing one of the physiological outcomes: heart rate (HR), oxygen consumption (VO2), or subjective physical exertion (RPE). Further, the PRISMA guidelines were followed and the quality of included studies was assessed using RoB-2 and ROBINS.
RESULTS:
A total of 3111 studies were screened, and after title, abstract and full text screening, 12 studies were included in the data analysis. The studies included overall 427 participants, 57% female with a mean age of 72.3 ± 4.6 years. Analysed Exergames were played on the following platforms: Dividat Senso©, Nintendo Wii©, Xbox 360 Kinect©, IREX©, Cloud Gate©, VR system©. Data is currently analysed in the following categories: HRmean, HR max, RPE, Vo2mean; Vo2peak, and metabolic equivalent. Analysis to be confirmed are indicating light to moderate intensity levels related to exergames. Inasmuch the results will allow, they will be presented by different categories (exergame type, gender, age, intervention dose and duration).
CONCLUSION:
To the current state of the analysis, Exergames are potentially capable to offer light to moderate intensity for older adults. Although preliminary implications are positive for exergaming with older adults, high diversity was found in study design according to intervention duration and assessment of physiological parameters. Therefore, further research is necessary to examine the outcomes in more detailed (exercise length, impact on gaming levels) aspects to offer specific recommendations that could be used by older adults.

CP-PN06 Physiology III - Mixed

EFFECTS OF DIFFERENT TRAINING METHODS ON INTERSTITIAL FLUID GLUCOSE OF ELITE ROAD CYCLING ATHLETES

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INTRODUCTION:

As the most important energy resource, glucose plays a key role in athletes' performance. During Long-duration endurance exercise, skeletal muscles use glycogen and triacylglycerol primarily and then circulating glucose. Muscle takes up glucose that diffused from blood to interstitial fluid during exercise. The aim of present research was to investigate the effect of training intensity on interstitial fluid glucose (IFG) of road cycling athletes and the IFG range corresponding to peak performance.
METHODS:
Under informed condition, six female road cycling elite athletes from Beijing Sports Training School were recruited to join this study. Subjects average age was 21±3 years, training time from 3 to 10 years, height 168.5±4.54 cm, weight 58.62±2.03. Resting heart rate was 70±9 bpm. Participants followed training plan as usual and did not have special dietary advice. Continuous glucose monitor (CGM) sensor (Abbott, Chicago, USA) were inserted into back area of upper arm with applicator and remained in subject for 7 days to detect interstitial fluid glucose (IFG). After 12 hours, we use scanning detector to match sensor and capture data from within 1cm to 4cm of the sensor. Sensors tested sample and stored data automatically every 15min.In addition, the scanner equipped with a blood glucose detector to measure blood glucose (BG) at before meals and during training. Peak power, cadence, speed and heart rate of riding were detected by dynamometer (SRM, Germany) and Polar (Finland). The average carbohydrate and daily calorie intake was calculated with follow-up nutrition survey. We use unary linear regression (SPSS 19.0) to analysis the correlation of BG and IFG of athletes. One-way ANOVA was used to compare IFG between different training methods. Continuous IFG data of athletes was analyzed to explore what glucose level match peak performance.
RESULTS:
IFG before meals and during training of athletes was linear correlation to SG (p=0.000, IFG=0.847 BG+0.631). IFG of 80km road riding (HR≈129 bpm) was significantly higher than wattbike interval heavy intensity training (HR≈188bpm) (6.78±0.66 mmol/L vs. 5.12±0.47 mmol/L, p<0.05).IFG of 20km time trial (HR≈178 bpm) was significantly higher than 100km road riding (HR≈130 bpm) (7.31±1.03 mmol/L vs. 5.66±0.44 mmol/L, p<0.05). More than 44% of the monitoring training period with IFG >6.1 mmol/L and peak performance matched IFG > 7.0 mmol/L.
CONCLUSION:
Road cycling is known as a typical endurance sport and consume glycogen extremely. In general, blood glucose decline with fluctuation during exercise. However, the present study showed that athletes maintained a constant IGF >6.1 mmol/L during training. Long period of low-intensity riding is easier to maintain glucose in tissue than high intensity training. The difference of adaption to road cycling could affect glucose consumption in muscle.

RESPONSE OF AUTONOMIC NERVOUS SYSTEM ACTIVITY DURING MODERATE AEROBIC EXERCISE AFTER DRINKING HIGHLY CONCENTRATED CARBOHYDRATES

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INTRODUCTION:
Intake of carbohydrates before exercise generally appears to be beneficial to exercise performance (1). However, our previous study showed that the level of autonomic nerves system (ANS) activity after consuming carbohydrates tended to be lower than after consuming water, and exercise performance of the later decreased (2). We also found that an intake of highly concentrated carbohydrates caused a higher rate of perceived exertion (RPE) compared to an intake of water during moderate aerobic exercise (MAE) (3). This higher RPE during MAE might be related to a decline in ANS activity since a correlation between RPE and ANS activity was revealed during exercise (4). Therefore, the aim of this study was to investigate the effect of an intake of highly concentrated carbohydrates before MAE on ANS activity.
METHODS:
This study had a randomized crossover design. Ten active female volunteers (age: 19.3±1.6yr, BMI: 20.9±1.7kg/(m)2) took part in the study after giving a written informed consent. After fasting for 12-h, the volunteers drank dextrose in water (150g×500ml-1: CHO) or a water placebo (WP) 30 minutes before a bicycle ergometer exercise at 50%VO2peak for 60 minutes. Cardio-respiratory data and heart rate (HR) were measured from the start of the exercise until 2 minutes after cessation of the exercise. ANS activity was measured throughout of the exercise period using heart rate variability (HRV) power spectral analysis, which enabled the identification of separate frequency components, i.e. total power (TP), low-frequency (LF; sympathetic nervous system activity) power and high-frequency (HF; parasympathetic nervous system activity) power. RPE was recorded every 6-min during the exercise period using the Borg scale (6-20). In addition, blood samples to measure blood glucose level were collected 30min before the exercise period, and then at 0-min, 15-min, 30-min, 45-min, 60-min during exercise, and finally 15-min after exercise cessation.
RESULTS:
The results showed a significant difference (p<0.01) in HR (CHO:139.4±11.3 bpm, WP: 127.5±10.9 bpm） and in RPE (CHO:12.5±0.4, WP:11.2±0.5) during MAE. In ANS activity, LF was significantly lower in CHO than in WP during the first half of MAE (p<0.01). In contrast, HF was significantly higher in CHO than in WP at 6-min and 60-min during MAE (p<0.01). It was also found that blood glucose levels were significantly higher in the CHO condition than in the WP condition at 0-min, 30-min, 45-min, and 60-min during exercise, and 15-min after exercise (p<0.05).
CONCLUSION:
These results support the conclusion that an intake of highly concentrated carbohydrates before exercise decreases ANS activity during moderate aerobic exercise. As a result, a higher RPE during exercise might occur due to this decline of ANS activity.
1) Ormsbee et al. (2014) 2) Tsukamoto et al. (2019) 3) Kimoto et al. (2019) 4) Khandoker and Jelinek (2018)

METABOLIC, RESPIRATORY AND CARDIOVASCULAR RESPONSE DURING PASSIVE HEATING COMPARED TO HEART RATE MATCHED CYCLING

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INTRODUCTION:
Passive heating (PH) has been proposed as a potential exercise (E) mimetic strategy showing acute and chronic effects on skeletal muscle adaptation in people who are unable to perform or coplete sufficient exercise. Like exercise, eating increases heart rate (HR), peripheral

artery blood flow and provoke thermoregulatory response. The aim of our study was to compare the acute metabolic, cardiovascular and respiratory response to passive heating and to compare it with the response to HR and duration mached cycling.
METHODS:
In a fixed crossover designed study, 9 healthy participants (23.6 ± 2.4 yr) underwent 30 min of whole body passive heating (55gradC in infrared sauna), followed by 30 min of manually load managed cycling on a separate day. Cycling load was added in steps to comply the same HR time profile as obtained during PH. HR, arterial blood pressure (ABP), oxygen consumpuion (VO2), respiratory quotient (R), ventilation (VE) and sublingual temperature (Tsl) were measured continuously during PH and E (Finapres Ohmeda, Cosmed quark CPET, Perimed PeriFlux5001). Based on meatbolic measurements stroke volume (SV) and cardiac output (CO) were determined.
RESULTS:
At the end of PH and E HR increased significantly compared to resting state (109,9(2,3) beats per min versus 74,6(2,7) beats per min) and was the same at poth procedures. However, other metabolic and cardiovascular parameters differ statistically significant (p⍰0,001) in last 5 minutes during E compared to last 5 minutes of PH (diastolicABP: 84,8(7,1)mmHg (E) compared to 93,1(5,8)mmHg (PH); systolicABP:159,1(9,0)mmHg (E) compared to 137,6(7,6)mmHg (PH); VO2: 1141,2(221,2)mL/min (E) compared to 339,650(70,7)mL/min (PH); R: 0,87(0,02) (E) compared to 0,82(0,01) (PH); VE: 30,2(1,8)L/min (E) compared to 11,5(0,5)L/min (PH); Tsl: 36,6(0,2)gradC (E) compared to 37,4(0,1)gradC (PH); SV: 10,1(0,6)arbitrary units (E) compared to 3,3(0,1)arbitrary units (PH); CO: 1110,0(10,2)arbitrary units (E) compared to 362,7(6,2)arbitrary units (PH)).
CONCLUSION:
Passive heating was reported to have some potential benefits for skeletal muscle mass gain and muscle force improvement however passive heating provoked minimal cardiovascular, respiratory and metabolic responses compared to HR and duration matched exercise on cycloergometer.

TECHNOLOGICAL, ATHLETIC TRAINING AND BIOLOGICAL RESPONSE TO THE IMPROVED RESISTANCE EXERCISE APPARATUS ON RATS

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INTRODUCTION:
The resistance exercise apparatus of climbing ladder with load on rats, reported by Lee S, is a relatively simple animal experimental method to simulate strength training at present. However, the device is still unsatisfactory in aspects such as climbing safety, stability, load-bearing capacity, load calculation, control of training time, single operation and ease of cleaning, and needs further improvement. In order to promote the application of the device in the study of resistance training on rats, the purpose of this study is to explore the improvement of the resistance exercise apparatus, and to observe the improved technological, athletic training and biological response.
METHODS:
This experiment has been approved by the ethics committee of the unit. Thirty-six healthy SPF male Sprague-Dawley rats were randomly divided into control and exercise group. The climbing ladder and weight bearing device were separately improved to develop a new resistance exercise apparatus of climbing ladder with load on rats. The exercise group took an 8-week incremental exercise program using this improved device. To observe the operation effect of this improved exercise apparatus. To observe the dynamic changes of average maximum load on SD rats from the exercise group during 8 weeks. To compare the effect of climbing ladder exercise with load on body weights of SD rats between the two groups .
RESULTS:
The improved climbing ladder was marked by the prioritization technique of architecture stabilization, weight bearing and easy cleaning. The improved bearing device has the advantages of being sturdy and durable, and simple method to calculating load. Moreover, the new experimental apparatus can be operated by one person during the exercise program. The average maximum load was successfully increased to 756 g after an 8-week exercise using the improved apparatus. Compared with the control group, the body weights of SD rats from the exercise group after training were significantly reduced($P<0.05$).
CONCLUSION:
The improved resistance exercise apparatus of climbing ladder with load can provide a more endurable and repeatable process in the study of rat strength training and it is recommended to use this new device in future research.

THE INVESTIGATION OF CARDIOLOCOMOTOR COUPLING IN THE WATER

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INTRODUCTION:
Biological rhythm fluctuates and is affected by a variety of factors. This rhythm interacts with external rhythmic stimulation and internal rhythms. Phase synchronization occurs between two different signals as a result of the interaction. Phase synchronization is often observed between heart rate and locomotor activity during rhythmic exercise (Coleman, 1920). This phenomenon said cardio-locomotor synchronization (CLS), and it has been shown to have a positive effect on the circulatory system.
Aquatic exercise is a constant rhythm (e.g., swimming, water aerobics). Additionally, aquatic exercise affects the circulatory system. Based on the above, it is assumed that it may also occur CLS during aquatic exercise. However, it was difficult to measure biological signals underwater using the existing device. Then, we have developed a device that can measure biological signals in the water. The purpose of this study was to investigate whether CLS occurs during walking in the water using the developed device.
METHODS:
The subjects were 8 healthy men (23-24 yrs). Using the developed device, each subject was measured for electrocardiogram (ECG), acceleration and angular velocity during walking. The video was recorded during the trials at the same time. The device was placed on their chest. Subjects warmed up to the heart rate of 120-130 bpm in the water for 5min before the experiment. They walked in the water at a constant speed for 5min. They walked on the treadmill in the same way. The coefficient of determination was calculated from the RRI and step intervals (Novak et al., 2007). The coefficient of determination was an index as the strength of CLS. The coefficient of determination was compared between water trials and treadmill trials.
RESULTS:
The coefficient of determination in the water trials was significantly larger than that in the treadmill trials in each subject ($P<0.05$).

CONCLUSION:
The novel finding of this study was that CLS occurred during aquatic exercise. From this result, it was speculated that CLS is likely to occur in the water. Therefore, exercise in the water is expected to have a positive effect on the circulatory system. It is suggested that biological rhythm fluctuates according to the environment.
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CP-SH01 Law and ethics

SPORTS DISCIPLINARY PROCESSES AND RESTORATIVE JUSTICE: EMBRACING THE SPIRIT OF THE GAME.

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"Cricket is a game that owes much of its unique appeal to the fact that it should be played not only within its Laws but also within the Spirit of the Game. Any action which is seen to abuse this Spirit causes injury to the game itself". (Preamble to the Laws of Cricket, 2019)
This paper explores the framework of quasi-legal disciplinary processes developed by Sport Governing Bodies (SGBs) and the consequent construction and imposition of sanctions. A major issue facing SGBs is misconduct that involves dissent at decisions and abuse directed at officials that is impacting on the retention of players, officials and other volunteers. It proposes that SGBs need to consider the adoption of principles of restorative justice to accompany and even replace penal sanctions that are seemingly blunt and ineffective.
It argues that within cricket, as an example, the game would benefit from the replacement of the existing principles of punishment with the development and implementation of a restorative approach to misconduct. Whilst reference is made to professional sport the primary focus of the analysis is the recreational game and, in this instance, a local cricket league played by amateur players. The paper incorporates disciplinary data from this League for the period 2012 – 2019. It outlines proposals for the development of a restorative rather than retributive approach but draws a distinction between specific offences with an identifiable victim and a broader offender rehabilitative offender based perspective. This latter approach permits the application of a more general restorative method in a wider range of situations as it is not tied implicitly to a particular victim. It is more applicable to general behavioral issues or a collective failure such as controlling players.
The paper constructs a tentative outline of a restorative approach in the context of the disciplinary offences analysed. It is the very nature of cricket that renders the game ripe for an alternative approach to player misconduct and disciplinary sanctions. The content of the Spirit of Cricket is a potentially powerful concept given that it links the past to the present and invokes respect and fairness. Furthermore, those elements of restorative justice that seem most problematic when it comes to the criminal justice system are, in cricket, a potential advantage namely the position of the victim and whether the system is making reparation as its primary goal. In cricket whilst dissent at a decision can be a key feature there is a much broader victim, the game itself. The concepts that may be troublesome for reintegration within the criminal justice system can be harnessed to stress and deliver behavioural change on both an individual and collective level. It will require a transformation in thinking and approach but at this juncture cricket, as with many sports, has little to lose and potentially a large amount to gain.

A STUDY ON THE CONSTRUCTION OF CHINESE SPORTS DISCOURSE BASED ON CORPUS LINGUISTICS

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Introduction
In order to explore the construction of Chinese sports discourse and to answer the questions of "what, for whom, and by whom should Chinese sports be developed", this abstract selects five State Council Communiques with prominent themes and analyzes the development process of sports discourse construction with the specific contents of the documents.
Method
This study uses the AntConc corpus software and the corpus online automatic word separation website to combine the Regulations on Public Cultural and Sports Facilities 2003, the Opinions of Strengthening Youth Sports and Enhancing Youth Physical Fitness 2007, the Guidance Opinions of Accelerating the Development of Sports Industry 2010, Twelfth Five-Year Plan of Sports Industry Notice 2011, and Outline of the Construction of a Strong Sports Country 2019, five documents for comparative analysis, and statistical analysis of nouns, adjectives and verbs in the documents.
Result
The nouns, verbs, and adjectives in each of the five documents were counted, and the specific word frequencies are detailed in the following data.
Among the nouns, the top five word usages in the five documents respectively are culture(100), sports(93), facilities(82), administration(42), authorities(37), "sports(79), youth(74), schools(54), students(52), hygiene(23)", "sports(161), industry(33), market(26), service(24), society(15)", "sports(272), industry(133), service(27), market(25), enterprise(21)", "sports(233), fitness(57), all people(41), project(39), system(33)".
In the adjectives, the top five words in the five documents are "public(73), according to law(14), people's(13), open(12), safe(6)", "healthy(36), active(10), important(10), basic(9), safe(9)", "active(14), public(8), international(8), open(8), relevant(7)", "positive(26), further(16), characteristic(9), relevant(9), normative(9)", "positive(15), healthy(14), new(13), characteristic(13), international(12)".
In the verbs, the top five respectively are "should(32), manage(30), build(27), open(12), stipulate(12)", "need to(32), strengthen(31), carry out(18), establish(12), build(12)", "develop(45), strengthen(22), manage(17), improve(13), regulate(13)", "develop(94), strengthen(20), manage(20), establish(19), build(18)", "build(55), develop(43), establish(30), improve(26), promote(25)".
Conclusion
From a comprehensive perspective, the subject of sports development in China is gradually enriched from youth and sports industry to the whole society, and the specific content of development is gradually changed from the construction of cultural and sports facilities to the strengthening of youth physical health to the improvement of sports industry management and the active promotion of national fitness. The scope of the subject is becoming broader and broader, and the object content is becoming more and more comprehensive. Overall, it upholds a positive and open attitude toward the international discourse community.

CP-SH02 Sociology

LIFESTYLE OF ITALIAN SPORT SCIENCES STUDENTS DURING SARS-COV-2 PANDEMIC

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Introduction
To counter and contain the spread of the SARS-CoV-2 infection, restrictive measures have been imposed, and these led to the disruption of normal life habits causing behavioral changes. The study aimed to investigate the lifestyle among Sport Sciences students to evaluate: practice of physical activity, eating behavior, use of electronic devices, and chronotype (CT). Indeed, people displays preferences to be active at certain time of the day, and based on these differences, they can be classified in three different CT: M-, N- and E-types [1]. Study showed a relationship between light-dark cycle, social life and cardiometabolic disease risk factors, especially in E-Types [2].
Methods
201 students (108 males and 93 females) were recruited. Participants filled out the Italian versions of the Godin-Shephard Leisure-Time Physical Activity Questionnaire (GSLTPAQ) and the reduced version of the Morningness–Eveningness Questionnaire (rMEQ). Moreover, they completed a composite questionnaire aimed to investigate their nutritional habits and daily use of electronic devices. The GSLTPAQ and the composite questionnaire were administered both before and during the COVID-19 pandemic. The entire sample was divided into three groups according to their CT: M-types (N:22), N-types (N:128) and E-types (N:51).
Results
In relation to the physical activity, the results during the COVID-19 pandemic showed that none of the three CT have substantially changed their physical activity habits compared to the PRE COVID-19 period, confirming to be a physically active population. Instead, consumption of fruits and vegetables increased for all three groups during the pandemic. The consumption of meat increased for M-types while it decreased for E-types groups. Positively, both N-types and E-types decreased the number of glasses of beer/wine and alcohol per week. M-types did not show differences between the two periods, but it must be considered that they started from very low alcohol consumption in PRE COVID period. The use of the electronic devices increased for all CT before sleeping, and also during the day in M- and E-types.
Discussion
This exceptional emergency has profoundly changed daily behavior, particularly among young people. The data collected before and during the pandemic period on young attending the Sport Science School have instead highlighted that this population remained active and improved eating habits during the covid emergency. Particularly, E-types, the CT that display a mismatch between light-dark cycle and social life with bad consequence for health [2], improved their lifestyle, perhaps due to a lesser influence of social commitments during pandemic.
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BODY IMAGE IN ADOLESCENCES: DIFFERENCES BETWEEN VOLLEYBALL PLAYERS AND SEDENTARY

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Background: Adolescence represents a critical stage in the development of positive or negative body image. Physical activity could influence the development of the body image. In fact, high levels of physical activity have a positive effect on body perception, independently from sex and Body Max Index (BMI). Moreover, for both sexes, lower levels of body satisfaction are linked to lower levels of physical activity and restrictive diet. The aim of this study was to analyse the differences in body image and body perception in two groups: adolescence volleyball players and sedentary peers.
Methods: Two validated questionnaires were administered to the groups, the Figure Rating Scale and the Body Shape Questionnaire 14 (BSQ-14). We analysed the body image dissatisfaction (FID, Feel minus Ideal Discrepancy), the improper perception of weight status (FAI, Feel weight status minus Actual weight status Inconsistency) and the body perception.
Results: A total of N=125 adolescents participated, divided in volleyball players (aged 14-15, N=34, aged 16-17, N=29) and sedentary (aged 14-15, N=31, aged 16-17, N=31).
Younger volleyball layers showed significant differences with their peers in FID ($F=2.06$, $p<0.05$), in the FAI ($F=3.76$, $p<0.01$) and in all the items of BSQ-14 ($p<0.01$).
Indeed, volleyball players aged 16-17 showed no differences with their sedentary peers in FID (2.04, $p=0.58$) in FAI ($F=1.54$, $p=0.22$) and only four items of BSQ-14 showed significant differences between the groups ($p<0.05$).
Conclusions: Results showed that younger volleyball players had a better perception of their body than their peers, with a correct perception of weight status and no problems in dissatisfaction. Physical activity showed to be a protective factor in the creation of body perception. Moreover, older volleyball players showed a body perception in line with their sedentary peers. They may be more influenced by external factors, as social networks, or they could have a more critical view of their body linked to the ideal “volleyball body” they saw in elite athletes.

COMPARING A JAPANESE FREE CLIMBING PROGRAMS’ EFFECTS ON PARENTS AND CHILDREN: RESULTS FROM AN EXPERIENTIAL EDUCATION INTERVENTION

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Introduction
The Tokyo Olympics will be held in 2021, and sport climbing has been added as a new event. Climbing remains relatively unfamiliar to many people in Japan and provides a unique and complex learning environment for parents and children to experience. Climbing includes elements of physical challenge (strength and flexibility), psychological management (confronting fear and anxiety), social interaction and support (belay and encouragement). This research explored the effects of an introductory climbing program on parent and child participants.
Methods

Participants included 18 children aged 8 to 14 years（6 males and 12 females; Mean age: 10.39 years old, SD: 1.38） and 16 parents （7 males and 9 females; Mean age: 42.69 years old, SD: 3.20）. Parents and children participated for three hours in an indoor climbing lesson on three occasions. This program included supervised experiences of bouldering and rope climbing. Participants were asked to answer questionnaires before, immediately after, and one month following completion of the program. Two months later, semi-structured interviews were also conducted with five parent and child dyads.
Results
There were many comments by children in the questionnaire that indicated how they enjoyed bouldering because it created conditions for enjoyable problem solving where they could make several attempts to climb a particular route in a casual and safe manner. Other participants noted that they valued the opportunity to support parents as belayers, which helped them gain confidence. The results of the questionnaire showed that the climbing experience increased self-growth in ways such as improving persistence, increasing self-confidence, and fostering mental resilience. Many parents favored rope climbing because of its unique and unfamiliar nature, which afforded new experiences and skill acquisition opportunities, such as tying ropes, performing belays, and supporting (and being supported) by others. Parents also had the opportunity to experience and observe different traits in their children, including goal orientation and persistence.
Discussion
The experience of a parent and child learning something new together (climbing) seems to have allowed participants to learn physical, mental, and interpersonal skills that are novel and inherently interesting. As for the interaction between participating families, mothers seemed to have an easier time talking with other parents and children compared to fathers, which may reflect broader social roles in Japan. Future experiential education programs that incorporate climbing should continue to emphasize the socially supportive nature of the activity (e.g. belaying and psychological support) but should also include mixed groups of learners from different families to facilitate greater interaction.

CP-SH03 Psychology

DIFFERENCES IN ANGER AND HARDINESS LEVELS IN STUDENT AND NON-STUDENT ATHLETES

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The study aimed to examine the differences in anger and hardiness levels in student athletes and if there were a linear relationship between anger and the number of hours studying. A sample of 496 Spanish Athletes (Mage = 27.77; SD = 9.15; 343 men and 153 women) participated in the study. First, to examine the differences in anger and hardiness between the groups of the sample, the results of the MANOVA analysis revealed significant differences between the study variables. Particularly, the student athletes revealed higher levels in the anger variables: anger trait, temperament, external anger expression and anger expression index. On the contrary, the non-student athletes reported higher levels in anger reaction. To ensure that the differences in anger were caused by the time spent studying a linear regression was performed. The statistics showed the fitness of the model ($R2 = .60$; $F = 49.57$; $p < .01$). However, there were no significant differences across the anger variables, hardiness and the number of hours studying ($p > .01$). To examine if there were cofounds between the sociodemographic variables a Chi-Square test was performed. Particularly, there were no significant differences among gender and student and non-student athletes ($p > .05$) and professional vs non-professional athletes ($p > .05$). As conclusions, the student athlete's reported higher anger levels in most of the variables (anger trait, temperament, external anger expression and anger expression index), but only the anger reaction was the variable that reported higher levels in non-student athletes. The increase of anger levels is not engendered by the number of hours studying. These outcomes might reveal that there are other variables that may interfere in the student athletes to have greatest anger levels. Thus, the differences in anger levels are not due to the number of hours studying.

A CASE STUDY OF THE ATHLETE–COACH RELATIONSHIP BETWEEN AN EXPERT JUNIOR COACH AND ELITE JUNIOR ATHLETE

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When investigating the state of relationships between athletes and coaches, it is necessary to pay attention not only to objective behavioral data, but also to qualitative dimensions of mutual confidence. A subjective sense of confidence has been raised as a means to grasp the qualitative aspect of training. Athletes' and coaches' sense of mutual confidence is a subjective estimate of their own state of motivation to learn and to coach, and an indicator that measures the overall state of expertise in athletes. This study details a description of the athlete–coach relationship between an expert swimming coach and an elite junior swimmer. It considers a coaching philosophy relative to an athlete's performance enhancement, and the sport motivation of an athlete. One national team coach and one athlete who won the Japan junior swimming competition participated in the study. This study adopted a qualitative research methodology, and aimed to explore questions about the meaning of the psychological and social realities of an athlete-coach relationship. This requires an understanding of the athlete's and coach's philosophy and experience, without separating it from its psychological and social contexts. In-depth, open-ended interviews were conducted to gather data on the two participants. To enhance the reliability of the data collection, interviews were conducted using both a semi-structured interview as well as a group interview. The interviews were transcribed verbatim and a total of 55 meaning units were extracted from the data set. The data were decontextualized using an inductive procedure for analyzing unstructured qualitative data. The inductive analysis process resulted in regrouping the interview transcripts into three categories: "mutual respect," "common goal orientation," and "mutually supportive." It became clear that through their experiences of the coaching and learning during training and competition, a strong meta-cognitive connection was formed. The participants placed themselves in relation to each other, acknowledging what was happening to them in their current state, having formed a subjective sense of their common goals. The results revealed that the athlete-coach relationship is a highly dynamic, multifaceted, interpersonal phenomenon. Successful coaches build relationships with athletes in a manner that maximizes athletes' commitment to daily demanding practices.

DO ATHLETES PERCEIVE DIFFERENCES IN THE MOTIVATIONAL CLIMATE CREATED BY MALE AND FEMALE COACHES? ANALYSIS AND IMPLICATIONS FOR ATHLETES NEED SATISFACTION

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Introduction
Sport research based on Self Determination Theory framework (Deci & Ryan, 2000) has shown that the way in which coaches interact with their athletes has important implications in athletes psychological functioning and in the quality of their participation (Duda, 2013). When gender leadership characteristics have been analysed, some studies indicated that women report higher levels of empathy and emotional intelligence, which may enhance their overall leadership abilities (Eagly & Carli, 2007).
Based on Dudas's conceptualization of motivational climate, the purpose of this research was twofold: First to study the differences in the athletes' perception of Empowering and Disempowering Climate created by male and female coaches. Second, to analyse the differences in the athletes' basic psychological need satisfaction (BPNS) depending on whether they are trained by a man or a woman.
Methods
A total of 1214 Spanish female athletes (basketball and football) between 8 and 37 years old (Mage=15± 3.39) completed two questionnaires: one about perceptions of the motivational climate created by their coaches (Nman= 80; Nwoman=26), and other on athletes BPNS.
Results
T-test revealed significant differences in the climate created by female and male coaches. Athletes perceived female coaches were higher in the lower-order dimensions of task-involving ($t=2.60;p<.01$), autonomy-support ($t=3.18;p<.01$) and social-support ($t=3.44;p<.01$), and in the higher-order dimension of Empowering Climate ($t=3.53,p<.01$). Meanwhile, athletes also perceived that male coaches were higher in the lower-order ego-involving ($t=-4.05;p<.01$) and controlling-coaching ($t=-5.79;p<.01$) dimensions, and in the higher-order dimension of Disempowering Climate ($t=-5.48;p<.01$). Regarding to athletes BPNS, autonomy satisfaction was higher in the athletes belonging to the group of female coaches ($t=4.76;p<.01$).
Discussion
Athletes perceived that the motivational climates created by female coaches were more empowering and less disempowering than the ones created by the men coaches. In addition, athletes' autonomy was more satisfied when their coach was a woman. These results are in concordance with previous literature, which highlighted the abilities of women to be leaders with behaviours that are different from the traditional competitive, controlling aggressive leadership behaviours of men (Helgesin, 1990).
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RUMINATIVE THOUGHTS IN COMPETITIVE SPORTS CONTEXT: AN INITIAL VALIDATION OF THE SPORTS COMPETITION RUMINATION SCALE (SCRS)

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INTRODUCTION:
"That already went wrong the last time.", or "Why am I not successful in competitions?" are thoughts that are often perceived as incriminatory or limiting by athletes. These thoughts can be triggered by one's athletic performance or goal setbacks, and can be intrusive and repetitive, which is why this type of thinking referred to rumination (Kröhler, 2019; Krys et al., 2020; Martin & Tesser, 1996). Although there is a variety of different rumination measures (Krys, 2019), general or clinical rumination scales hardly allow tapping thoughts that are specific to competitive sports. Therefore, we developed the 8-item Sports Competition Rumination Scale (SCRS), which captures ruminative thoughts regarding competition-related problems, and validated it for future research and application in coaching.
METHODS:
Overall, we collected data of 355 athletes from different team and individual sports within an online survey. Here, we focus our analyses on athletes who are within the typical competitive age of 15 and 40 years (M = 23.59; SD = 5.42; N = 311; female: 152, male: 158, divers: 1). The validity of the SCRS was examined using a confirmatory factor analysis (CFA) and a nomological network with established rumination and anxiety measures.
RESULTS:
The CFA revealed a good model-fit and the SCRS is internally consistent. Correlations with different rumination measures from general and clinical psychology, and relations with sport specific anxiety measures support the nomological network. Interestingly, an additional variance analysis showed that athletes' age has a different effect of sports-specific rumination for women and men.
CONCLUSION:
The SCRS provides a useful, reliable, and short measure of sport-specific rumination about competition-related problems and offers a wide range of potential applications such as in talent scouting and evaluation, and sports psychological coaching. However, future studies should examine the extent to which there is a relationship between sport-specific ruminative thoughts and the real measurable athletic performance.

PERFECTIONISM PROFILES AND HEALTH RISK, AMONG HIGH AND LOW LEVEL ATHLETES

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Introduction
The 2x2 model of perfectionism (1) posits that combinations of low perfectionistic strivings (PS) and high perfectionistic concerns (PC), Pure PC, are associated with maladaptive outcomes (i.e., anxiety), while those with high PS and low PC, Pure PS, are associated with adaptive ones (i.e., motivation). To date, findings are inconsistent and if high PS can represent a protection or risk factor depending on sports level is

unclear. The aim of this study was to assess perfectionism profiles in relation with negative and positive outcomes among two level groups of athletes.
Methods
Participants were divided in two groups: one included 118 high-level athletes (HL: M=22.42 y, SD=4.09; 50.8% males) performing at international/national level and the other included 165 low-level athletes (LL: M=18.84 y, SD=4.08; 63,6% males) performing at regional/local ones. Questionnaires were administered to both groups twice within two months. At time 1, were completed measures of sport perfectionism and motivation, while measures of stress, burnout, sleep quality, disordered eating and anxiety were completed at time 2. To determine the four perfectionism profiles, a K-means (nonhierarchical) cluster analysis procedure was conducted. Then, MANOVA and subsequent univariate tests were used to investigate if the cluster groups could be distinguished by their scores on the outcomes scales.
Results
Four cluster of athletes were produced and overall multivariate model was significant (p<.0005) for both groups (HL: Wilk'sλ=.57, F(30,308.9)=2.20, pη2=.17; LL: Wilk'sλ=.66, F(30,446.8)=2.24, pη2=.13). HL group clusters differed on all outcomes (pη2 range=.09-.16) except for sleep quality, disordered eating and motivation measures: mixed perfectionism (high PS/PC) had significantly higher mean scores than Pure PS on all negative outcomes, while Pure PS had significantly higher mean scores than Pure PC and Mixed Perfectionism on self-confidence. LL group clusters differed on all outcomes (pη2 range=.05-.11) except for sleep quality, somatic anxiety, self-confidence and disordered eating measures: Pure PC had significantly higher mean scores than Pure PS on almost all negative outcomes, while Pure PS had significantly higher mean scores than pure PC and Mixed Perfectionism on motivation.
Discussion
Findings provided additional support for the four perfectionism profiles in both groups. In line with other studies (2), athletes whose perfectionism profile is Pure PS are more likely to be associated with positive outcomes, regardless sports level. Athletes are more likely to be associated with negative outcomes if perfectionism profile is Mixed Perfectionism for HL group and Pure PC in LL group. Altogether, the study extended understanding perfectionism in high and low level athletes and its potential effects on several outcomes.
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SEX MODERATES THE RELATIONSHIP BETWEEN REDUCED PHYSICAL ACTIVITY AND DEPRESSIVE SYMPTOMS DURING CONFINEMENT: EVIDENCE FROM A LONGITUDINAL STUDY

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Introduction:
Psychological distress has increased in the general population due to the COVID-19 pandemic [1]. Young people, especially women [2], have been particularly affected because of social isolation, loneliness, education disruption, future uncertainty, changes in daily routines, and decreased physical activity levels [3, 4]. However, this evidence comes from cross-sectional designs, and only a few studies have performed longitudinal analyses with data before and during the pandemic [4]. Our objective was to fill this gap by assessing the pandemic lockdown effects on depressive symptoms and physical activity levels, as well as its potential association.
Methods:
Ninety healthy college students between 18 and 25 years old (50.70% women; M = 21.18, SD = 2.14 years) were assessed within the two previous months to the COVID-19 lockdown. Subsequently, within 30 and 40 days after the declaration of social confinement in Spain, volunteers were invited to participate in a follow-up evaluation. Eighty-two participants (47.60% women; M = 21.99, SD = 2.14 years) agreed to engage. Before and after lockdown, depressive symptoms were assessed with the Beck Depression Inventory-II, while total physical activity was measured with the International Physical Activity Questionnaire.
Results:
At baseline, there were no statistically significant differences between sexes in sociodemographic, clinical and depression variables. After confinement, the whole sample showed decreased values of total physical activity ($t(81) = 5.42$, $p < .001$) and increased levels of depressive symptoms ($t(81) = -4.10$, $p < .001$). Related to the latter, a larger effect size was found in women ($d = .72$) compared to men ($d = .25$). Additionally, we found that sex moderated the relationship between depressive symptomatology and total physical activity ($B = -.002$, 95%CI [-.0029, -.0003], $t = -2.52$, $p = .01$). In detail, there was a negative association between changes in depressive symptoms and changes in total physical activity exclusively in females ($r(38) = -.35$, $p = .03$).
Conclusions:
According to our results, women were more prone to suffer the psychological consequences of pandemic lockdown than men. Moreover, they could benefit greater than males from the protective effect of physical activity, which is a low-cost, non-pharmacological, high-impact strategy. This information is of interest in establishing effective action protocols to promote emotional wellbeing and quality of life in young adults.
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ACUTE EFFECT OF BRIEF MINDFULNESS-BASED INTERVENTION ON ATHLETES' MOOD AND SALIVARY CORTISOL CONCENTRATION

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Background: The constant demanding of attention and competition-induced stress elicit complex psychophysiological responses during the soccer competition, which may influence soccer performance. Mindfulness-based intervention (MBI) is a psychological intervention that may benefit cortisol secretion and improve a positive mood state. However, it is unclear whether MBI could be used as a recovery tool for athletes' psychological status during half-time.

Purpose: The current study aimed to investigate the acute effect of the brief MBI during a half-time break in a simulative lab-based soccer protocol on athlete's mood and salivary cortisol concentration.
Method: In a single-blinded cross-over design, seventeen male college athletes (Age: 20.7 ± 3.2 yrs; Height: 175.1 ± 5.0 cm; Maximal oxygen consumption: 59.3 ± 5.0 ml/kg/min; Body mass index: 21.4 ± 2.2 kg per square meter) completed two main trials, i.e., MBI trial and control trial (CON). In each main trial, participants completed 45 mins of running protocol to simulate the typical activities in 45 min of a soccer game. The protocol lasted 15 min as one block (walking at 4 km/h, jogging at 12 km/h, cruising at 15 km/h, and sprinting at 19 km/h) and repeated 3 times consecutively. In the MBI trial, participants were required to breathe mindfully and focus on the body's feeling (i.e., body scan) according to audio guidance, whereas in the CON trial, participants were asked to listen to tourist audio with soothing music as background. The order of receiving the two trials was randomized. The mood state (i.e., Brunel mood scale) and salivary cortisol were measured at rest state before each main trial and after the intervention. Rating of perceived exertion was monitored for exercise intensity throughout the trial.
Result: (1) Salivary cortisol was reduced in posttest compared with pretest in the MBI trial (6.82 ± 2 vs. 4.95 ± 1.6 nmol/L, $P < 0.01$) but not in the CON trial (pre vs. post: 5.91 ± 1.44 vs. 5.94 ± 1.8 nmol/L). In addition, in the posttest, the salivary cortisol concentration in the MBI trial was lower than that in the CON trial (4.95 ± 1.6 vs. 5.94 ± 1.8 nmol/L, $P = 0.05$). (2) No significant differences were observed regarding mood state for both negative dimensions (fatigue, depression, tension, confusion, and anger) and positive dimension (vigor).
Conclusion: Findings of the current study revealed the effectiveness of a brief MBI on reducing salivary cortisol concentration during half-time of a simulative lab-based soccer protocol. However, the mood state was not affected by the brief MBI.
The work described in this study was substantially supported by the Dean's Research Fund of the Faculty of Liberal Arts and Social Sciences, The Education University of Hong Kong, Hong Kong Special Administrative Region, China (Project No. FLASS/DRF/IRS-2 04540). No conflict of interests should be disclosed.

e-poster not debated

PP-UD01

Biomechanics

USING TIME VARIABILITY BETWEEN TRIALS IN THE COGNITIVE TUG TEST TO PREDICT FALL RISK IN PD POPULATION

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INTRODUCTION:
People with Parkinson's Disease (PD) double the ratio of falls reported by community dwelling older adults, which results in an increased economic cost of healthcare systems and reduced quality of life of this population and their caregivers (1). Quite a few studies have been conducted on the use of the Timed Up and Go test (TUG) performed under different conditions as a predictor of fall risk (3,4). However, time variability between trials (TVBT) in the TUG has not been explored yet in PD population. Considering PD characteristics, we hypothesized that patients with a higher history of falls would show a higher TVBT during the TUG, both under single and dual-task conditions.
METHODS:
Thirty patients (21 men and 9 women) with confirmed idiopathic PD (Hoehn and Yahr scale: 1-3) performed three trials of the TUG under single condition (TUGs) and cognitive dual tasks conditions: Arithmetic calculations (TUGcac) and Verbal Fluency (TUGcvf). Participants were also evaluated regarding various aspects related to PD: modified Unified Parkinson Disease Rating Scale (III), the Spanish version of Freezing of Gait Questionnaire (FOG-Q), the short version of the Falls Efficacy Scale-International (short FES-I), Mini-Mental state examination, Trail Making Test, 10 m walk test and static posturography (sway area). Correlation and multiple stepwise regression analyses with backward selection were used to identify the variables related to fall risk. The history of falls (previous six months) was used as the dependent variable.
RESULTS:
TUGcvf showed higher correlation with the history of falls ($r=0.72$; $p<0.01$) compared to TUGs ($r=0.50$; $p<0.01$) and TUGcac ($r=0.66$; $p<0.01$). Time to perform the TUGcvf test, FES-I and TUGcvf-TVBT variables entered into the regression equation and were significantly related to the history of falls. A significant regression equation was found ($F(2,28) = 31.192$, $p < 0.001$), with an $R2$ of 0.684, thereby indicating that approximately 68.4% of the variance of the fall risk could be predicted by these variables. Interestingly, TUGcvf-TVBT variable explained 6.2% of the fall risk.
CONCLUSION:
As hypothesized, greater TBVT in TUGcvf was related to a higher risk of fall, and this variable helped to assess fall risk. Our results suggest the use of TVBT in the TUG performed under cognitive dual-task condition to improve the assessment of fall risk in PD patients.
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AN ANALYTICAL APPROACH TO THE UNDERSTANDING OF GRF GENERATION DURING HUMAN WALKING

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INTRODUCTION:
The physiomechanical tasks of accelerating the front and raising the center of mass during walking at constant speed are the primary sources of energy expenditure during walking (1). While variations in the production of anteroposterior forces result in de(accelerations), changes in vertical forces compared to the weight force are reflected in changes in the height of the center of mass during the step (2). Although these patterns are based on well-established principles derived from classical mechanics, how and at what stages of gait these adjustments occur are still unknown. We aimed to analytically study the kinetic compensatory determinants within and between steps in human gait.
METHODS:
Twelve individuals aged 65 years walked at self-selected speeds in a 20-meter corridor where 8 force platforms were located (placed in longitudinal pairs, 1000Hz, BTS). After filtering the data (Butterworth, low-pass 8Hz, 3rd order), we determined the times and impulses of the single and double stance (analyzed using separated and summed signals) of the step. We also calculated the percentage asymmetry between the production of negative and positive impulses (total and in phases) and between subsequent steps. We performed exploratory and correlational analyses (bivariate, Pearson, $p <00.5$) in the free software Jasp.
RESULTS:
There is a larger braking impulse at the stance phase, which is systematically compensated by a larger propulsion impulse in the double stance. Further, we observed greater asymmetries in the single stance phase with compensatory adjustments in the single stance phase of the subsequent step. In the most varying conditions in terms of breaking and propulsion impulse, the total production of anteroposterior impulse is larger ($r = 0.87$, $p = 0.002$).
CONCLUSION:
The greater propulsion during double stance suggests that the role of gastrocnemius previously determined (3) regulates this unbalance. Consequently, this asymmetry contributes to the subsequent phase (single stance), assisting in swinging the contralateral leg and pendular

transduction (4). Our results provide the primary evidence of specific responses and adjustments in the kinetic parameters of the locomotor system during normal gait.
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GLUTEUS MAXIMUS DELAYED ONSET MUSCLE SORENESS EFFECTS ON LOWER LIMB MUSCLE ACTIVITY AND BIOMECHANICS DURING SPRINTING

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INTRODUCTION:
Hamstring strain is likely to occur the first half of the stance phase in sprinting or during the late swing phase (1,2). In order to decelerate the lower limb, the hamstrings and gluteus maximus (Gmax) contract eccentrically during the late swing phase. Our hypothesis was that, when the Gmax becomes dysfunctional because of delayed onset muscle soreness (DOMS), hamstring works harder than usual, resulting in an increased risk of strain.
METHODS:
This study was conducted with a total of healthy 15 male undergraduate or graduate students (age 23.1±1.3years). On Day 1, before performing DOMS-causing exercises, and on Day 3, while participants were having DOMS in the Gmax, lower limb kinematics/kinetics and muscle activity data were recorded using a 3D motion analysis system and electromyography (EMG), respectively. we decided to record EMG and kinematics during the second half of the swing phase just prior to (130 ms) heel contact and kinetics during the stance phase.Data were analyzed and compared between Day 1 and 3.
RESULTS:
Hip flexion angle on Day 3 was significantly lower than that on Day 1, but the opposite was true for knee flexion angle ($P < .05$). Vastus medialis, biceps femoris (BF), and Gmax muscle activities on Day 3 were significantly higher than those on Day 1 ($P < .05$). Peak propulsive forces on Day 3 were significantly higher than those on Day 1 ($P < .05$).
CONCLUSION:
Kinematic changes such as decreased hip flexion angle and EMG changes such as increased BF EMG activity on Day 3 to compensate for the loss of function of the Gmax may lead to increasing hamstring workload and cause it to become fatigued more rapidly.
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FINGER-FLEXORS FORCE-FATIGUE DYNAMICS DURING AN INTERMITTENT ALL-OUT TEST: A PILOT STUDY COMPARING ADVANCED-CLIMBERS AND NON-CLIMBERS

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INTRODUCTION:
Rock climbing requires the use of repeated and intense contractions of the finger-flexors with short rest times. The ability to resist fatigue under these conditions is positively related to climbing performance1. Force-fatigue dynamics can be explored through an all-out test consisting in maximum intermittent contractions1. Knowing how climbing experience affects these fatigue dynamics could help practitioners and coaches in training scenarios. The aim of the present pilot study was to characterize the finger-flexors force-fatigue dynamics during an intermittent all-out test and to check the possible effect of the climbing experience.
METHODS:
The pilot study was conducted with 4 advanced-climbers2 and 6 non-climbers. A flat wooden climbing hold (20 mm deep) was attached to a force transducer mounted on a height adjustable metal frame. Participants applied force on the hold using a half-crimp grip during an intermittent all-out test consisting of 30 maximum contractions with a work:rest ratio of 7s:3s. A mean value for the 5 central seconds of each contraction was computed using filtered force data (Butterworth low-pass filter, 4th order, 10 Hz cut-off frequency). The mean-force values for each of the 30 contractions were computed. The maximum mean-force during the test (MF) was obtained and used to express the 30 mean-force values as MF percentages. These force values were fitted to a bi-segmental lineal regression model, determined by the least sum of squares. In addition to the MF, the force-fatigue dynamics of the participants were characterized by: (1) the Critical Force level (CF) computed as the average of the last 6 contractions1; (2) the energy store component (W') computed as the impulse integral above the CF1, which is an indicator of the isometric work capacity; (3) the slope of the initial fast-fatigue rate (SLOPE1); (4) the slope of the later slow-fatigue rate (SLOPE2); (5) the x-coordinate of the intersection (number of contraction) between the regression lines (Xint); and (6) the y-coordinate of the two regression lines intersection (force value) (Fint). Normality assumption was checked before performing unpaired T-tests to assess the climbing experience effect on the MF and force-fatigue dynamics.
RESULTS:
T-tests revealed greater MF ($p=0.005$), W' ($p<0.001$), and Fint ($p=0.017$) for climbers, while no significant differences were found for the other variables.
CONCLUSION:
These results support findings in other studies1 where climbing level was related to higher maximum finger strength and greater isometric work capacity. In addition, climbers performed at greater percentages of the MF at the end of the fast fatigue part of the test. These parameters, especially Fint which has not been used before, may be taken into account when assessing force-fatigue dynamics in climbers.
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EFFECTIVENESS OF MOTION ANALYSIS BY MEASUREMENTS DURING COMPETITIONS IN FENCING

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INTRODUCTION:
Most studies on biomechanics of fencing are lab-based experiments, and few studies evaluate movements measured during competitions [1]. Therefore, this study attempts a motion analysis by measurements during sabre fencing competitions. Due to this, participants were able to play bouts without requiring a specific movement, and the number of markers for recording movements was minimized. Then, the similar movements of the elite and the novice were compared.
METHODS:
The subjects were 5 sabre fencers, including elites and novices. Each participant played 5 times each with 4 opponents. 5 markers were attached to record movements: top of the head, instep of shoes on both feet, hand guard, sword tip. The center of gravity of the triangle formed by the three points of the head and both feet was defined the center of the body. The motion was recorded from the beginning to the end of the bout, and Two dimensional (2-D) kinematic parameters were quantified. In order to compare elites and novices, we selected bouts with similar cases. As a result, two bouts scored by a lunging movement from on-guard position, immediately after the "allez" signal, were selected for comparison.
RESULTS:
As a result of 2-D motion analysis, it was shown that the elites hand guard speed increased more rapidly than the novices just before the touch. The following three points can be considered as the factors for this.1) the speed of the center of the body peaked early in lunging movements in both the elite and the novice and then gradually slowed. The peak speed for the novice was higher than that for the elite, and then slowed down significantly over time. By contrast, the elite had a small change in speed, and the speed was maintained until just before the touch. As a result, the speed of the center of the body just before the touch was higher in the elite. 2) After landing of the lead foot, the distance from the center of the body to the hand guard in the novice changed little. By contrast, this distance in the elite continued to increase even after landing of the lead foot. Hence, it is suggested that the speed of the sword is increased by extending the armed upper limb at the end of the attack after landing the lead foot. 3) The novice attacked with the sword sticking out straight, and the elite attacked swinging from the side. It is reasonable to support that this wrist usage affected the acceleration of the hand guard just before the touch. However, due to the limitations of the analysis method (2-D motion analysis), this effect could not be quantified.
CONCLUSION:
This study provided effectiveness suggestions for practice. For future direction, it will be necessary to enlarge sample size and generalize the conclusions.
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CHRONOLOGICAL CHANGES IN VERTICAL JUMP PERFORMANCE AND SENSATION AFTER TRAMPOLINE JUMPING EXERCISE

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Introduction
When performing a vertical jump on a rigid surface shortly after engaging in a trampoline jumping exercise, individuals may experience a decrease in jump height and associated perceptual illusion. These motor and perceptual changes diminish by repeatedly performing vertical jumps on a rigid surface (1). However, the chronological recovering process from these motor and perceptual changes without jumping on a rigid surface remains unclear. Accordingly, we investigated the chronological changes in jump performance on a rigid surface and self-estimation of the jump performance after a trampoline jumping exercise.
Methods
Eight subjects performed vertical jumping on a rigid force plate before (Pre-Test) and after (Post-Test) completing a trampoline jumping exercise. In the Pre-Test, the subjects performed three vertical jumps and the experimenter told them their average jump height. Then, the subjects performed a trampoline jumping exercise 30 times. There were three conditions in terms of the time that elapsed between the end of the trampoline jumping exercise and the first vertical jump in the Post-Test (0 s, 30 s, and 60 s). In the Post-Test, the subjects performed five vertical jumps. Each time the subjects performed a vertical jump, they were asked to subjectively estimate their own performed vertical jump height based on the Pre-Test average height (EH: Estimated Height). They were not given feedback regarding the actual performed height (RH: Real Height). We calculated the rate of change of the RH and EH based on the Pre-Test average height ((Post - Pre) / Pre × 100). In our analysis, we focused on the first jump value from the Post-Test in each condition. We performed a one sample t-test with the change rate values to detect the change in jump height. Paired t-test were performed for the RH and EH in each condition to evaluate the differences between the two height types.
Results
In the 0 s condition, RH and EH significantly decreased (RH: -8.75 ± 1.85%, $p < 0.001$; EH: -6.77 ± 3.17%, $p < 0.001$). Although RH had recovered in the 30 s and 60 s conditions (30 s: -1.35 ± 3.70%, $p = 0.336$; 60 s: -1.49 ± 4.68%, $p = 0.399$), EH remained low (30 s: -5.98 ± 3.85%, $p = 0.003$; 60 s: -5.40 ± 1.96%, $p < 0.001$). Thus, we observed a significant dissociation between RH and EH in the 30 s and 60 s conditions ($p < 0.05$).
Discussion
Our data indicate that the amount of time between the trampoline jumping exercise and the vertical jump on a rigid surface had a strong effect on performance recovery. In contrast, it is suggested that recovery of the performance estimation based on proprioception after trampoline jumping exercise need more time because the self-estimation of the jump performance remain lower than the actual jump for at least 60 seconds.
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PELVIC AND TRUNK ROTATION ANGLE DIFFERENCE DURING THROWING MECHANICS IN ADOLESCENT BASEBALL PITCHER WITH DECREASED SHOULDER ABDUCTION ANGLE

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INTRODUCTION:
In growing baseball pitchers, poor pitching forms cause severe upper extremity injuries that cause pitching problems and result in long recovery times. tudies have shown that various biomechanical factors affect excessive cubitus valgus stress during pitching. As one of the causes of excessive cubitus valgus stress, a decrease in shoulder abduction angle, so-called "elbow lowering", is said to cause pitching disorders. Although the dynamics of the pelvis and trunk at the time of pitching are cited as factors in lowering the elbow, a certain view has not been obtained. Therefore, the purpose of this study was to investigate the characteristics of the rotation angle of the pelvis and trunk in kinematics in a growing baseball pitcher whose shoulder abduction angle decreased during pitching.
METHODS:
Thirty-nine junior high school and high school baseball pitchers (average age 14.0 ± 1.1 years) were participated in this study. Pelvic and trunk kinematics were measured by three wireless sensors of an magnetic and inertial measurement system in each phase. The wireless sensor units were placed on the center of episternum and sacrum. In the pitching attempt, the pitch was aimed at a target 18m away from the plate. For the analysis of the pitching motion, one pitch was analyzed after sufficient pitching practice. The pitches were classified into Knee high position (KHP), Foot Plant (FP), Maximum external rotation (MER), and Ball release (BR). The pitching time was normalized and the rotation angles of the pelvic and trunk was calculated. In addition, the difference between the pelvic rotation angle and the trunk rotation angle (hereinafter referred to as PR-TR) was extracted as a separate rotational movement between the pelvis and the trunk. The notation of the rotation angle is positive in the direction of the pitching side. Based on the shoulder-shoulder-elbow line in MER,0degrees or less was classified the elbow lowering group, and 0 degrees or more was classified the normal group. Statistical analysis was performed using the student t-test and the pearson correlation. The level of significance was set at $p<0.05$.
RESULTS:
Of the 39 cases, 20 were in the elbow-lowering group and 19 were in the normal group. The shoulder abduction angle at MER was significantly lower in the elbow lowering group (-6.54 ° ± 5.09) than in the normal group (3.95 ° ± 4.36). In PR-TR during MER, the elbow lowering group was significantly lower (elbow lowering group: 10.41 ° ± 17.9, normal group: 21.84 ° ± 13.35). In addition, a positive correlation was found between PR-TR during MER and shoulder abduction angle.
CONCLUSION:
In athletes with a decrease in shoulder abduction angle, so-called elbow lowering, PR-TR during MER is significantly low, so it is possible to shift to BR with insufficient separation movement of pelvis and trunk rotation Conceivable. In addition, PR-TR is related to the abduction angle of the shoulder during MER, suggesting that the smaller the PR-TR, the lower the abduction angle of the shoulder.

NEW TECHNIQUE OF GIANT SWING BACKWARD OF HORIZONTAL BAR

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INTRODUCTION:
Giant swing backward is one of the most important skills in the horizontal Bar in gymnastics. This is because basic technical elements of all high level skills in the horizontal Bar are required in giant swing backward (Kaneko, 2000). It is well known both in and out of Japan that the bend technique is a basic technique included in giant swing backward. This technique allows an increase in rotational acceleration by widely and largely bending each joints of the body during the pull-up phase. It is especially important to use shoulder joints in large extent and it is necessary to relax shoulders.
On the other hand, Fusuke Maeda who has scored higher than the world best record in Japanese national championship reported that it is important not to relax shoulders during pull-up phase of giant swing backward and performers should tolerate instead. The aim of the current study is to examine the effectiveness of motion sensation which Maeda has reported.
METHODS:
Maeda was interviewed repetitively between June 2018 and October 2020 and analysis took place based on phenomenological movement theory which was suggested by Kaneko (2005).
RESULTS:
Below is the summary of Maeda's report regarding pull-up phase during giant swing backward.
1. Perform by leaning pelvis back, tolerate and do not relax shoulders, move shoulders and toes backwards, and move chest and pelvis forward.
2. Perform 1 when the performer moves toes away from the horizontal Bar.
3. y performing the movements in 1, body gains tension like flicking fingers.
4. By performing 1-3, the performers can gain maximum reaction of the bar and accelerate forward.
5. By accelerating forward, the horizontal Bar will bend largely and the performer can maximize rotational acceleration.
CONCLUSION:
Being conscious to tolerate rather than relaxing shoulders is emphasized because relaxations of shoulders are practiced many times during younger age that it is performed unconsciously. When shoulders are relaxed, the movements become powerless and body loses tension that the performers cannot bend the horizontal Bar and gain reactions.A high level skill like Kovacs includes double salto which requires extreme joints movements and produces two bends of horizontal Bar during pull-up phase.By performing the movements in 1-3, reactions from bend can be gained and it allows the body to accelerate forward. This acceleration is useful to increase the bend of horizontal Bar and it is assumed that the increased bend creates a faster rotational acceleration.

COMPARISON OF THROWING MOTION FOR ELITE MALE ATHLETES USING THE ROTATIONAL TECHNIQUE IN THE SHOT PUT AND DISCUS THROW

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INTRODUCTION:

This study focuses on the rotational technique used in the shot put (hereinafter referred to as “SP”) and discus throw (hereinafter referred to as “DT”), two events which, excepting the arms, require similar movements.
METHODS:
We conducted a biomechanical analysis of the rotational technique used by first-class athletes in the SP and DT to compare the rotational technique of the same individual in both events. The results of the study provide the following technical implications.
RESULTS:
Firstly, when comparing the stance width during each phase, a difference was observed between the DT and the SP stance width when the power position was held (SP 0.70m, DT 0.89m), which suggests that the adjustment of the stance width when the power position is held is related to adaptation to the size of the circle diameter (SP 2.135m, DT 2.500m).
Secondly, with regard to the change to the center of gravity velocity, while there was an increase in the center of gravity velocity during the second turn phase in the DT, a decrease in the center of gravity velocity during the second turn phase was observed in the SP. Translational movement in the direction of the throw weakened during the second turn phase in the SP, which may indicate that the movement was converted into rotational motion.
Thirdly, when studying the changes in the torsos angle of torsion, it was established that athletes actively twisted their torsos during the first turn phase of the SP and the aerial phase of the DT. During the second turn phase, which is a core technique to both events, there was a markedly larger angle of torsion in the torso in the DT (SP 54.2°, DT 69.1°).
CONCLUSION:
During the throw phase in the SP, the left foot was grounded close to when the largest angle of torsion occurred, while in the DT, the torso had somewhat twisted back from largest angle of torsion when the left foot approached the ground. In the SP, the timing of the left foot grounding state was a clear transition point toward the delivery phase, while in the DT, it is highly likely that the torso had begun to twist back before the left foot was grounded, and the acceleration began earlier than in the SP in advance of the delivery phase.
Through comparison of the two events, we were able to comprehend the characteristics of different movements and gain useful expertise for the purposes of coaching.

Coaching

PSYCHOMOTOR EFFECTS OF DIFFERENT TEACHING STYLES

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INTRODUCTION:
Nowadasy the PE teacher can often face the phenomenon that students ’enthusiasm for physical education has greatly diminished. The possibility of exercise alone is no longer a motivating factor for many students to be active in lesson. The extent to which the child is willing to make an effort for better performance, the teachers teaching style and methods play a decisive role. Comparing direct, teacher-centered and indirect, learner-centered teaching styles, we examined the students attitudes, motivations and physical activities related to physical education classes
METHODS:
The subject of the research was a comparison of teacher-centered and learner-centered teaching style. The research was carried out among the students of the János Neumann Primary School in Szombathely (n=46). The class 8.A (n=23) teacher-centred, the class 8.B (n=23) learner-centred methods were taught from the beginning of the school year. Pupils attitudes towards physical education were examined using a PASSES questionnaire, once at the beginning of the school year and once at the end of the research. Lesson activity was measured in 3 lessons, with accelerometer.
RESULTS:
The presented results are based on the questionnaire measurement of the students. By the first measurement, class B showed a significantly higher value compared to class A. During the output measurement, the teacher support value of class A improved greatly, in the case of class B a deterioration was observed. During performance measurement, Class A students showed significantly higher values. Time spent in MVPA (medium and lively activity zone) for class A was 24,28 min, for class B 19,74. min. The time in MVPA for Class A was on average 53.97% of the the lesson measured, for class B only 43,52%.
CONCLUSION:
Our results demonstrate that student-centered education initially unknown to the students, if these teaching methods are not consciously, gradually incorporated into the methodology of the lessons. Another serious influencing factor is the nature of the class community, because the essence of student-centered education is that students are able to learn from and with each other. Its positive effects can only occur in the long run, and perhaps a periodic deterioration can also be observed. However, this does not show the shortcomings of learner-centered teaching methods. All that matters is that we gradually begin to apply these methods in education.
Keywords: student-centered teaching style, teacher-centered teaching style, PASSES- questionnaire accelerometer, physical activity, PE .

SPORTS TRAINING: PLANNING METHODS, METHODOLOGICAL PRACTICES AND LOAD MANAGEMENT IN BASKETBALL, SOCCER, FUTSAL AND TENNIS.

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INTRODUCTION:
In recent decades, sports science has undergone great changes, providing an important framework of scientific evidence on training methodology (1). Much of the researchers efforts have been focused on studying the most effective strategies to reduce injury risk (2). Among these, the load management in training and competition, fatigue monitoring (3) or strength training (4) stand out. Therefore, the aim of the present study was to provide information on methodological training practices as well as on workload control and fatigue monitoring methods that are used in four of the most popular sports worldwide.
METHODS:
261 coaches and physical trainers from 20 different countries (Argentina, Australia, Azerbaijan, Chile, China, Colombia, Ecuador, Spain, United States of America, Finland, France, Mexico, Monaco, Norway, Portugal, United Kingdom, Dominican Republic, Serbia, Switzerland

and Vietnam) participated in the study by answering an online survey. The survey design and distribution were carried out through the online platform Qualtrics XM (Utah, United States). Chi Square test was used to evaluate the potential differences.
RESULTS:
Short-term planning, based on the weekly microcycle, is by far the most widely used in soccer (84.2%), basketball (66.7%) and futsal (66.7%). Block periodization (47.8%) and classical periodization (30.4%) are much more frequent in tennis. There are no differences between sports in relation to the frequency with which they incorporate non-specific or complementary training (p=0.533). In all cases it was carried out between 1 and 2 days a week. However, we find significant differences in the time allocated to non-specific training in each of those sessions (p=0.000). In basketball and tennis they usually spend between 30 and 45 minutes while in soccer and futsal this time is between 10 and 30 minutes. Strength training is the main non-specific content in all sports. However, while in basketball, soccer, and futsal, strength training is incorporated in approximately 90% of teams, in the case of tennis it is only used with 65% of athletes. GPS and LPS are more used in soccer and tennis than in basketball and, especially, in futsal (p=0.001). Similarly, differences also appear in the use of RPE (p=0.002), very common in soccer, but only used with 50% of tennis players. Likewise, the use of video tools during training is much higher in tennis than in the other disciplines, especially soccer and basketball (p = 0.008).
CONCLUSION:
There are differences in planning models, in methodological proposals, and in load management and fatigue monitoring methods according to sport.
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IS THERE AN ASSOCIATION BETWEEN WALL-PASS SKILLS AND SPORT EXPERIENCE, PAST BASKETBALL EXPERIENCE, GENDER AND STANDING HEIGHT?

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INTRODUCTION:
Skill tests have been used in basketball PE classes even in sport science major courses to provide fundamental basketball skills. However, since students play/train in their own sport events, that might impact on the measurements in those skill tests. At the same time, past experience of playing basketball, such as mini-basketball (basketball specific to elementary school boys and girls in Japan), gender and standing height may also affect these tests. Grading should be conducted while considering these influences if these have an impact on measurements in skill tests in addition to the learning effect from PE classes. Thus, the present study examined this association between wall-pass skills and sport experience, past basketball experience, gender and standing height.
METHODS:
The subjects were 244 F-university students (71 males and 73 females) who took basketball PE classes. They were asked to undergo a wall-pass skill test four times. In the wall passing, they gave a push pass directed to a concrete-make wall eight feet away, caught its rebound, and gave a push pass again as quickly as possible. This was repeated 15 times. Simultaneously, they were asked about the sport clubs to which they belong, their gender, their standing height, the number of years of experience they have had in playing basketball in elementary, junior high and high school. The sport clubs were categorized into four: basketball, ball games other than basketball, sport events other than ball games and no club. However, since students who play an identical sport event play/train the same exercise/training, and individuals are nested in sport clubs, which are nested in four categories, the mixed linear mode was used by using them as a random effect.
RESULTS:
The comparison of deviance with the NULL model with only random effects (deviance = 4350.9) and the FULL mode adding fixed effects in addition to the NULL model (deviance = 4229.8) showed a significant fit (chi-squared = 121.49, df = 5, $p<0.001$). The estimated variances of the random effect were 3.603 in individuals, 1.020 in sport clubs, 0.487 in sport categories and 3.207 in residuals. This revealed a 0.1% significant difference in individuals and sport clubs, but not in the sport categories. Namely, this wall passing skill can be considered to be influenced by individuals and sport clubs, but not by categories. The partial regression coefficients were -2.900 in males (as that of females is a reference variable, it was set to 0.0), -0.018 in standing height, -0.197 in basketball experience in elementary school, -0.057 in basketball experience in junior high school and -0.261 in basketball experience in high school. This indicates a significant relationship with standing height (to =-8.789, df=227, $p<0.001$).
CONCLUSION:
Wall passing is greatly influenced by standing height while also being affected by individuals and sport clubs.

5-A- SIDE GAME AS A TOOL FOR THE COACH IN SOCCER TRAINING

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INTRODUCTION:
It is essential that coaches have a broad perspective to fully understand the stimuli imposed on players during the execution of Small side games in soccer (SSGs). In fact, the physical responses resulting from training can be influenced by the interaction of several variables during the performance of different SSGs formats. For this reason, it is relevant to understand how the manipulation of variables such as training method, exercise duration, number of repetitions or recovery time affect training load responses and performance. The main objective of this work was to provide coaches with relevant theoretical aspects and examples of practical applications that can be used from a specific SSGs format (i.e., 5-a-sided).
METHODS:
The search strategy used to guarantee the quality of articles, comprised search terms specifically related to the research topic.
The search strategy comprised search terms that combined one of the 2 primary keywords (“soccer” or “football”) with a second keyword (“small side games” or “small and conditioned
games”), with a third keyword (“recovery time,” “training load,” “continuous method,” “fractionated method”) and a fourth keyword (“5-a-side”)
RESULTS:

The results showed that, during the 5-a-side game, the format to choose the training method (i.e., continuous or fractional) and the manipulation of related variables (e.g., number of players, game format and recovery time) are fundamental for training load management.
CONCLUSION:
The manipulation of the variables in the 5-a-side format results in significant variations in the training load and in the probable improvement of the different domains of soccer training (i.e., physiological, technical and tactical), evidencing several benefits in the use of this specific game format. In addition, practical examples of 5-a-side exercises have been prescribed based on the theoretical considerations described. Whatever the choice of SSGs format, it should always consider the goals of the coach depending on the period of the season, training session and the goals proposed to the team in the different training domains.

Disabilities

PHYSICAL ACTIVITY LEVEL AND PHYSICAL STATE OF PEOPLE WITH INTELLECTUAL DISABILITIES AFTER HOME CONFINEMENT CAUSED BY COVID-19.

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INTRODUCTION:
Physical activity (PA) levels of the population decreased during the period of home confinement caused by COVID-19 pandemic. This situation had a more pronounced impact on certain sectors of the population, especially people with disabilities. During this period, people with intellectual disabilities (ID) significantly decreased their activity levels, with significant repercussions on their physical and cognitive health (1). To the best of our knowledge, post-confinement studies in this population have only used questionnaires and not field physical tests. The present study aims to analyse the impact of home confinement on the physical condition and level of PA in people with ID.
METHODS:
20 participants (10 men and 10 women; 37.30±9.96 years) with ID from an Occupational Centre were recruited. Previously, their relatives were informed and signed a participation consent. The level of daily PA was determined using the IPAQ questionnaires. Agility was evaluated with the Timed up and Go Test (TUG), strength of the lower limbs with the 30 seconds Chair Stands Test (30s-CST) and upper limb strength with a manual dynamometer.
RESULTS:
Participants showed low PA levels and physical condition. In fact, 50% of participants only exercised when they were in the occupational centre, and given the impossibility of attending it during confinement, this could be the reason why the results showed that 85% of participants reported low PA levels (<600 Mets-min/week). The remain 15% obtained moderate PA levels (600 Mets-min/week). These low levels were reflected in the physical condition (TUG=13.04±4.56 seconds; 30s-CST=9.73±3.30 repetitions; HG-right=15.13±5.20 Kg and HG-left=11.82±4.85 Kg).
CONCLUSION:
Comparing our results with prior studies to confinement in ID people, we observed a negative difference of 72.71% in the TUG and of 10.81%in the 30s-CST (2). Furthermore, grip strength was lower in both hands in men (right=47.84%; left=58.30%) and women (right=19.82%; left=13.68%) (3). PA levels and physical condition seem to be negatively affected after confinement. It would be advisable to provide them with educational resources and strategies to increase the practice of PA outside the occupational centre.
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THE SHORT PHYSICAL PERFORMANCE BATTERY FOR ADULTS WITH INTELLECTUAL DISABILITY: A STUDY OF RELIABILITY

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INTRODUCTION:
People with intellectual disability (ID) age prematurely, showing early signs of aging in their 40's and 50's. Consequently, their lower physical capacity and musculoskeletal disability, among others, are similar to people older than 60 years old without ID (1). Short Physical Performance Battery (SPPB) is almost the most common measure for the analysis of physical performance in the elderly (2). The aim of this study is to determine the reliability of the SPPB among older adults with ID without Down Syndrome (DS) between 40 to 65 years old, and its correlations with anthropometrics measures and other physical performance tests.
METHODS:
20 subjects aged 40 to 65 years (10 men, 10 women) with ID without DS were recruited from an occupational center. IRB, informed consent from parents/legal tutors, and informed assent were obtained. The SPPB test (including balance, gait speed and standing up from chair assessments) was administered to all participants. Anthropometric measures, hang-grip and leg extension and flexion strength test were also applied, as well as their ID level was obtained. Reliability was analyzed performing 3 test sets with a 1/2-day interval between assessments. In each set participants perform 3 repetitions of each test. Descriptive and Pearson correlations were calculated for all variables.
RESULTS:
The total SPPB mean of the 3 sets was 10.80 ± 1.06. Gait speed mean was 3.27 ± 0.53s and standing up from chair 9.81 ± 7.73s. Reliability of the global SPPB was high: 0.86 (CI95%: 0.71-0.94). The reliability was high for the components of balance, 0.79 (95%CI: 0.60-0.91) and for standing up from chair, 0.91 (95%CI: 0.81-0.96). The reliability for the gait speed component was not assessed because its variance was 0. Gait speed component is negatively correlated with knee extension and flexion strength (-0.46, $p<0.05$ and -0.46, $p<0.05$ respectively). Body mass index (BMI) is positively correlated with tandem balance performance (0.45, $p<0.05$).
CONCLUSION:

People with better results in leg strength perform better in gait speed and people with higher BMI last more time in tandem position. Despite the SPPB test is reliable to assess physical performance among older adults with ID, without DS, it is not clear its usage in clinical applications and populations studies.
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AGE OF PEAK PERFORMANCE IN ELITE PARA POWERLIFTERS

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INTRODUCTION:
Age of peak performance (APP) and athletic longevity are important considerations when patients with disabilities select an adaptive sport. Generally, power-based sports have lower APP than endurance events [1]. However, the APP of para powerlifting has not been investigated. The purpose of this study was to evaluate APP and duration of maintained performance of elite male and female para powerlifters. We hypothesized that athletes of both genders would have relatively late APP and maintain elite performance for several years.
METHODS:
The best annual performances from 2009–2021 of 1183 male and 481 female elite para powerlifters (composed of 5494 unique events) were collected from the World Para Powerlifting Ranking IPC database. Additional information collected included: year of event, year of birth, bodyweight, weight class, and rank. Best lifts were converted to Wilks to control for athlete bodyweight. Ages of athletes ranked in the top 3 of their weight class (T-3) were compared over time and with lower-ranked athletes using 1-way ANOVA and unpaired t-tests, respectively. APP for each gender was determined using a cubic regression model.
RESULTS:
The age of T-3 male athletes has increased significantly from 32.3 years old (yo) to 36 yo from 2009–2020 ($p<.0001$). Furthermore, the ages of T-3 male athletes (33.2±6.3 yo) were not significantly different compared to lower ranked athletes (33.2±9.3 yo) ($p=.92$). However, T-3 female athletes were significantly younger (33.3±7.4 yo) than lower ranked athletes (34.5±9.8 yo) ($p=.022$), and the age of T-3 lifters has not significantly changed from 2009-2020 ($p=.34$). The age of peak performance for males was 33 yo ($r^2=.14$), with 95% of peak performance maintained until 41.5 yo. APP in females was 32 yo ($r^2=.06$) with 95% of peak performance maintained until 40.6 yo.
CONCLUSION:
Elite para powerlifters have late APPs and slow regression of strength, suggesting that high levels of performance can be achieved late into their athletic careers. As such, para powerlifting is a promising option for adaptive athletes interested in life-long physical activity.
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CONCORDANCE BETWEEN SUBJECTIVE AND OBJECTIVE DECISION TREES TO PRESCRIBE AN ADAPTED PHYSICAL ACTIVITY PROGRAM TO OLDER ADULTS FOLLOWED IN GERIATRIC OUTPATIENTS CLINICS

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INTRODUCTION:
Functional capacities (balance, gait parameters) and muscle function (mass, strength, power or quality) decline with age, sedentary lifestyle, illnesses and are important predictors of physical autonomy and quality of life. The extent of these changes can be attenuated through physical activity practice. Assessing objectively these physical parameters require space and trained personals to be perform. In addition, Geriatric evaluations in Outpatient Clinic (GOC) necessitate to address numerous health problems which are already time consuming to evaluate for clinicians and exhausting for patients. One solution to face these barriers is to use short but validated questionnaires to identify mobility profile. Thereafter, one might prescribe adapted physical Activity (PA) program to patients, but tools are lacking and so, are poorly integrated in standard geriatric care. We aimed to explore if a tool called "PACE", co-created with MDs, patients, kinesiologists and physiotherapists help physicians to prescribe PA program in GOC.
METHODS:
To prescribe PA programs, physicians used a subjective decisional tree including 12 questions divided into 4 categories (walking speed, cardio-muscular, balance and trunk mobility). In parallel and later on, kinesiologists used an objective decisional tree including 4 tests (30s sit-to-stand, balance test, Functional Reach Test; 4-m normal walk test) to establish a mobility profile. The score obtained with the decisional trees are related to a specific physical activity program (1/35). During the first month, among 110 patients evaluated at a GOC, 40 were eligible (92%: age>65yrs + no-rehabilitation treatment + no contraindication to exercise) and 37 received a prescription and accepted to perform these exercises at home every day for 12 weeks (33%).
RESULTS:
First, implementing physical activity prescriptions in GOCs seems possible and feasible using PACE (Standard care:0 vs PACE:33%). Our subjective decisional tree demonstrated a 50% agreement with our objective decisional tree since 50% of the prescription remained the same but 50% needed to be change accounting for safety issue. More specifically, the agreement between both decisional trees seemed related to lower limb muscle strength and cardiorespiratory profile estimated using the 30-sec chair test and the questions "Are you able to get up from your chair by yourself ?", "Are you able to climb stairs alone without a break ?" and "Are you able to walk ten steps carrying a shopping bag ?"
CONCLUSION:
These pilot results (prototyping phase) are important in helping us to identify pitfall, discrepancies between respondent (patient/caregiver/physician), modality (in-person/phone), misleading questions etc.) to further improve the PACE tool . Overall, finding a specific, adapted and accepted pragmatic tool to promote physical activity prescription in GOCs is relevant in order to improve the health / life trajectory of older adults.

Health and Fitness

CONTINUOUS AND INTERVAL TRAINING ATTENUATE ENCEPHALOMYELITIS BY SEPARATE IMMUNOMODULATORY MECHANISMS

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INTRODUCTION:
Studies have reported beneficial effects of exercise training on autoimmunity, and specifically on multiple sclerosis (MS) and experimental autoimmune encephalomyelitis (EAE). However, it is unknown whether different training paradigms affect disease course via shared or separate mechanisms.
Objective: To compare the effects and mechanism of immune modulation of high intensity continuous training (HICT) versus high intensity interval training (HIIT) on systemic autoimmunity in EAE.
METHODS:
We used the proteolipid protein (PLP)-induced transfer EAE model to examine training effects on the systemic autoimmune response. Healthy mice performed HICT or HIIT by running on a treadmill. Lymph-node (LN)-T cells from PLP-immunized trained- versus sedentary donor mice were transferred to na€ıve recipients and EAE clinical and pathological severity were assessed. LN cells derived from donor trained and sedentary PLP-immunized mice were analyzed in vitro for Tcell activation and proliferation, immune cell profiling, and cytokine mRNA levels and cytokine secretion measurements.
RESULTS:
Both HICT and HIIT attenuated the encephalitogenicity of PLP-reactive T cells, as indicated by reduced EAE clinical severity and inflammation and tissue pathology in the central nervous system, following their transfer into recipient mice. HICT caused a marked inhibition of PLP-induced T-cell proliferation without affecting the T-cell profile. In contrast, HIIT did not alter T-cell proliferation, but rather inhibited polarization of T cells into T-helper 1 and T-helper 17 autoreactive populations.
CONCLUSION:
HICT and HIIT attenuate systemic autoimmunity and T cell encephalitogenicity by distinct immunomodulatory mechanisms.

AGE-RELATED CHANGES IN MUSCLE MASS AND ECHO INTENSITY OF LOWER LIMB MUSCLES: A LONGITUDINAL STUDY

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INTRODUCTION:
Muscle strength has been influenced not only by muscle mass but also by muscle quality, that is, the proportion of non-contractile tissue such as intramuscular fibrous and adipose tissue. Therefore, it is important to understand the age-related changes in muscle characteristics such as muscle mass and quality to develop an evidence-based approach for improving muscle performance. Several cross-sectional studies have shown that age-related changes in muscle quality may occur at an earlier age than loss of muscle mass. Ota et al. (2020) demonstrated that age-related decreases in muscle mass of the rectus abdominis and external oblique muscles occur after 50 years of age, whereas age-related changes in muscle quality which were measured by echo intensity occur after 30 years of age. Thus, age-related changes in muscle mass and echo intensity have been reported in cross-sectional studies. However, no longitudinal study has focused on age-related changes in muscle characteristics including various lower limb muscles. We investigated the age-related changes in muscle mass and echo intensity of lower limb muscles in longitudinal study.
METHODS:
The subjects comprised 37 healthy women (aged 43.1±13.6 years). Subjects with physical dysfunctions that could potentially influence measurements such as acute neurological and severe musculoskeletal impairments, were excluded.
Muscle thickness of the rectus femoris, vastus lateralis, vastus intermedius, biceps femoris, gastrocnemius, soleus, and tibialis anterior muscles was measured as an index of muscle mass using a real-time B-mode ultrasound device. We also evaluated echo intensity on ultrasonography images as a muscle quality index. Enhanced echo intensity indicates changes in muscle quality due to increased intramuscular fibrous and adipose tissue, that is, non-contractile tissue in the muscle. Muscle thicknesses and echo intensity were assessed before and after 2-year period. Differences in muscle thickness and echo intensity between baseline and after 2 years were examined using a paired t-test.
RESULTS:
After 2 years, a significant decrease in muscle thickness was observed only in the tibialis anterior muscle compared to baseline. There were no significant differences in the thickness of the rectus femoris, vastus lateralis, vastus intermedius, biceps femoris, gastrocnemius, and soleus muscles. As for the echo intensity, a significant increase was observed in all muscles after 2 years.
CONCLUSION:
This longitudinal study showed that age-related muscle atrophy was greatest for the tibialis anterior muscle among lower limb muscles. Additionally, our findings suggest that the proportion of non-contractile tissue such as intramuscular fat may be more susceptible to aging than muscle atrophy.
Ota M, et al. Age-related changes in muscle thickness and echo intensity of trunk muscles in healthy women: Comparison of 20s to 60s age groups. Eur J Appl Physiol 120:1805–1814, 2020

PHYSICAL ACTIVITY PATTERNS AND MEDITERRANEAN DIET ADHERENCE IN FAFE ACTIVE ELDERLY: A PILOT STUDY.

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INTRODUCTION:

Healthy aging is a multi-dimensional concept, in which diet and exercise seem to play a major role. Engage in exercise programs has been related with other lifestyle behaviors. Therefore, the aim of this study was understood physical activity patterns and Mediterranean diet adherence in Fafe active elderly.
METHODS:
Thirty-five subjects with 66.5 years old that engage Fafe city hall physical activity programs were selected for the current study. Physical activity was evaluated through Pam Coach Monitor and data was recorded for 5 days (including 2 weekend days). Mediterranean diet adherence was obtained through Prevencíon com Dieta Mediterránea (PREDIMED) questionnaire.
RESULTS:
Elderly subjects showed a good adherence to Mediterranean diet (9.8±1,7), namely 100% of subjects used olive oil, 80% and 60% consumed fruits and vegetables, respectively. Nevertheless, dairy products consume was lower (14,3%) and sweet deserts was to high (48,6%) regarding healthy diet guidelines. Accelerometer data shown that subjects spent 77,87% of their daily time in light activities, 21,98% in moderate and 0,15% in vigorous. Moreover, subjects stay almost the time in 20-30 pam score, which define them as active.
CONCLUSION:
In general, Fafe active elderly accomplish the guidelines related with Mediterranean diet, which suggest that physical active programs may improve other health-related lifestyle behaviors. Although, the observed light physical activity patterns were early described for elderly, it's important to highlight that moderate intensity in physical activity programs should be encourage, since it has been related with higher health benefits.

CARDIORESPIRATORY FITNESS EXERCISE PRESCRIPTION IN ELDERLY BASED ON BP NEURAL NETWORK

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INTRODUCTION:
Cardiorespiratory fitness (CRF) declines as age increases in elderly. An individualized CRF exercise prescription can maintain the CRF level and delay aging process. Traditional exercise prescriptions are general and lack of individualization. In this study, we proposed to use a backpropagation (BP) neural network to create individualized CRF exercise prescriptions for elderly people.
METHODS:
First, we screened research through various databases and collected basic information about elderly (eg, age, sex, BMI, VO2max initial value, improvement) as potential inputs. In order to accurately extract the information needed to build the model, we have performed reasonable preprocessing of the key indicators in the basic information, including data expansion and coding. The BP neural network was built and trained in MATLAB. In our study, Bayesian regularized artificial neural networks (BRANNs) is applied to improve our BPNN algorithm. Cross-validation is an appropriate method to divide the data into training and testing. We use cross-validation to observe the performance of the model. For the evaluation of the prediction model, we selected three evaluation indicators, Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R-squared (R2) to evaluate the accuracy rate of the exercise prescription elements prediction model.
RESULTS:
The model consists of 8 layers BP neural network and the structure is 5-6×10-3. By inputting the basic information of elderly after exercise evaluation and the expected improvement degree of CRF, this model can generate a suitable exercise prescription. After expanding the collected data, an evaluation system for evaluating the sample cardiopulmonary health (VO2max) is obtained through machine learning and modeling. The experimental results indicate that the exercise prescription predicted by our proposed model closely follows the real exercise prescription. The best of RMSE of this BP neural network is 0.089 in intensity set, 0.873 in time set, 1.089 in volume set. Similarly, the best of MAE of this network are 0.065 in intensity set, 0.588 in time set, 0.628 in volume set. Besides, the average R2 are all above 0.99Our model provides a convenient solution for future elderly health exercise.
CONCLUSION:
This work demonstrates the potential of the BP neural network model in predicting individualized sports for elderly. The advantages of the BPNN model come from the capacity to learn input data at multiple spatial and temporal levels of abstraction. In summary, our study proposed in this paper provides an innovative and effective solution for the health exercise of elderly.

EFFECTS OF ACUTE HIGH-INTENSITY INTERMITTENT EXERCISE ON BLOOD PRESSURE AND ARTERIAL STIFFNESS IN POST-MENOPAUSAL WOMEN WITH DIFFERENT ACE GENOTYPE

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INTRODUCTION:
Purpose: The present study aimed to investigate the effects of an acute high-intensity intermittent jumping exercise on blood pressure (BP) and arterial stiffness in postmenopausal women with different angiotensin-converting enzyme (ACE) genotypes.
METHODS:
We recruited 100 postmenopausal women (62.3±6.05 years old), and divided into deletion/deletion (DD, n=12) genotype and insertion/insertion/insertion/deletion (II/ID, n= 88) genotype. The participants performed 12 sessions of 30 seconds 75% heart rate reserve (HRR) ± 2 beat per minutes (bpm) jumping and 60 seconds 50% HRR ± 5 bpm walking. In addition, 3 sets of upper limb resistance exercises (20 seconds triceps exercises/10 seconds recovery, 20 seconds latissimus dorsi exercises/10 seconds recovery) were performed as fast as possible. We analyzed ACE genotype from the oral mucosa sample before exercise. Heart rate (HR), BP, and rating of exertion (RPE) were performed before and at immediate, 10th, and 45th minutes after exercise. Brachial-ankle pulse wave velocity (baPWV) was performed before and after exercise (during 60-120th minutes).
RESULTS:
The decreased level of resting HR in DD was significantly higher than that of II/ID when entering the water from land (-9.6 ± 4.14 vs. -6.7 ± 4.25 bpm, $p < .05$). The SBP increased of DD was significantly higher than that of II/ID immediately after exercise (25.7 ± 12.60 vs. 14.9 ± 14.52 mmHg, $p < .05$). The SBP decreased of DD at 45 minutes after exercise was lower than that of II/ID (-5.4 ± 14.34 vs. -13.8 ± 12.61 mmHg, $p < .05$). There was no significant difference between DD and II/ID in the changes of baPWV after exercise (59.3 ± 112.27 vs. 23.4 ± 97.00 cm/s, $p > .05$).
CONCLUSION:

Compared with II/ID, the postmenopausal women with DD had a significantly decreased resting HR in water, a higher increased level in SBP immediately after exercise, and a lower decreased level in SBP at 45 minutes after exercise.

DIFFERENCES IN CARDIOVASCULAR AUTONOMIC CONTROL DUE HYPERTENSION IN PREMENOPAUSAL WOMEN– THE ROLE OF AEROBIC PHYSICAL TRAINING.

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INTRODUCTION:
Systemic arterial hypertension in men is characterized by cardiovascular autonomic impairments that contribute to the worsening of the disease, and aerobic physical exercise have fundamental importance to attenuate these impairments. However, in normotensive women, ovarian hormones seem to positively influence cardiovascular autonomic control. In this case, we do not know whether these hormones also offer greater protection in hypertension, as well as the role of aerobic exercise on cardiovascular autonomic control in these conditions. We aimed to investigate whether hypertensive women, before menopause, presented a reduction in heart rate variability (HRV), blood pressure variability (BPV) and baroreflex sensitivity (BRS) compared with age-matched normotensive women. We also investigated whether aerobic exercise has beneficial effects on these parameters.
METHODS:
Thirty-two before menopause women (age 41 ± 4), were assigned into two groups (n=16 each): normotensive (NT) and hypertensive (HT). We evaluated hemodynamic, metabolic, and cardiovascular autonomic control, before and after 16 weeks of aerobic physical exercise. HRV and BPV were evaluated by spectral analysis and BRS by sequence method. The training session lasted 60 minutes, 3 times per week, the intensity was calculated by the sum of heart rate (HR) at rest and 70-80% of reserve HR. Statistical analysis was performed two-way ANOVA to compare hypertension and aerobic physical exercise factors.
RESULTS:
HT women showed increased weight, body mass index, heart rate and mean blood pressure (MBP) and reduced VO2peak than NT. While the exercise improved VO2peak (NT: 35 ± 4 vs. 46 ± 3; HT: 29 ± 5 vs. 37 ± 8, $p<0.001$) and the MBP (NT: 84 ± 10 vs. 78 ± 7 vs. HT: 87 ± 7 vs. 82 ± 7, $p<0.01$). The HRV results showed that hypertension impaired variance (NT: 2346 ± 1260 vs. HT: 1003 ± 636, $p<0.001$), low-frequency (NT: 719 ± 418 vs. HT: 220 ± 102, $p<0.001$) and high-frequency (NT: 1057 ± 766 vs. HT: 385 ± 390, $p<0.001$) bands in absolute units, but not influence the parameter in normalized units, LF (NT: 44 ± 15 vs. HT: 49 ± 20, $p=0.48$) and HF (NT: 56 ± 15 vs. HT 52 ± 20, $p=0.48$). Whereas aerobic physical training did not improve these values. BPV neither hypertension nor physical training influences the parameters. While BRS, hypertension reduced total gain (NT: 13.5 ± 4 vs. HT: 9.7 ± 6, $p<0.01$), however the physical training did not improve these values.
CONCLUSION:
Our results suggests that ovarian hormones could not prevent the impairments on cardiovascular autonomic control due hypertension, mainly in HRV parameters in absolute unit. While the normalized units did not chance and the vagal modulation predominance remained. In addition, the aerobic physical training did not promote any beneficial effects in these women, independently of hypertension.

ASSOCIATION BETWEEN THE INCREMENT OF MAXIMAL OXYGEN UPTAKE AND LEFT VENTRICULAR VOLUME OF HEALTHY ADULTS IN AEROBIC EXERCISE INTERVENTION

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INTRODUCTION:
Cardiac output is directly associated with left ventricular volume (LVV), particularly end-diastolic volume [1]. And the LVV is correlated with the shape or structure of the heart which may be reconstructed by aerobic exercises [2]. However, few studies have specifically examined the relationship between VO2max (and its increment) and LVV in the healthy adults in aerobic exercise intervention. This study aimed to analyze the association of LVV in baseline and increment of VO2max after aerobic exercise intervention.
METHODS:
One-hundred and six adults (20-59 years old, 60 females and 46 males, BMI: 18.5-23.9) with physical health participated in the 16-week aerobic cycling exercise intervention. Multivariable linear regression models were performed to estimate the independent associations of incremental VO2max with LVV parameters. The full models were adjusted for age, gender, and BMI. Two-sided tests and a 5% significance level were used in the analysis.
RESULTS:
Participants with VO2max increasing had lower VO2max ($P=0.001$), left ventricular internal dimension in end-systole (LVIDs) ($P<0.001$), and left ventricular end-systolic volume (LVESV) ($P<0.001$) in the baseline than those without VO2max increasing after aerobic exercise intervention . The VO2max increment was negatively associated with the initial LVV, including LVIDs ($P=0.004$) and LVESV ($P=0.019$), in aerobic exercise intervention . In the full adjusted model, incremental VO2max was significantly associated with LVIDs, LVESV, and VO2max. A decrease of one unit in LVIDs, LVESV, and VO2max in the baseline was related to an increase in the incremental VO2max by 5.4 ml/kg/min, 0.2 ml/kg/min, and 0.5 ml/kg/min.
CONCLUSION:
Overall, our study demonstrates that incremental VO2max indicative of cardiorespiratory fitness improvement was independently associated with the initial LVV in the baseline. Our findings indicate that the initial LVV may predict the increment of VO2max before aerobic exercise intervention or training.

SPECIFIC BIOELECTRICAL IMPEDANCE VECTOR ANALYSIS IDENTIFIES BODY FAT REDUCTION AFTER A LIFESTYLE INTERVENTION IN FORMER ELITE ATHLETES

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INTRODUCTION:

Specific bioelectrical impedance vector analysis (BIVA) has been proposed as an alternative bioimpedance method for evaluating body composition. Although the ability to assess FM% does not change over time, this is the first longitudinal study to address BIVA´s suitability for assessing changes in fat mass. This investigation aimed to verify the ability of specific BIVA in identifying changes in fat mass after a 16-week lifestyle program in former athletes.
METHODS:
The 94 participants included in the Champ4life project (clinicaltrials.gov: NCT03031951) were randomized into intervention (n=49) and control (n=45) group, from which 82 former athletes completed the intervention. Nevertheless only 80 men and women former athletes (age 43.9 ± 9.2y; body mass index 31.1 ± 4.6 kg/m2) were included in this study, without any missing data. Fat mass was estimated by dual-energy X-ray absorptiometry. Bioelectric resistance, reactance, phase angle, and vector length were assessed by bioelectric impedance spectroscopy at a 50 kHz frequency and specific BIVA procedures were applied.
RESULTS:
A significant ($p<0.05$) group × time interaction for fat mass, specific resistance, reactance, and vector length was found. Fat mass and vector length significantly ($p<0.05$) decreased in the intervention group, while no change was measured in the control group. Considering the participants as whole group, the vector length was positively associated with fat mass percentage at baseline ($r2=0.682$; $p<0.001$) and after the intervention period ($r2=0.571$; $p<0.001$), even adjusting for age and sex. Changes in vector length were associated with changes in fat mass percentage, even after adjusting for age, sex, and group ($\beta=0.34$; $p<0.001$).
CONCLUSION:
The results suggest that specific BIVA approach is suitable to track fat mass changes during an intervention program aimed to reduce body fat in former athletes.

EFFECTS OF AEROBIC EXERCISE ON THERMOGENESIS AND LIPID METABOLISM OF SUBCUTANEOUS ADIPOSE TISSUE IN OBESE RATS

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INTRODUCTION:
Lipid metabolic response is the main way of adipose tissue metabolism, and thermogenic regulation is an important way for adipose tissue to participate in the regulation of energy metabolism. In this study, we observed the effect of aerobic exercise on UCP-1 protein level and lipid metabolism spectrum in subcutaneous white adipose tissue (sWAT) of obese rats. To explore the effect of aerobic exercise on thermogenesis and lipid metabolism of sWAT and its preliminary correlation, so as to further improve the possible mechanism of aerobic exercise regulating lipid metabolism.
METHODS:
1.Animals and groups: Sixteen 16-week-old male SD rats with obesity induced by high-fat diet (45% energy provided by fat) were divided into obesity control group (OC, n = 8) and obesity exercise group (OE, n = 8). The body weight of obese rats was 22.4% higher than that of the chow-diet (10% energy provided by fat) control group. 2. Training protocol: The treadmill was raised to 10° for the duration of the training period. Rats in the OE had 8 weeks training (60%-70% VO2max, 50 minutes/day, 5 days/week). Electrical stimulation (0.6 mA intensity) was used to ensure rats' adherence to the exercise regime. The sWA was taken at 48 h following the last bout of endurance exercise training. 3. Lipidomics: Lipids were analyzed using UPLC-QTOF/MS. Lipids were identified by progenesis ® Qi software and lipid maps database Identification. Orthogonal partial least-squares discrimination analysis (OPLS-DA) was calculated by using R language ropls data package to obtain variables with variable importance in the projection (VIP), Metaboanalyst platform was used to calculate p value and fold change to screen lipid difference. The small molecular pathway database was used for lipid metabolism pathway.
RESULTS:
Compared with OC, OE significantly reduced body weight, triglyceride and low density lipoprotein cholesterol of rats. The protein level of UCP-1 in sWAT were higher in OE than in OC. 1630 lipids were identified and 100 different lipids were located in sWAT of obese rat. The level of polyketides was higher in OE than in OC. The level of glycerolipids, fatty acyls, prenol lipids and sterol lipids were lower in OE than in OC. According to the SMPDB database, The different lipids was mainly distributed in the phosphatidylinositol phosphate metabolism, glycerol metabolism and phospholipid synthesis pathway.
CONCLUSION:
Aerobic exercise could significantly promote the thermogenesis and regulate the lipid metabolism level of sWAT in obese rats, which may be an important reason for the significant reduction of body weight and blood lipid level in obese rats. After long-term aerobic exercise intervention, the synchronous response of UCP-1 protein and lipid metabolism level in sWAT of obese rats indicated that the increase of thermogenesis induced by aerobic exercise in obese rats closely related to phosphatidylinositol phosphate metabolism, glycerol metabolism and phospholipid synthesis in adipose tissue.

REDUCED PHYSICAL ACTIVITY LEVELS IN COMMUNITY-DWELLING OLDER ADULTS IN DENMARK DURING THE COVID-19 PANDEMIC

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INTRODUCTION:
Being physically active is important in the prevention of adverse health effects in older adults, such as falls (1), cardiovascular outcome (2) and mortality (3). Although many older adults are positive toward physical activity, the factors limiting participation in physical activity are numerous and the COVID-19 pandemic has compounded the problem by dramatically reducing the amount and quality of social gatherings and interactions for older adults. The objective of this study was to investigate changes in physical activity due to the COVID-19 pandemic, among community-dwelling older adults in Denmark.
METHODS:
We assessed different exertion levels, frequencies, and duration of physical activity of 62 older adults (70.4±4.3yrs) during leisure time activity undertaken over a period of seven days, using the Physical Activity Scale for Elderly (PASE). The results of the scale are calculated, unitless values. The pre-pandemic measures were obtained late 2019 and January 2020, while the second and third measures were obtained one month into the first and second lockdown period in Denmark (April 2020 and January 2021 respectively). A repeated measures

ANOVA with Greenhouse-Geisser corrections was used to test for differences between time points, with Bonferroni corrections used as post hoc test.
RESULTS:
The PASE score for the total leisure activities, moderate and strenuous sports were: pre-pandemic 39.8 (±26.4), 12.2 (±13.9) and 3.1 (±6.4); first lockdown: 32.7 (±22.1), 6.8 (±11.5) and 2.5 (±8.7) and; second lockdown: 16.3 (±10.3), 3.3 (±5.7) and 0.8 (±2.2). There was a reduction in total leisure activities from pre-pandemic to: (i) first lockdown by 17% (P=0.03) and; (ii) second lockdown by 59% (P<0.01). The PASE score for moderate exertion levels of sports was reduced from pre-pandemic to: (i) first lockdown by 44% (P<0.01) and; (ii) second lockdown by 73% (P<0.01).
CONCLUSION:
The total leisure activities for the older adults in our study decreased by 59% from pre-pandemic period to the second lockdown, which equals the PASE score of a combination of walking for 1-2 hour 3-4 times a week and 1-2 hours of moderate sports 1-2 days a week. Since recent literature indicates that physical activity levels can affect both the risk of falling and the risk of getting osteoporosis, this data may suggest that Community-dwelling older adults in Denmark might face a higher risk of experiencing fall related fractures during the pandemic.
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PHYSICAL ACTIVITY, SEDENTARY BEHAVIOR AND CARDIORESPIRATORY FITNESS ASSOCIATIONS WITH SHORT-TERM HEART RATE VARIABILITY AND INFLAMMATORY AND OXIDATIVE STRESS MARKERS

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INTRODUCTION:
The objective was to assess the associations between objectively measured physical activity (PA), sedentary behavior (SB), and cardiorespiratory fitness (CRF) with indices of heart rate variability (HRV), and plasma inflammatory and oxidative stress markers
METHODS:
44 participants [29 women, 15 men, age=49.5(6.4) yrs, BMI=28.1 (6.2) kg·m-2] from the “Lifestyles and Oxidative Stress Markers in Cardiometabolic Risk Study”. Data were collected between 7.00-10.00 A.M. in a fasted state and without prior consumption of coffee, tea, or tobacco; in the following order: Resting heart (HR) rate for HRV analysis (SDNN, RMSSD, LF, HF, LF/HF, SD1, SD2, Sample Entropy, PNS and SNS index), a blood sample to measure inflammatory [C-reactive protein (CRP) and cytokines (IL-1ß, INF-G, TNF, MCP-1, IL-6, IL-8, IL-10, IL-18, IL-23] and oxidative stress markers [Catalase (CAT) and Glutathione Peroxidase (GPX)], anthropometric measures, a submaximal cycling test for VO2max estimation with active recovery to assess absolute HR recovery (30s, 1, 2, 3, 4, 5 min), Deltas (30, 1, 2, 3, 4, 5) and HRR kinetics [time constant (t), and amplitude (HRRamp)] and 7-day PA monitoring [time sedentary, time in light PA (LPA) and time in moderate to vigorous PA (MVPA)]. Non-normal distributed variables log-transformed (ln) and all statistics were performed at a=0.05
RESULTS:
Women spent more time in SB (P=0.035, ES=0.72) whit less sedentary breaks (P=0.014, ES=0.43), higher ln IL-6 (P=0.02, ES=0.84) and ln TNF (P=0.01, ES=0.97) and lower HRV indices [SDNN, LF/HF, SD2 (P>0.05)] than men. There were no significant differences in PA or SB between groups defined by a determined CRF. However, the group with high CRF showed lower values of ln TNF (P=0.02) and IL-10 (P=0.003), a tendency for lower ln IL-1ß and ln IL-6 (P=0.05) and higher HRV indices [RMSSD, PNS, SampEn, SD1 (P<0.05)] compared with low CRF group. GLMs controlling by age, sex, smoking, socio-economic status, waist circumference (WC) and CRF cluster, showed an association between sedentary time and ln CRP [ß=0.006, P=0.001] and ln MCP-1 [ß=0.003, P=0.038]. Also, there were significant associations between time in LPA vs. Delta3 [ß=0.05, P=0.043] and vs. Delta4 [ß=0.06, P=0.043], ln IL-10 vs. PNS index [ß=0.37, P=0.03], GPX vs. ln LF [ß = -0.42, P=0.013], CAT vs. ln HF [ß= -6.13, P=0.029], and GPX vs. SD2 [ß=-6.83, P=0.034]. Age, sex and CRF were significant covariates in almost every model. In this sense, there were significant correlations between relative VO2max vs. ln TNF (r=-0.61, P=0.001), ln IL-6 (r=-0.45, P=0.012) and ln IL-10 (r=-0.64, P=0.003) and between time in LPA vs. HRRamp (r=0.45, P=0.034) in women and time in MVPA vs. HRRamp (r=0.59, P=0.035) vs. Delta2 (r=0.76, P=0.002) and Delta3 (r=0.77, P=0.002) in men
CONCLUSION:
SB appears to be related to a higher inflammatory status and lower HRV, with differences by age, sex, and CRF. PA level did no show association with inflammation and HRV but could be related to a better post-exercise HR recovery

AN INVESTIGATION INTO THE RELATIONSHIP BETWEEN LIFESTYLE, HEALTH STATUS, MENTAL STRESS AND VIRUS-FIXATED ANXIETY AMONG UNIVERSITY FRESHMEN DURING THE COVID-19 PANDEMIC

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INTRODUCTION:
The Covid-19 pandemic has caused major disruption to the lives of millions of people all over the world. In Japan, university freshmen have been deprived of a normal college life and, as a consequence, are more likely to suffer from poor health and stress. The physical isolation from their families and the normal rigors and deprivations of student life may also make university freshmen particularly susceptible to virus-fixated anxiety. The purpose of this study was to investigate the relationship between lifestyle and physical and mental health among university freshmen during the pandemic.
METHODS:
The research subjects were 152 freshmen who had entered university in April 2020. All of the research subjects were surveyed via the internet two months after entering university with respect to the following: 1) sleep duration, 2) food intake and dietary changes in terms of type of food consumed and calorific intake, 3) changes between current and one year ago in terms of the frequency of physical activities regularly engaged in, 4) number of distinct physical activities regularly engaged in, 5) number of friendships made since entering university, 6) effect of the restrictions on going out upon physical and mental health, 7) mental stress, and 8) degree of anxiety about Covid-19.

RESULTS:
A multiple regression analysis conducted on the relationship between physical and mental health and lifestyle (F [2, 149] = 10.9, p < .001) revealed a significant deficit in terms of food intake (Beta=4.3, p<.001). A logistic regression analysis conducted on mental stress (Chi-square [3] = 15.6, p < .01) revealed a significant relationship only with gender (Bate = -1.1, p < .01), whereas the logistic regression analysis conducted on anxiety about Covid-19 (Chi-square [3] = 9.8, p < .05) revealed a significant relationship with both gender (Bate = -0.9, p < .01) and sleep duration (Bate = -0.8, p < .05).
CONCLUSION:
The data suggests that the lifestyle typical of many university freshmen during the Covid-19 pandemic tends to exacerbate physical and mental problems. Fewer opportunities to eat out or shop for food lead to a poor diet and lack of nutrition. Furthermore, the data suggests that a lack of sleep (less than six hours) may increase anxiety about the pandemic. This type of virus-fixated anxiety and mental stress generally was found to be more common and more acute in females. As a result, female freshman should be afforded greater consideration and care with respect to their mental health during the pandemic.

MEASUREMENTS OF THE PHYSIOLOGICAL CURVATURES AND FUNCTIONAL MOTIONS OF THE VERTEBRAL COLUMN

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INTRODUCTION:
The sedentary lifestyle is rapidly spreading among younger age groups as well. The recent Health Behavior in School aged Children (HBSC) study shows that most adolescents do not meet the recommendations for moderate and intense physical fitness and activity (Németh, Horváth, Várnai, 2019.). The aim of our research is to use a longitudinal survey to investigate the effects of decreased physical activity on the physiological curvatures and functional motions of the vertebral column in prepubertal children.
METHODS:
The study was performed among 10-year-old children, 5th grade students of the Gárdonyi Géza Primary School in Győr (N=51). The Spinal Mouse device was used to examine the vertebral column. The device is capable of examining the morphological characteristics and mobility of all vertebrae between C7 - S1. The study was carried out with the support of the project EFOP 3.6.1 16 2016 00018 –Increasing the role of RDI in the higher education system through intelligent specialization in Sopron and Szombathely. The research ethical license is 2020/136.
RESULTS:
The gender distribution of students was 19 girls (N=19), and 32 boys (N=32). The results show that at normal posture, the curvature of the lumbar spine is in the normal range for both sexes. There was a significant difference between the Th10/11 vertebral position of girl and boy students (p<0.002). Subsequently, the spinal characteristics of the children were again measured after performing the Matthias test. The new results showed a significant difference in terms of transitions between the Th1/2 (p<0.001); Th10/11 (p<0.001); Th11/12 (p<0.030), and Th12/L1 (p<0.041) vertebrae. The children's spine length was measured during normal posture as well as after performing the Matthias test. The results show that there is a significant difference in spine length between the two sexes only in the position of normal posture (p<0.006); no difference was found after performing the Matthias test.
CONCLUSION:
In terms of boys, shortening of spine length was observed after the Matthias test, suggesting that these segments are the starting points for posture weaknesses, therefore, special attention must be paid to strengthening the muscles in these spine sections.
Keywords: Spinal Mouse, vertebral column, functional examination, prepubertal.

THE EFFECT OF THE 2020 COVID-19 LOCKDOWN MEASURES ON THE DIET, HYDRATION AND PHYSICAL ACTIVITY HABITS OF SCOTTISH ADULTS

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INTRODUCTION:
COVID-19 was declared a global pandemic due to the viruss spread and the danger posed to vulnerable individuals. Scotland introduced lockdown and social isolation measures, reducing time spent outdoors and in public places. The population was under home confinement conditions without having access to sports facilities or gyms during this period. Increased social isolation has been linked to poorer mental health and well-being, leading to increased alcohol consumption, reduced physical activity (PA) levels, and increased sedentary activities. This study aimed to examine the impact of the lockdown due to the COVID-19 pandemic on physical activity, diet, and hydration in Scottish adults.
METHODS:
A mixed-methods online survey, which utilised both open and closed questions, was used to examine these factors during lockdown from July 2020 to November 2020. Participants were asked about their physical activity, diet, and hydration habits and whether lockdown impacted these. The study was approved by the University of Stirling General University Ethics Panel (GUEP).
RESULTS:
A total of 297 adults (aged 18-72 y; body mass index 25.3 kg/m^2; 83% female participants) living in Scotland completed the self-reported questionnaire. The results demonstrated that lockdown measures increased healthy and unhealthy food intake and alcohol consumption (p<0.05); however, no statistically significant change in the daily fluid intake was observed. Most participants reported that their PA levels had decreased, with only 22% of the participants meeting the guidelines for physical activity when the strength guidelines were included. The participants completed significantly less moderate PA than the guidelines recommend (p<0.001). Further analyses revealed that were not sufficient levels of strength-based activities completed, and sitting activity increased for nearly all the participants.
CONCLUSION:
Hydration habits were not largely impacted during the lockdown; however, alcohol consumption increased among female respondents. The percentage of participants meeting the PA guidelines was significantly low when accounting for strength-based activities. This observation underlines the importance of addressing the impact of social isolation on lifestyle factors such as PA and alcohol intake. The main limitations of this study are the sample size, the female participants predominance, and the utilisation of a self-reported questionnaire; however, the results provide an indicator of the changes in diet, hydration and PA in the Scottish adults during the COVID-19 lockdown and

can be useful to inform future intervention aiming to attenuate the effects of the pandemic and the lockdown measures on the diet, hydration and physical activity habits. Further research could include other methods such as utilising accelerometers to quantify the PA of the participants and a 7-days weighed food/fluid diary to estimate the energy, fluids, and macronutrient intake.

BIOMARKERS OF MUSCLE DAMAGE IN SERUM AS A RESULT OF AN ISO-INERTIAL SQUAT EXERCISE

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INTRODUCTION:
This study aimed to quantify and characterize the acute increases in biomarkers of muscle damage from different muscular structures after an iso-inertial squat exercise
METHODS:
Eleven young volunteers (23.8 ± 3.8 years) participated in the study. The participants self-reported that they engaged in weekly activity of moderate intensity for 6.7 ± 3.6 h·week-1, that they had not suffered muscle or tendon injuries in the previous 6 months, and that they had not been involved in a specific resistance training programme in the 6 months preceding the study. Repeated measures (pre-exercise, and after 24, 48, 72, and 144 hours) were taken to determine the effects of a "maximum-effort" iso-inertial half-squat training session (10 sets of 10 repetitions) on serum biomarkers of muscle damage CK, as cytosolic marker of muscle damage, Sarcomeric mitochondrial CK (sMtCK), as a potential marker of muscle mitochondrial disruption and CK-MB isoform (CK-MB) as a potential marker of muscle sarcomere disruption. Moreover, maximal voluntary force production of the knee extensors and knee flexors was measured in isometric conditions on a custom-built bench and reported as the maximum voluntary isometric contraction (MVIC).
RESULTS:
After exercise, CK, mainly located in the cytoplasm, showed consistent increases during the follow up, with peak increases from baseline of 666.34 ± 1331.69% Post48hr. Mitochondrial marker sMtCK showed a very similar timeline to that of CK, but with a lower percentual increase, peaking at Post72hr (400.61 ± 845.47%). Sarcomeric-located CK-MB showed an early peak increase at Post24hr (323.46 ± 259.79. Baseline levels of all markers were statistically recovered at Post72hr.
Moreover, the knee extensors showed a significant decrease in the MVICs (peak, -32.90% at Post1hr; $P < 0.0001$) that did not recover until Post72hr. No significant changes were seen in the MVICs of the knee flexors during follow-up.
CONCLUSION:
Unaccustomed iso-inertial exercise is expected to produce moderate EIMD and a loss of muscle strength (20%–50% decrease) that is prolonged (1–7 days for recovery). These functional impairments are accompanied by the leakage of several biochemical markers in the serum that suggest the following are affected, in order of decreasing severity: (i) the myocyte membrane, (ii) the sarcomeric mitochondria, and (iii) the muscle ultrastructure.
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THE POSITIVE EMOTION IS ASSOCIATED WITH PHYSICAL ACTIVITY IN COLLEGE STUDENTS

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INTRODUCTION:
Mental health of college students has become a public concern in recent years. Among many other indicators of mental health, positive emotions have great health significance in adulthood and later life. Prior research has explored approaches to help college students to achieve positive emotions in their lives. In this study, we attempted to explore the relationship between physical activity (PA) and positive emotions among college students. Specially, we aimed to compare the relationships of positive emotions and negative emotions with PA of different intensities.
METHODS:
The study sample involved 1,252 undergraduates at a large public university in China. We collected data on PA, and positive emotions and negative emotions. Vigorous-intensity PA (min/week), moderate-intensity PA (min/week), and light-intensity PA (min/week) were derived from the International Physical Activity Questionnaire. The positive and negative emotions were distinguished by the different emotion terms selected from the Positive and Negative Affect Schedule (PANAS-SF). We conducted multiple regression models, with emotions as dependent variables and PA variables as predictors after controlling for age, gender, and BMI.
RESULTS:
Vigorous-intensity PA （$\beta=0.22$, $p<0.01$）, moderate-intensity PA ($\beta=0.20$, $p<0.01$）and light-intensity PA ($\beta=0.15$, $p<0.01$）significantly predicted positive emotions. No significant relationship was observed between negative emotions（$\beta<0.1$, $p>0.01$）and PA of different intensities.
CONCLUSION:
PA of all intensity levels is associated with positive emotions but not negative emotions in college students. Maintaining a moderate amount of physical exercise across various intensity levels may facilitate college students positive emotions.

MICROCURRENT ELECTRICAL NEUROMUSCULAR STIMULATION PROMOTES RECOVERY OF MUSCLE PERFORMANCE AFTER ECCENTRIC CONTRACTION: DOUBLE-BLIND, RANDOMIZED CONTROLLED TRIAL.

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INTRODUCTION:
We have previously shown that in rodent skeletal muscle, microcurrent electrical neuromuscular stimulation (MENS) can accelerate force recovery after eccentric contractions (ECCs). It remains unclear, however, whether this is also true for human muscle. The aim of this study was to investigate the effects of ECC and MENS on muscle performance in humans.
METHODS:

Fifteen healthy young men were recruited in this study. All subjects were moderately active, non-smokers who had not participated in any regular resistance training for at least 1 month before the onset of this study. The subjects were divided into 2 groups: a MENS treatment group (T; n=8) or a non-treatment group (NT; n=7). A single bout of ECC on elbow flexor muscle of one arm was applied to all subjects. The exercise consisted of maximal ECCs at 120°/sec of an angular velocity, and the motion ranged from 120° to 0° elbow flexion, where a fully extended elbow joint angle was considered to be 0°. The arm was passively returned to the initial position at 10°/s, creating a 12-s rest between contractions. ECCs were repeated 50 times. MENC treatment (25 μA, 0.3 Hz, 20 min/day) was applied to exercised biceps brachii muscles in the T subjects immediately after and 1-6 days after ECC. The following measurements were performed before, immediately after (POST0), and 1 (POST1), 3 (POST3), and 6 days (POST6) after ECC: maximum voluntary isometric contraction (MVC), visual analog scale (VAS), time for muscle contraction (Tc), muscle displacement (Dm), strain ratio (SR), serum creatine kinase activity, serum lactase dehydrogenase activity, muscle soreness, range of motion of the elbow joint (ROM), and upper-arm circumference (CIR). The experiments were carried out under a prospective, double-blinded, and randomized condition.
RESULTS:
Before and immediately after ECC, MVC did not differ significantly between T and NT ([in Nm] 58.1 ± 11.6 in T vs. 53.0 ± 10.4 in NT at Pre-ECC; 31.1 ± 7.2 in T vs. 26.1 ± 8.0 at POST0). MENS treatment facilitated force recovery: MVC was significantly higher in T than in NT at POST1, POST3, and POST6 ([in Nm] 40.5 ± 9.7 in T vs. 26.6 ± 4.6 in NT at POST1; 44.9 ± 12.9 in T vs. 28.7 ± 8.0 in NT at POST3; 52.8 ± 13.6 in T vs. 31.3 ± 7.2 in NT at POST6). The results of VAS, an indicator of muscle soreness, showed that MENS also relieved muscle soreness: VAS was significantly lower in T than in NT at POST3 and POST6 ([in mm] 32.1 ± 16.9 in T vs. 47.4 ± 28.0 in NT at POST3; 3.4 ± 5.7 in T vs. 18.1 ± 15.8 in NT at POST6). The beneficial effects of MENS were not observed for the other parameters.
CONCLUSION:
Our results indicate that for not only rodents but also humans, MENS treatment is an effective strategy to promote restoration of muscle performance that is impaired with ECC. It is widely accepted that ECCs bring about muscle damage, which is characterized by, e.g., swelling, increased membrane permeability, and proteolysis. It is plausible that MENS treatment inhibits some of these.

IS THERE AN ASSOCIATION BETWEEN FRONT SHOT SKILL TESTS AND THE FACTORS OF GENDER, STANDING HEIGHT, SPORT EVENTS AND PAST BASKETBALL EXPERIENCE?

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INTRODUCTION:
Traditionally, basketball skill tests have been used to measure basic basketball skills. They have been utilized for grading in sports-related university PE classes. Various factors might influence the measurements in these skill tests in addition to the skills learned in PE classes, such as gender, standing height, and basketball experience. Besides, since students on a PE major course belong to a certain sport club, the influence of sport events is also thought to impact the measurements in basketball skill tests. If an influence like this other than the learning effect from PE classes is found, grading might be unfair. Thus, this study aimed to examine the relationship between front shot skills and various factors. However, students who belong to the same sport club undergo similar training. Therefore, taking this similarity into consideration, the relationship was examined using a mixed linear model.
METHODS:
The students participating in this measurement were asked to conduct a front shot four times. In the front shot, five shots were thrown successively from the free throw line. Two points were given if successful, one point was given if unsuccessful but the ring was touched and zero points were given otherwise. The subjects were 244 F-university students. At the same time, the subjects were questioned on the sport clubs to which they belong, their gender, their standing height and their basketball experience when they were in elementary school to high school. After classifying the sport clubs into the four categories of basketball, ball games other than basketball, sport events other than ball games and no club, the data was analyzed using the mixed linear model with repetition by the same student, clubs and sport categories as the random effect because they are nested in this order.
RESULTS:
As a result of the deviance analysis, a significant model fit (chi-squared = 50.376, df = 5, $p<0.001$) was found in the full model including both random (individuals, clubs and club categories) and fixed effects (gender, standing height and past basketball experiences, deviance = 6555.9) when compared to the null model including only the random effect (deviance = 6605.9). The estimated variances were 0.008 in individuals, 0.004 in clubs, 0.019 in club categories and 0.219 in residuals. In this, a 5% significant difference was found in that of clubs and 0.1% difference in club categories. Next, when viewing the regression coefficients as fixed effect, that of males is 0.040, standing height is 0.002, experience in elementary school is 0.019, experience in junior high school is 0.023 and experience in high school is 0.063. Significant differences were found in basketball experience in elementary (to=2.011, df=232, $p<0.05$) and high schools (to=53.516, df=214, $p<0.001$).
CONCLUSION:
Front shot skills are more influenced by sport club and club categories than by individuals and by experience in elementary and high school.

EFFECTS OF DIFFERENT POSITIONS DURING HANDBALL COMPETITION ON PHYSIOLOGICAL RESPONSES

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INTRODUCTION:
Handball is a sport that has the three elements of ‘running, throwing and jumping’. This sport involves speed and powerful offence and defence moves. Handball includes the following seven positions: goalkeeper (GK), right back (RB), left back (LB), centre back (CB), right wing (RW), left wing (LW) and pivot (P). The population of handball players in Japan comprises junior high school students (boys: 16,794; girls: 10,884; total: 27,678) and high school students (boys: 27,131; girls: 16,018; total 43,149). It is also incorporated into school education and is included in the curriculum guidelines for health and physical education in junior high and high schools as well as in the E-ball game ‘goal type’ exercise item. However, handball, which consists of the three elements of ‘running, throwing and jumping’, is different from other ball game sports because it is difficult to enhance guidance according to the skill and physical strength of the student and to ensure health and safety. By comparison, it is considered that it is not often implemented as an exercise event. Therefore, the present study aimed to clarify the exercise intensity of each position and create a guideline for water intake in consideration of health and safety.

METHODS:
Seven healthy women (age: 20.4 ± 1.4 years, weight: 55.8 ± 4.3 kg, height: 158.9 ± 3.4 cm, mean ± SD) registered as athletes with the Japan Handball Association living in the Okayama Prefecture were enrolled. All the study procedures were approved by the Ethics Committee of the Kawasaki University of Medical Welfare. We have no COI with regard to this study. Measurement items were urine volume, urine specific gravity, heart rate, RPE and drinking water volume. The measurement protocol included a warm-up of 30 min followed by a break of 10 min, match (first half) for 30 min, break for 10 min and match (second half) for 30 min.
RESULTS:
Heart rate, %HRmax and RPE after the match in the back players (CB, RB, LB) was higher than that in the others player (GK, RW, LW, P). Urine volume after the match in the back players (CB, RB, LB) was lower than that in the others player (GK, RW, LW, P). Urine specific gravity was high for all players and indicated dehydration in all positions.
CONCLUSION:
The exercise intensity of the back players was high, whereas the exercise intensity of the side players and goalkeeper was low. Moreover, it is necessary to give frequent instructions for hydration before physical education classes, during classes, before games and before practice.

AN EVALUATION OF THE PHYSIOLOGICAL STRAIN INDEX DURING A PROLONGED SUBMAXIMAL EXERCISE WITH SLEEP DEPRIVATION

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INTRODUCTION:
The physiological strain index (PSI) is a prevention tool to detect incidences of heat-related illnesses at an individual level. The PSI is based on core temperature (Tc) and heart rate (HR) to assess the strain on the cardiovascular and thermoregulatory systems on a scale of 0 – 10 (Moran et al., 1998). Fatigue is known to induce physiological and psychological perturbations, hence, impairs (un)conscious behaviors for thermoregulation (Westwood et al., 2021). During prolonged exercise and sleep deprivation, fatigue can weaken the ability to maintain thermal homeostasis, and therefore, acts as risk factor for heat-related illnesses. This study aimed to evaluate whether the PSI reflects increasing and cumulative fatigue during prolonged submaximal exercise with sleep deprivation.
METHODS:
Twenty one soldiers (1 female; 21.0 ± 1.1 years; 180.6 ± 8.5cm; 78.9 ± 11.9kg) of the Swiss Armed Forces performed a submaximal 100km march (total duration 24h11 – 25h38). HR and Tc were measured using the chest belt Open Body Area Network (USARIEM & MIT, USA) in 1-min epochs. At five time points (at km 0, 30, 55, 72, and 93) four fatigue indicators were assessed: rate of perceived physical and mental exertion (RPEp; RPEm) using two CR100 scales, physical fatigue (PF) measuring the absolute acceleration during a counter movement jump and mental fatigue (MF) using a questionnaire. The PSI was calculated as PSI = 5•[(Tc(t)–Tc(0))•(39.5–Tc(0))-1]+5•[(HR(t)–HR(0))•(180–HR(0))-1] and compared to the fatigue indicators at the five time points; Tc(t1-5) and HR(t1-5) were calculated as average Tc and HR values of one hour prior every time point, and Tc(0) and HR(0) as average Tc and HR values of the first hour after the start.
RESULTS:
PSI ranged from 2.56 – 3.09 with a peak of 3.58 at km 55 and the repeated measures ANOVA revealed no significant differences compared to km 0 ($p > 0.05$). However, all fatigue indicators differed significantly from almost each time point to the other ($p < 0.05$). The PSI reported a weak to medium correlation with MF and RPEp ($r = 0.24 / 0.34$, both $p < 0.05$), however no significant correlation with PF and RPEm ($r = 0.10 / 0.18$, both $p > 0.05$).
CONCLUSION:
The four fatigue indicators showed that physical and mental fatigue had increased significantly during the march. In contrast, the PSI remained steady at a low level of physiological strain and showed no association with fatigue. When shorter or longer breaks are taken, PSI may lack to identify cumulative fatigue. Whether the PSI would miss a heat- or exertion-related occurrence cannot be conclusively assessed, as no subject experienced such conditions.
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EXERCISE-RELATED INJURIES IMMEDIATELY AFTER THE COVID-19 LOCKDOWN

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INTRODUCTION:
The COVID-19 pandemic has drastically changed people's way of life. Lockdown was established as a measured to prevent the extreme transmission of the virus and protect the health of the population. Home quarentine limited the opportunities to exercise, so the experts encouraged to perform physical activity during this period and adapt it to the home setting [1]. However, the lack of specific training stimuli may derive in the corresponding loss of neuromuscular adaptations, so progressive and programmed return to normal physical activity following lockdown is essential in order to minimize risk of injuries [2]. This study sought to determine the effects caused by prolonged home confinement on the risk of injuries when returning to the usual outdoor exercise routine.
METHODS:
This was a cross-sectional study consisted of a self-reported online questionnaire containing 30 items. The questionnaire was delivered via Google Forms to collect the type, volume, frequency and intensity of exercise pre and during quarantine (7 weeks), as well as injury-related information along the first 2 weeks following lockdown. Clinics, sport medical professionals and social media were considered in order to launch the questionnaire. We included 131 adults who completed the survey, of which thirteen were ruled out for further analysis due to inconclusive responds and/or missing data.
RESULTS:
Overall, 51 females and 67 males (30.5 ± 8.8 years) participated in the study. Twenty-five participants injured through the lockdown, 79 along the first week and 14 on the second week. The distribution of the injuries was diverse, with lower limb being the most injured area (66.1%), following by trunk (22%), upper limb (5.9%) and neck (0.8%) [$p < .05$]. Most type of injuries were muscle/tendon (81.4%), ligament (6.8%) nervous (5.9%) bone (2.5%), and others (3.4%) [$p < .05$]. A significant association was found between the type and location of injury

[X2 (16) = 109.50, p < .05], showing a positive and moderate correlation (CC = .69 p < .05). Aerobic training sessions were associated with the location and type of the injury [X2 (8) = 17.12; X2 (4) = 9.60; p < .05], mostly in the lower limbs and muscles, respectively.
CONCLUSION:
This study points out that home-adapted exercise is different from usual outdoor exercise routines. Despite exercise practice was essential during the home lockdown in terms of physical and psychological health it seems that home exercise may not be able to elicit the same effects offered by usual outdoor activities (running, cycling, team sports, etc.). Therefore, each exercise modality requires a particular training to obtain specific adaptations and reduce the risk of injuries.

THE RELATIONSHIP BETWEEN THIGH INTER/INTRAMUSCULAR NON-CONTRACTILE TISSUES AND VISCERAL ADIPOSE TISSUE IN ELDERLY INDIVIDUALS

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INTRODUCTION:
Non-contractile tissues (NCT) in the thigh beneath the fascia lata is associated with muscle disfunction (1) and impaired metabolic health (2). NCT spreads between (inter-) and within (intra-) muscles, and the amount of thigh inter/intramuscular NCT is strongly correlated with insulin sensitivity (3). It is thus expected that the amount of thigh inter/intramuscular NCT can be used as a biomarker of the metabolic syndrome, similar to the visceral adipose tissue (VAT). This study sought to investigate the relationship between thigh NCT and VAT in elderly individuals.
METHODS:
We took axial MR scans of the thigh and abdomen from 82 healthy elderly participants (41 males, 41 females: aged 64-86 years). We measured 1) the cross-sectional areas (CSA) of the thigh subcutaneous adipose tissue (SAT) and NCT between (interNCT) and within (intraNCT) muscles at 50% of the thigh length, and 2) the VAT CSA between the L4/L5 vertebrae. Linear regression analyses were performed and Pearson's correlation coefficients were calculated for the relationships between SAT, inter/intraNCT and VAT CSAs.
RESULTS:
The interNCT CSA was not different between genders (males: 26.2±7.5, females: 26.6±6.3 cm2), while the thigh SAT CSA was larger in females than males (54.9±26.9 vs. 26.1±13.9 cm2, p < 0.01). In contrast, CSAs of intraNCT and VAT were larger in males than females (intraNCT: 8.4±2.4 vs. 6.3±1.8 cm2; VAT: 118.6±69.8 vs. 68.9±32.7 cm2, p < 0.01). InterNCT was significantly related to VAT both in males (r = 0.69, p < 0.01) and females (r = 0.51, p < 0.01). Similarly, moderate correlations were found between intraNCT and VAT in both genders (males, r = 0.49, p < 0.01; females, r = 0.43, p < 0.01). In all participants, the correlation with VAT was significant both for interNCT (r = 0.55, p < 0.01) and intraNCT (r = 0.57, p < 0.01). Regression lines for the relationships between SAT and VAT CSAs, and interNCT and VAT CSAs, were significantly different between males and females but not for intraNCT and VAT CSAs.
CONCLUSION:
The amount of inter/intraNCT was strongly correlated with VAT CSA in both genders separately, and when the groups were combined. Overlapping distributions of males and females in the relationship between intraNCT and VAT CSAs suggest strong association of the two variables regardless of gender, however this relationship was less clear for interNCT and SAT. These results suggest that the amount of NCT in the thigh, and intraNCT in particular, can be a biomarker of the visceral adiposity and metabolic syndrome.
This work was supported by the Council for Science Technology and Innovation (CSTI), Cross-ministerial Strategic Innovation Promotion Program (SIP), "Technologies for creating next-generation agriculture, forestry and fisheries" (funding agency: Bio-oriented Technology Research Advancement Institution, NARO) and JSPS KAKENHI (16H01870).
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EFFECTS OF TRAINING IN OSTEOSARCOPENIC OBESITY. A SYSTEMATIC REVIEW

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INTRODUCTION:
Obesity, sarcopenia and osteoporosis are the major clinical problem in older women and men. osteosarcopenic obesity represents a disease of high mortality and morbidity. That syndrome describes the simultaneous deterioration of bone, muscle and excess fat, resulting in reduced functionality and systemic metabolic, for that reason, an optimal exercise is effective to induce improvement in OSO (osteosarcopenic obesity) syndrome component.
METHODS:
A database search was conducted in PubMed (MEDLINE), Web of Science, and Scopus, researchgate from the earliest record to 2021 for studies (randomised controlled trials and non-randomised controlled trials) with exercise training interventions or follow up with a minimum period of 2 weeks. In the beginning, 44 articles were initially screened, but due to the inclusion criteria, only 4 were included with a final sample of 349 patients. As an inclusion criterion, the search was limited to elderly people. Also, there were added articles that analysed comparisons of change in total body fat mass (kg), body fat percentage (%), lean body mass (kg), and strength training.
RESULTS:
From 4 of the revised studies, 4 works reveal that a Strength protocol increases functional capacity (chair stand test, Muscular strength, skeletal muscle mass, maximum isometric force). Also, Strength training has a favourable effect on body fat, causing improvements in anti-inflammatory level. Furthermore, three studies indicated that Strength training produces an improvement in bone mineral density in people who are obese or overweight. Besides, no significant difference in gait speed was found.
CONCLUSION:
Strength exercise training can induce modest improvements in muscle strength. After a strength training protocol, there is a significant increase in handgrip strength, skeletal muscle mass, bone mineral density, preventing falls as well as improving the functional capacity of patients.

History

ADDRESSING THE PROBLEM OF NOTATION ASSOCIATED WITH HANDSTAND ELEMENTS ON THE POMMEL HORSE

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【Introduction】

In gymnastics, action as an element is indicated by the element name; the name establishes boundaries and distinguishes the element from similar elements. If the definition of the element is ambiguous, fair scoring cannot be guaranteed and confusion may occur in the competition.

In this study, we consider the notation "3/3 travel," a notation that is currently used for handstand elements in the pommel horse gymnastic competition. The study clarifies the problem of this notation and proposes an element name that appropriately represents the definition of the handstand elements that are being performed.

【Method】

This study clarifies the notation "3/3 travel" associated with pommel horse handstand elements based on Kaneko's (1974) structural system theory. In addition, we consider the naming notation of handstand elements based on Kanekos notation theory and propose a new notation that appropriately expresses the definition of pommel horse handstand elements.

【Results】

1. Notation of "travel" in the pommel horse

In the pommel horse, the notation "travel" is used to describe the movement in which both hands move from the starting position of the element to another support position. Examples include "travel forward in side support". Since the 1989 Code of Points, the definition of the elements that involve travel has been shown along with the terminology of the travel range, including "1/3," "2/3," and "3/3."

2. The problem notation of "3/3 travel" in handstand elements

In the mid-1980s, when the "flair through handstands dismount" with the "handstand twist" was first performed, variations changing the support position of the "handstand twist" were performed one after another. The 2006 Code of Points, sets "3/3 travel" as a condition for upgrading the difficulty of handstand elements. At that time, a special rule was established: if at least one hand supports both ends of the horse, the move is recognized as "3/3 travel." The rule was established because many of the handstand elements performed at that time with a "handstand twist" supported by only one hand on both ends of the horse. However, there is a contradiction in the definition of the notation "travel" between the circle elements and the handstand elements, by describing the movement as only one hand to another part as "travel."

3. Proposal of a new notation to replace "3/3 travel"

Currently, the definition of the element that is used as the notation "3/3 travel" is supported by the three leather parts of the pommel horse, both leather ends of the horse and the leather between pommels, while performing a "handstand twist." The study clarified that these elements were not necessarily both hands "traveling" from one end of the horse to the other. Therefore, within the handstand element the notation of "travel" cannot properly express the definition of the element. We suggest the use of a new notation "3 parts of the leather supports" instead of "travel."

CONSIDERING THE VALUE OF A "BACKWARD JUMP WITH TURN" AS A FLOOR EXERCISE

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Introduction:

A salto with a "backward jump with turn," performed as a floor exercise, has been placed in the same category as a "salto backward" in the "2017 code of points" [Fédération Internationale de Gymnastique (FIG), 2017]; accordingly, the unique value of the "backward jump with turn" in the code of points is being lost. A salto with a "backward jump with turn" is an acrobatic element that has been placed in different categories in the code of points over the years, and various factors have contributed to this ongoing confusion. This study aimed to identify the factors that have changed the perception of the "backward jump with turn" and to re-recognize its unique value.

Method:

We collected historical data related to floor exercises from various sources: code of points over the years, videos on gymnastics competitions, and relevant literature. From the data, we summarized the development process of the salto with a "backward jump with turn" and the salto's changing categorization within the code of points. We also evaluated some of the factors influencing the perception of the "backward jump with turn."

Results and discussion:

In 1978, a development technique that increased the turn of the "backward jump with turn" led to the "backward jump with 3/2 turn to 3/2 salto forward." However, the maneuver was indistinguishable from the "salto backward." Therefore, all saltos with backward jumps with turns were placed in the "Acrobatic Elements Backward" structure group (FIG, 1993). In the "2001 code of points," however, they were moved to the "Acrobatic Elements Sideways and Backward Take-offs with 1/2 Turn" group (FIG, 2001). Nevertheless, the current code of points (FIG, 2017) places them in the same category as the salto backward.

It is inferred that the following factors influenced the change in perception of the "backward jump with turn" in the code of points:

1. As the development of the "backward jump with turn" or "salto forward" has progressed in terms of an increasing turn, the classification criteria for saltos with "backward jumps with turns" and "backward saltos" have become ambiguous.
2. In floor exercises, as well as in other apparatuses, the value of distinguishing techniques according to the difference in the timing of turns is diminishing.
3. The "backward jump with turn" was once recognized as a variant of the takeoff movement of the "salto forward" and was considered to be an advantageous method, as it enhanced the height of the aerial phase. The "floor" has been improved. As a result, the value of a takeoff movement that enhances the height of the "salto forward" is declining.

Considering these factors, it cannot be said that the movement of the "backward jump with turn" has its own sufficient value, and it is hoped that it will be recognized as a unique movement in terms of "backward saltos" in the future.

RESEARCH REGARDING TRENDS IN THE JAPAN BASKETBALL ASSOCIATION DURING : FOCUSING ON ARTICLES BY SANG-BECK LEE IN THE BULLETIN

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In this study, focusing on Sang-Beck Lee, who is thought to have held an important position in the Japan Basketball Association, we explore trends in the Japan Basketball Association based on his activities and perspective. We sought to identify the reasons for the development of the organization and increase in competitiveness during the early Showa period. By exploring trends in the Japan Basketball Association from Sang-Beck Lees individual perspective, we believe that new insights may be gained.
During the early Showa period, the bulletin "Basketball" was used for purposes such as understanding or sharing information about competitive basketball. There, Sang-Beck Lee told the basketball-affiliates who read the bulletin about competitive spirit, rules of competition, refereeing guidelines, and sufficiency of facilities, and gave hints about technique. We found that his activities, in particular the fact that he based his activities on an international perspective, contributed to the development of the Japan Basketball Association and an increase in the competitiveness of Japan. He and the Japan Basketball Association believed that without increasing the value and improving the reputation of competitive basketball, basketball in Japan would not develop.
Sang-Beck Lee and the Japan Basketball Association also aspired to technical achievement in the Berlin Olympics (1936). Further, one may say that they saw technical achievement in the Tokyo Olympics (1940) and an increase in the value and reputation of competitive basketball, as well as the development of the sport.

Mentoring/Coaching

ANALYSIS OF CHINESE INTELLIGENT SPORTS RESEARCH BASED ON KNOWLEDGE GRAPH

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INTRODUCTION:
Intelligent sports is to use intelligent processing technologies to make intelligent responses and decision for various sports needs. Intelligent sports is a new topic of sports research and practice under the background of sports informationization, and has become one of the research hotspots in China. Based on the analysis of the scientific knowledge graph of the intelligent sports research in China, this research summarizes the research hotspots of Chinas intelligent sports, and provides suggestions for intelligent sports research in order to achieve the healthy integration of sports and technology.
METHODS:
Scientific literature measurement method (Based on the 913 articles on the research subject of “intelligent sports” in the CNKI database from 2004 to 2020, using CiteSpace V software for visual processing and analysis)
RESULTS:
Keywords are high-level generalization of research content and research perspective. Keyword co-occurrence analysis can directly reflect the research hotspots of a research field in a certain period of time. Through the keyword co-occurrence analysis of 913 articles, “big data” has the highest frequency and the highest intermediary centrality in the field of intelligent sports research in China. It can be inferred that big data-related research has become a hot topic in intelligent sports research. Meanwhile, “big data” has a strong correlation with the other three high-frequency keywords: “Internet of Things”, “cloud computing” and “AI”, which shows that these technologies have been widely concerned and applied in sports. Intelligent sports research hotspots are mainly focused on the following two aspects: From the perspective of technology application, intelligent technologies represented by AI and big data are applied in smart stadiums, sports injury prevention and recovery and other sports fields to achieve the accurate and efficient decision-making in sports. From the perspective of research content, "sports industry", "competitive sports", and "mass sports" are the top 10 keywords in Chinese intelligent sports research, which indicates that these three fields are the research focus of intelligent sports in China. The research is mainly based on the application status and experience of intelligence technologies applied in scientific training, sports equipment design and other sports fields to propose solutions to the problems existing in the development of intelligent sports.
CONCLUSION:
According to the status analysis, this research puts forward the following suggestions for the better development of intelligent sports research: Establishing a cooperative research mechanism with multi-innovative subjects; Strengthening research on the construction of intelligent sports theory and evaluation system; Paying attention to research on intelligent sports humanistic and social issues; Speeding up the application research of sports big data such as data standards and data security.

A CASE STUDY OF COACHING ROUND-OFF DISMOUNTS ON BALANCE BEAM: RESOLVING THE PHENOMENON OF INTERRUPTION

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Introduction
A “phenomenon of interruption” refers to when an experienced athlete is suddenly interrupted during a movement. In the practice of athletics sports, this phenomenon is common yet difficult to overcome. Coaches must provide individualized and appropriate countermeasures during training, that are guided by concrete case studies about this problem. Therefore, this study details the coaching of a female Japanese gymnast (referred to as “GymnastA”) who struggled with the “phenomenon of interruption” during round-off dismounts from a balance beam.
Method
GymnastA was a sophomore university student in Japan. She had participated in the All Japan Gymnastics Championships in which only the top 84 gymnasts in Japan are invited to participate. In this study, I reflect my coaching process of GymnastA over a period of six months. For the reflection analysis, I refer to the video of GymnastA’s performance and the research memo that describes the coaching methods used during practices and interactions.
Results and Discussion

I noticed that GymnastA steps her first foot down with her toes when performing the hop (referred to as "tiptoe hop") of a round-off. I concluded that the “phenomenon of interruption” was caused by this movement. Therefore, the goal of my coaching was to correct her round-off hop by changing the first footstep to include her entire sole on the balance beam (referred to as "solid foot hop"), not just her toes. This movement correction was difficult because GymnastA was planning to participate competitions in the near future and was used to performing the tiptoe hop. By the end of the six-month period of coaching she had acquired the solid foot hop, after which the “phenomenon of interruption” stopped occurring.
The described coaching process of round-off dismounts off a balance beam can be interpreted as follows; to resolve the “phenomenon of interruption” during movement, it is necessary to break the conventional "feeling of interruption" and reconstruct it to a "feeling of success." The first step in the hop is considered to be an important phase related to the subsequent “movement rhythm” of the entire round-off; in this case, by modifying this initial starting phase the movement, “ phenomenon of interruption” of was resolved as the entire round-off dismount was corrected significantly.
Practical knowledge regarding the “phenomenon of interruption” of movement was obtained from this study.

DIFFERENCES IN UTTERANCES WHEN THE FIXED VTR IMAGES AND THE VR IMAGES ARE REPRODUCED: FROM THE UTTERANCES OF THE COACHES IN THE WOMEN’S COLLEGE BASKETBALL GAME IMAGES

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Differences in utterances when the fixed VTR images and the VR images are reproduced: From the utterances of the coaches in the women’s college basketball game images
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INTRODUCTION
This study is intended to reproduce the images recorded by a fixed video camera and the images recorded by a 360 degree omnidirectional camera and investigate the differences and characteristics of how coaches capture the images from the differences in each utterance of the coaches during basketball games.
METHODS
The persons to be analyzed are 2 novice coaches and 2 proficient coaches in the college basketball club. As for the image collection method, the practice games of the college basketball were recorded by installing a fixed video camera (set the angle of view so that the entire coat fit into the screen using a wide-angle lens) and a 360 degree omnidirectional camera on the side of the benches where the coaches sit. 4 subjects uttered while watching the images recorded by a fixed video camera (hereinafter referred to as “fixed VTR images”) and the images recorded by a 360 degree omnidirectional camera (hereinafter referred to as “VR images”). The subjects freely utter what they think while watching the recorded game images.
RESULTS
As a result of classifying utterances, there were 9 categories. The categories are description of situation, expectations and proposals, prediction, retrospection, praise (general), praise (concrete), instruction (general), and criticism. The total number of the utterances made by the proficient coaches is larger than that made by the novice coaches both in the fixed VTR images and in the VR images. In addition, the novice coaches have a smaller total number of the utterances in the VR images than in the fixed VTR images, while the proficient coaches have a larger total number of the utterances in the VR images than in the fixed VTR images. As for the concordance rate of the utterances, the concordance rate of the proficient coaches is higher than that of the novice coaches in the categories except for praise (concrete) and instruction (concrete), and the total concordance rate is also higher in the proficient coaches.
CONCLUSION
1)It is likely that the novice coaches cannot observe the phenomena in the VR images although they can in the fixed VTR images. On the other hand, it is highly likely that the proficient coaches can observe the phenomena in the fixed VTR images as well as in the VR images.
2)In the fixed VTR images, both novice and proficient coaches tend to observe the phenomena objectively, such as the description of situation and the criticism.
3)In the VR images, the proficient coaches tend to give praise or instruction based on individual specific phenomenon of the players’ or team’s movements.

Molecular Biology and Biochemistry

A SYSTEMATIC REVIEW OF THE GENETIC PREDISPOSITION TO INJURY IN FOOTBALL

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INTRODUCTION:
Injury has a profound effect on a football team’s potential success and economic burden. Considerable research in football has been dedicated to finding ways to decrease injuries, which has seen a rising interest in genetic susceptibility. Due to the distinctive loading patterns between sports and their implications in the aetiology of injury, the influence of genetics in football may be unique. Therefore, the aim of this review was to identify genetic association studies investigating injury involving football players and assess which genetic variants have the most empirical evidence to date.
METHODS:
A comprehensive search of the Pubmed, SPORTDiscus, and MEDLINE databases was conducted using the Boolean search of: ((football OR soccer) AND (injury OR injuries)) AND (genetics OR gene OR genotype OR snp OR polymorphism)). Additionally, Google Scholar was searched using word combinations of the aforementioned Boolean search. Furthermore, reference lists of the identified articles and reviews were searched for additional relevant studies. Studies were included if they met the following inclusion criteria: (1) were primary cohort or case-control investigations; (2) reported that football players were included in their population sample; (3) examined the association of a genetic variant with injury; and, (4) were published in the English language.
RESULTS:

There were 29 candidate gene association studies (CGAS) and one genome-wide association study (GWAS) identified. Across the 29 CGASs, a total of 97 unique polymorphisms were assessed within 63 genes. Forty unique polymorphisms were associated with injury at least once. However, only Actinin alpha 3 (ACTN3; rs1815739) and Aggrecan (ACAN; rs1516797) have been successfully replicated in independent cohorts. The XX genotype of ACTN3 (rs1815739) was found to be associated with an increased susceptibility to non-contact muscle injuries, whilst the G allele and TT genotype of ACAN (rs1516797) were found to be associated with increased and decreased susceptibility to anterior cruciate ligament injuries, respectively. In the only GWAS, three additional polymorphisms had a 'suggestive' association ($P < 10\text{-}5$) with tendinopathy; however, they failed to reach the genome-wide statistical significance threshold ($P < 10\text{-}8$).
CONCLUSION:
Currently, 40 polymorphisms have been associated with injury in football at least once, but only two polymorphisms have had their results successfully replicated in independent population samples. There are several methodological issues (e.g., inadequate sample sizes and population heterogeneity) which limit the quality of analysis that can be performed and the consequent reliability and external validity of findings. The future participation of organisations in international consortia is imperative to facilitate improved methodological approaches and improve clarity concerning the exact underlying pathobiology of injury susceptibility in football.

STUDY OF BIOCHEMICAL PARAMETERS IN THE DIVING UNIT OF THE SPANISH MARINE INFANTRY

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INTRODUCTION:
The source of energy that is used to power the movement of contraction in working muscles is adenosine triphosphate (ATP). Muscles contain only limited quantities of ATP. When depleted, ATP needs to be resynthesized from other sources, such as: phosphocreatine (PCr) route, anaerobic glycolysis and aerobic processes. The activation of one or the other route will depend on the intensity and duration of the physical activity.
The PCr route results in energy production very quickly, but has a very short half-life since the amount of PCr in the muscles is very limited. The creatine generated as a result of this route can be rephosphorylated to PCr by aerobically consuming ATP or can undergoes a non-enzymatic cyclization to creatinine, which is eliminated in the urine. Urine creatinine measurement can be used as an indicator of increased anaerobic muscle metabolism (high urine creatinine = increased PCr metabolism)1. Secondly anaerobic glycolisis route its activated producing lactate as a result of muscular glycogen consumption. This muscle glycogen will also be depleted shortly (1-2 minutes). Acid lactic accumulates and produces certain clinical manifestations; dizziness, headache, pain in muscle groups involved in exercise, etc. There are muscular buffering systems for lactic acid which can be optimized with training and allow to move the lactic threshold to the right.
METHODS:
In this project, we measured lactate threshold and urine creatinine before and after a maximum effort test in ergometric tape in 12 members (women and men) of the diving unit of the Spanish marine infantry (aged between 22 - 40 years, mean age 37 years old) to determine the anaerobic system contribution in this exercise. We also measured plasma Hemoglobin to determine if diving training is affecting O2 plasma transport in this population. The body responds to changes in PpO2 by adjusting the activity of the erythrocytes, the O2 transport blood cells. Hypoxia and apnea related to artificial breathing conditions could result in change of O2 transport 2 .
RESULTS:
We found blood lactate increase (5.3 mmol/L ± 0.44) (lactate threshold) around 95% of maximum theoretical heart rate (174 ppm) showing no difference with regular population 3.
We found no differences in urine creatinine concentration values before and after the maximum effort test suggesting that muscular metabolism of PCr is not contributing so far to this kind of physical activity. Mean urine creatinine values before maximum effort test was 2.95 ± 0.29 mg/100 mL and mean urine creatinine values after the test was 2.97 ± 0.45 mg/100 mL.
Mean plasma hemoglobin concentration of 10 male members of the diving unit was 14, 93 g/dL showing no differences compare with regular population (13, 8 g/dL – 17, 2 g/dL).
CONCLUSION:
These results suggest that the physiological adjustments of the diving unit of the Spanish Marine Infantry due to specific training program and due to maximum effort test are not affecting renal, muscular and Oxygen metabolism.

Motor Learning and Motor control

COMPETITION IN A CONTINUOUS TAPPING TASK STABILIZES MOVEMENT.

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INTRODUCTION:
An analysis of the 2009 Men's 100m Sprint Final reported that the phenomenal world record set in this competition involved unintended interpersonal synchronization between the first and second-place sprinters (1). Contrastingly, another study reported that synchronization is theoretically applicable, although it re-analyzed this race and found no evidence to support interpersonal synchronization (2). Thus, interpersonal synchronization during competitions offers a possible explanation for the change in athletes' movements from time to time. Interpersonal synchronization involving cooperation and observation has been found to occur when individual movements are altered by interaction. Further, it has been speculated that competition also occurs when the auditory rhythm of competitors causes stable changes in mutual movements, although no results have supported this speculation (1). To clarify this, it is first necessary to examine how competition changes the time-series movement. This study used Fitts's tapping task, a cyclic arm movement constituting a simple reciprocating body movement that can be reproduced in a laboratory environment, to compare the changes of time-series movement time in individual and competitive conditions.
METHODS:
There were 16 subjects in the study. Following Fitts's task, the index of difficulty (ID) of a task determined from the target width and the distance between targets is ID6. The 15-second trial was performed twice, under individual and competitive conditions. For all trials, the coordinates of the stylus tip were obtained at 245 Hz using the Motion Capture System. The average movement time (MT) between targets per trial was calculated by determining the difference from the times corresponding to successive positive and negative peak values in

sequence and calculating the average value. In doing so, it used the coordinates of the pen tip in the direction of movement (x-axis direction) with the median value normalized to zero. The stability of the movement was also examined by calculating the standard deviation (SD) of MT for each trial.
RESULTS:
MT was significantly shorter in the competition condition than in the individual condition (individual: 0.458 ± 0.013s, competition: 0.416 ± 0.011s, $p < 0.05$). This indicates that the competition shortened the MT of the subjects. Additionally, the SD of MT was significantly smaller in the competition condition than in the individual condition (individual: 0.059±0.029s, competition: 0.036±0.012s, $p < 0.05$). This suggests that the competition reduces the variability of the subjects' MT and stabilizes the movement.
CONCLUSION:
The competition decreased the average MT and stabilized the exercise with less fluctuation in MT than when performed individually. This result suggests that competition may have made the movement more stable due to the interaction with competitors.

UTILIZATION OF STORED ELASTIC ENERGY IN NON-CONCENTRIC TAIJIQUAN

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INTRODUCTION:
Key words: Taijiquan, mind-directed, stored elastic energy, eccentric muscle contraction, concentric muscle contraction
Non-concentric Taijiquan is a mind-directed, stretchy, and springy exercise without the use of concentric muscle contraction for self-defense. The utilization of stored elastic energy without concentric muscle contraction has not been studied but it has been discussed in the martial arts community for more than a century in China. Yeung (2013) suggested that this is possible with two groups of muscles, with one group of muscles issues eccentric force while the other group recoils with stored elastic energy. The aim of this paper is to verify that it is possible to utilize stored elastic energy in Non-concentric Taijiquan.
METHODS:
The methodology is qualitative quadrilateral research method with in depth study of Taijiquan for self-defense, review by a panel of long time practitioners and teachers of Taijiquan, and a falsification process via the public forum of Rum Soaked Fist (a discussion forum for people interested in the internal martial arts), and trials by teachers with their students and participants of workshops.
RESULTS:
The design of testing the possibility of utilizing stored elastic energy with eccentric muscle contraction came from the in depth study of Taiji pushing hand techniques, its viability was proven by the panel, and it was not falsified in the public forum. Students and participants were told to stretch forward both their arms with elbows pointed downward and being pressed down to an equilibrium position with a weight produced by the researcher approximately over his or her one repetition maximum to eliminate the attempt to push the weight with concentric muscle contraction. All the subjects after clear instructions were given and some practicings can push the weight away by utilizing another group of muscles eccentrically with ease.
CONCLUSION:
The utilization of stored elastic energy in Non-concentric Taijiquan is possible and it is observable and workable for people with the knowhow, but further studies are required to produce the exact measurements for generalization as an unique feature of Non-concentric Taijiquan.
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RESPONSE INHIBITORY CONTROL VARIES WITH DIFFERENT SENSORY MODALITIES

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INTRODUCTION:
Response inhibition has an essential role in preventing anticipated and unpredictable events in our daily lives. It is divided into proactive inhibition, where subjects postpone responses to an upcoming signal, and reactive inhibition, where subjects stop an impending movement based on the presentation of a signal. Different types of sensory input are involved in both inhibitions; however, differences in proactive and reactive inhibition with differences in sensory modalities remain unclear.
METHODS:
This study compared proactive and reactive inhibitions induced by visual, auditory, and somatosensory signals using the choice reaction task (CRT) and stop-signal task (SST). Also, event related potential (ERP) was measured to examine the effects of sensory modalities on response inhibition-related neural processing.
RESULTS:
The experiments showed that proactive inhibitions were significantly higher in the auditory and somatosensory modalities than in the visual modality while reactive inhibitions were not. Examining the proactive inhibition-associated neural processing, auditory and somatosensory modalities showed significant decreases in P3 amplitudes in Go signal-locked ERPs in SST relative to those in CRT.
CONCLUSION:
The present results might reflect a decreasing attentional to response execution in SST in both auditory and somatosensory modalities. In contrast, we did not find significant differences in the reactive inhibition-associated ERPs. In conclusion, it is suggested that the sensory modality affected proactive inhibition due to the attentional to response execution for Go signal and the difficulty of the task, while reactive inhibition dose not.

IMPLICATIONS OF OPTIMAL FEEDBACK CONTROL THEORY FOR SPORT COACHING AND MOTOR LEARNING, A SYSTEMATIC REVIEW

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INTRODUCTION:
Historically, theories of motor control have always had a strong influence on what is considered best practice in the field of sport skill acquisition. This can be seen, for instance, in the influence of the schema theory on a 'prescriptive' approach to learning (1) and the influence of the ecological-dynamics approach on 'self-organization' methods of learning (2). The current study focusses on Optimal Feedback Control Theory (3), a more recent computational theory of motor control, for which operationalization to sport practice so far has been limited. We aim to formulate implications of this theory for the debate between a 'prescriptive' and 'self-organization' approach to learning and for the practical field of sport skill acquisition in general.
METHODS:
A systematic search was performed to screen for studies that have used an optimal feedback control theory-related approach to study motor learning in whole body skills.
RESULTS:
Fifty-one studies were found eligible for inclusion in this review. Results showed that 'prescriptive' training generally lowers levels of overall movement variability. Self-organization learning led to an improved variability ratio: lower outcome variability with higher variability in non-task-relevant movement components.
CONCLUSION:
We present a decision tree that practitioners can adopt to define their training method. Generally, 'self-organization' training is recommended to reap the benefits of functional, non-task-relevant variability. However, if the trainer/coach aims to specifically lower all movement variability, use of the prescriptive approach is warranted.
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Neuromuscular Physiology

THE RESIDUAL TORQUE ENHANCEMENT IS RELATED TO THE IRON CROSS PERFORMANCE ON RINGS

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INTRODUCTION:
Static strength exercises performed on the rings event (e.g., iron cross, IC) are often accomplished after an eccentric action. Comparing similar isometric actions, the isometric force increases when it is preceded by an eccentric action due to an intrinsic muscle property known as residual force (or torque) enhancement (rFE or rTE) 1,2. Therefore, it is reasonable to think that rTE could improve the performance of these gymnastic elements. The aim of this study was to investigate the impact of the rTE in the performance of the IC.
METHODS:
Seven gymnasts participated in this study. A force gauge was attached to the rings cables. Surface EMG electrodes were placed on the pectoralis major, latissimus dorsi, teres major, rhomboideus, trapezius, serratus anterior, biceps brachii, and triceps brachii. Gymnasts performed two trials: (1) a maximum voluntary isometric contraction (MVC) emulating the IC posture and (2) execution of an IC preceded by an eccentric action initiated from a support position. For each trial, we determined a recording of 2-s window with a stable force production. The selected time-window was used to compute the mean force and the root mean square (RMS) from the EMGs. In addition, we calculated: (1) the mean-torque value of the trial (estimated using the participants' arm length); (2) the rTE 1,2; (3) the global RMS of the trial; (4) the change in the percentage of activation between IC and MVC (RMS_diff%) 2; and (5) the neuromuscular efficiency (NME) 2 defined as the normalized RMS divided by the normalized torque (MVC values were used to normalize). Paired t-tests were used to assess differences between MVC and IC while Pearson correlation coefficients were used to test two relations induced by rTE and focused on: (1) the muscle activity (RMS_diff%s) and (2) the neuromuscular efficiency (NMEs).
RESULTS:
Paired t-tests showed greater values during the IC performance for the mean-torque ($p=0.005$), the global RMS ($p<0.001$), and the pectoralis major RMS ($p=0.037$), the latissimus dorsi RMS ($p=0.010$), and the biceps brachii RMS ($p=0.018$). In addition, rTE was correlated with serratus anterior RMS_diff% ($r=-0.754$, $p=0.050$), NME from global RMS ($r=-0.865$, $p=0.012$), NME from teres major ($r=-0.825$, $p=0.022$), and NME from serratus anterior ($r=-0.861$, $p=0.013$).
CONCLUSION:
Gymnasts produced greater torque values during an isometric action after an eccentric action (IC) than during an isolated isometric action (MVC), in part due to the higher activation of the pectoralis major, the latissimus dorsi, and the biceps brachii. Importantly, gymnasts who presented larger torque differences between the IC and the MVC (rTE) were more efficient at neuromuscular level indicating that IC performance could involve passive properties of the muscle-tendon complexes and of the protein titin in the sarcomeres.
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Nutrition

EFFECTS OF DIFFERENT EXERCISE MODES ON THE PROTEOMIC CHARACTERISTICS OF SUBCUTANEOUS ADIPOSE TISSUE IN HIGH-FAT DIET RATS

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INTRODUCTION:
To explore the effects of different exercise modes on proteomic characteristics of subcutaneous adipose tissue in high-fat diet rats based on TMT proteomics technology, so as to provide theoretical basis and new ideas for exercise prevention and treatment of obesity and other related diseases.
METHODS:
48 3-week-old male SD rats were randomly divided into standard quiet group (C), standard moderate-intensity continuous training group (CE), standard high-intensity interval training group (CH), high-fat quiet group (HS), high-fat moderate-intensity continuous training group (HE), high-fat high-intensity interval training group (HH) after one week of adaptive feeding, each of eight. Rats of the C, CE and CH groups were fed normal diet, while those in the HC, HE and HH groups were fed high-fat diet. The training group received the exercise intervention for 8 weeks, 5 days a week. Rats of the CE and HE groups underwent 60%-70% V(·)O2max intensity continuous treadmill training for 50 minutes, and rats of the CE and HE groups underwent 50min interval training at the intensity of 50%V(·)O2max, 70%V(·)O2max and 90%V(·)O2max. After the intervention, the body weight of the rats was weighed, the body fat percentage of the rats was measured by DEXA scanning, and the subcutaneous adipose tissue was taken for wet weight measurement. Three rats from each group who completed the intervention process were randomly selected for subcutaneous adipose tissue TMT proteomics test.
RESULTS:
After 8 weeks of intervention, the body weight and body fat rate of the rats in the CE group were significantly lower than those in the C group ($P < 0.05$), the weight of the rats in the CH group was significantly lower than the rats in the C group ($P < 0.01$). The body fat percentage of the rats in the HE group was significantly lower than that of the HC group ($P < 0.01$), but the total subcutaneous adipose tissue wet weight was significantly higher than that of the HC group ($P < 0.01$). The body fat percentage and total subcutaneous adipose tissue wet weight of the HH group were significantly lower than those of the HC group ($P < 0.01$), the body weight and total subcutaneous fat tissue wet weight of the HE group were significantly higher than those in the CE group ($P < 0.01$). The proteomics results showed that in the standard diet group, with the C group as the control, there were significant differences in 285 and 478 proteins between the CE group and the CH group. Bioinformatics showed that differential proteins were related to RNA polymerase and Toll-like receptor signaling pathway and so on. In the high-fat diet group, with the HC group as the control, there were significant differences in 38 and 164 proteins between the HE group and the HH group respectively. Bioinformatics showed that differential proteins were related to RNA polymerase and NOD - like receptor signaling pathway and so on. Under different exercise states and modes, 65, 175, 406 proteins were significantly different between HC group and C group, HE group and CE group, and HH group and CH group, respectively. Bioinformatics showed that the differential proteins were related to influenza A, hepatitis C and other disease pathways.
CONCLUSION:
Regardless of standard diet or high-fat diet, moderate-intensity continuous training and high-intensity interval training can affect the immune response and molecular transcription process in the proteome of rat subcutaneous adipose tissue, but the immune pathways affected by different exercise modes are different. High-intensity interval exercise shows better fat loss and anti-inflammatory effects. Under different exercise states and exercise modes, long-term high-fat diet will cause inflammation and metabolic pathway disorders in the subcutaneous adipose tissue of rats, and more disease pathways are involved in the quiet state. It is suggested that in daily life, exercise and diet should be controlled in combination to promote health.

EFFECT OF BEETROOT JUICE SUPPLEMENTATION ON 5-KM INTERMITTENT SWIMMING PERFORMANCE IN ELITE SWIMMERS

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INTRODUCTION:
The supplementation of beetroot juice (BRJ) has been suggested to benefit performance of cycling, running, and rowing. However, less studies were conducted to investigate the potential benefits of BRJ supplementation on long distance swimming. The present study aimed to investigate whether BRJ supplementation can improve 5-km intermittent swimming performance in elite open-water swimmers.
METHODS:
In a randomized crossover study design, eight elite open-water swimmers in Hong Kong (4M, 4F) completed two 5-km intermittent swimming training sessions (10 x 500-m), separated by two-week washing out period. Before each training session, participants were provided either 6-day supplementation of 70mL nitrate-rich BRJ per day (BRJ; 6 mmol of Nitrate) or nitrate-depleted placebo drink (PLA). In each training session, the velocity of each 500-m was recorded. The heart rate (HR), peripheral oxygen saturation (SPO2), and rating of perceived exertion (RPE) were also recorded after each 500-m swim.
RESULTS:
Compared with PLA, the velocities of the ninth 500-m and the tenth 500-m were faster in BRJ trial (BRJ vs. PLA: ninth, 1.34 ± 0.03 m/s vs. 1.32 ± 0.05 m/s, $p = 0.019$; tenth, 1.43 ± 0.04 m/s vs. 1.4 ± 0.06 m/s, $p = 0.023$). When considering the potential gender difference, the similar results were also observed in females, whereas no differences were found in velocities between BRJ and PLA in males. The HR in last 500-m was also higher in BRJ than that in PLA (193 ± 0.96 bpm vs. 184 ± 1.50 bpm, $p = 0.004$). No differences were found in RPE and SPO2 in two trials.
CONCLUSION:
The 6-day BRJ supplementation may benefit performance of 5-km intermittent swimming training in female elite open-water swimmers in Hong Kong. However, the RPE and SPO2 were not affected by the BRJ supplementation.

THE EFFECTS OF CAFFEINE ON FLOORBALL SKILL PERFORMANCE

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INTRODUCTION:
Caffeine has been known to be an ergogenic aid for sports performance and has shown improvement in team sports. Research on caffeine and sport performance has shown that caffeine can enhance athletic performances in endurance sports and team sports. However, most caffeine research to date has examined sports skill performances such as rugby and field hockey and limited research has been done on the effects of caffeine in the form of coffee on indoor sport athletes such as floorball. For this reason, there could be a possibility that consumption of coffee may improve floorball skill performance. Thus, the effects of caffeine on sports skills performance warrants further investigation. The purpose of the study was to investigate the effects of caffeine on floorball.
METHODS:
A total of 15 experienced University floorball players (8 males: age: 21.0 ± 4.0 yrs, Height: 1.70 ± 0.13 m, Weight: 63.2 ± 9.8 kg, 7 females: age: 21.0 ± 3.0 yrs, Height: 1.52 ± 0.13 m, Weight: 46.8 ± 12.3 kg) participated in this randomized, single-blind crossover study in 3 sessions (pre-test assessment and 2 experimental sessions). Participants were randomly assigned to Caffeine Group (CG) and Placebo Group (PG). In each experimental session, they ingested 6 mg/kg of body mass of either caffeine (coffee) or placebo (Decaffeinated coffee) 60 minutes prior to the floorball skill test. Participants also completed the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and a 16-item online caffeine questionnaire. Each experimental session consisted of 4 repetitions (2-minute rest between repetitions) of a maximal 30m-slalom sprint (agility), figure-8 movement station 1 (S1), station 2 (S2) (dribbling) and static shooting test (shooting).
RESULTS:
There were no significant differences between these stations variables, S1 (sprint) (PG: 17.4 ± 1.70 vs. CG: 17.5 ± 1.59 secs, p = 0.805); S1 (dribble) (PG: 19.5 ± 2.11 secs vs. CG: 19.7 ± 2.15 secs, p = 0.498); S2 (total time) (PG: 7.42 ± 0.93 secs vs. CG: 7.40 ± 0.79 secs, p = 0.861); S2 (passing score) (PG = 1.22 ± 0.38 vs. CG = 1.05 ± 0.33, p = 0.048); S3 (shooting) (4.42 ± 0.88 vs. 4.98 ± 1.01, p = 0.054). The results of the questionnaire revealed that participants drank caffeine predominantly to feel alert (3.27 ± 1.61), stay awake (3.20 ± 1.64), and concentrate (2.93 ± 1.65).
CONCLUSION:
Results of the study indicated that caffeine may not significantly improve sports skills performance. This could be due to the utilization of the anaerobic energy systems which may not have been triggered to provide more performance enhancement as exhibited by skill indices. Future studies are needed to examine the effects of caffeine on other aspects of performance that deals with the stimulation of the central nervous system. Also, investigating on responders and non responders to caffeine may give further insight on performance. However, consumption of caffeine may still prove useful for endurance athletes' performance as shown in many studies

A COMPARATIVE ANALYSIS OF THE KNOWLEDGE AND ATTITUDE OF FLUID REPLACEMENT AMONG CHINESE ELITE ATHLETES IN WINTER AND SUMMER SPORTS

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INTRODUCTION:
During exercise, the bodys metabolism speeds up, and heat dissipation is enhanced through perspiration. If fluids cannot be replenished in a timely manner, it can lead to an increase in body temperature and an increase in cardiovascular load. Scientific sports fluid replacement is beneficial to the body to maintain a stable state of hydration, and is helpful to improve the exercise ability. Based on the investigation of Chinese elite athletes' knowledge and attitudes of fluid replacement, this study conducts a comparative analysis of elite athletes in winter and summer sports, in order to provide a scientific basis for the development of health education.
METHODS:
A simple random sampling formula N=t2P(1-P)/e2 is used to determine the sample size. According to relevant literature and similar surveys, 34.2% of the survey subjects of the exercise population recognize the importance of fluid replacement for health. Let P=34.2%, t=1.96 (95% confidence level), e=4%, that is N=540. It was used to select the respondents of the athletes who played in China national and national youth teams from March to April 2020. And the questionnaire was conducted by using the questionnaire platform. Enumerative data was expressed as a percentage of the population, and differences were compared between different types of respondents using the chi-square test or Fishers exact test.
RESULTS:
A total of 792 questionnaires were collected in this study, of which 779 were valid, with an effective rate of 98.4%.
36.3% of the subjects knew the correct daily fluid volume, 89.1% knew the correct way of fluid replacement, 71.2% knew that the body was mildly dehydrated when thirsty. In summer sports, athletes of endurance sports, ball sports and combat sports had significant differences in the awareness of fluid replacement before, during and after exercise ($P < 0.01$), and the international masters of sports had the highest awareness of mild dehydration when thirsty ($P < 0.01$). In winter sports, the higher the sports level, the higher the awareness rate of fluid replacement knowledge ($P < 0.05$).
89.9% of the subjects were willing to change the habit of fluid rehydration to improve sports performance, and 40.4% of the subjects were interested in fluid replacement knowledge. The main ideal ways to acquire the knowledge of fluid rehydration were unit or team education, network and expert lecture. In summer sports, female athletes were more willing to change their hydration behavior for competition results ($P < 0.05$). In winter sports, the proportion of people who are interested in fluid rehydration knowledge increases with the level of sports.
CONCLUSION:
No matter in winter sports or summer sports, the awareness rate of fluid replacement knowledge was not high, and the attitude of fluid replacement was not positive enough. It is suggested to carry out health education on fluid replacement for athletes.

ASSOCIATION BETWEEN ANTIOXIDANT VITAMINS AND CALF VENOUS COMPLIANCE IN HEALTHY YOUNG ADULTS

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INTRODUCTION:

High consumption of vegetables has a beneficial influence on arterial and venous vascular health. Indeed, we have reported that there was a positive association between the consumption of vegetables and venous compliance, and that people with greater venous compliance tended to have lower blood pressure (Oue et al. 2020). However, it has not been investigated which nutrient factors in vegetables is related to the venous compliance yet. One of many nutrient factors in vegetables is the antioxidant vitamins such as vitamin A, C and E, which might change the vascular function and structure. For example, vitamin C is essential for the normal vascular functions of endothelial cells (e.g. control of nitric oxidant synthesis and release) (May and Harrison 2013). Vitamin E has the possibility of reducing reactive oxidant species overload in vessels, which could prevent cardiovascular disease (Tinkel et al. 2012). In addition, vitamin A could also contribute partly to the histoarchitectural alterations in vessel which is related to oxidation stress and inflammation (Gatica et al. 2012). Thus, the purpose of this study was to test our hypothesis that antioxidant vitamins have an association with venous compliance.
METHODS:
Ninety-four young healthy volunteers (44 men, 50 women; aged 19-23 years) participated in this study. Consumption of nutrients and food groups, calf venous compliance, and fitness level (maximal oxygen uptake) were measured. Consumptions of nutrients and food groups that were obtained from the self-administered diet history questionnaire were adjusted by total energy intake using the residual method. Calf venous compliance was determined using the numerical derivation of the cuff pressure–venous volume relation obtained by venous occlusion plethysmography according to a cuff deflation protocol.
RESULTS:
Simple linear regression analysis showed that venous compliance was significantly associated with α-carotene ($r = 0.259$, $P = 0.012$), β-carotene ($r = 0.386$, $P = 0.001$), α-tocopherol ($r = 0.241$, $P = 0.019$), β-tocopherol ($r = 0.212$, $P = 0.040$), but not vitamin C ($r = 0.139$, $P = 0.182$). In a multivariable model adjusted by sex and maximal oxygen uptake, the positive association between β-carotene and venous compliance remained at a significant level ($P < 0.05$), while other association did not.
CONCLUSION:
Our results suggest that higher consumption of β-carotene of antioxidant vitamin could be associated with greater venous compliance in healthy young adults.
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SODIUM PHOSPHATE SUPPLEMENTATION IMPROVES THE EFFICIENCY OF THE CARDIORESPIRATORY SYSTEM DURING EXERCISE UNDER NORMOBARIC HYPOXIA IN ENDURANCE ATHLETES

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INTRODUCTION:
Several previous studies indicate an ergogenic effect of phosphate salts intake on heart efficiency at rest and during exercise in normoxia. These changes were expressed, in particular, by a reduction in heart rate (HR), explained by an increase in stroke volume (SV) and an improvement in myocardial contractility caused by increased concentration of cell ATP. Acute hypoxia causes an increase heart rate (HR) both at rest and at given work rate, thereby increasing the myocardial energy demand. Enhancement the efficiency of the cardiorespiratory system can be beneficial for endurance athletes competing at altitude. We therefore determined the effect of sodium phosphate (SP) supplementation on HR and oxygen pulse (VO2/HR) – noninvasive index of evaluating work capacity of the cardiorespiratory system, during exercise in acute moderate hypoxia in endurance athletes.
METHODS:
Twelve trained cyclists and triathletes (age, 34,3 ±4,1 years; VO2max, 60,4 ±4,7 ml•kg-1•min-1; body height, 1,82 ±0,06 m; body mass, 71,7 ±5,7 kg; fat content, 13,2 ±2,2%) received tri-sodium phosphate (50 mg•kg-1 of fat free mass/d) or placebo for 6 days in a randomized, cross-over study, with a three-week washout period between supplementation. Before and after each supplementation phase, the subjects performed an incremental exercise test to exhaustion (40W/3 min) under normobaric hypoxia (FiO2=16%, ~2500 m). HR and oxygen uptake (VO2) were continuously registered during the test. The lactate threshold (LT) was determined by the D-max method. During the first test of each supplementation phase, HR and VO2/HR at LT workload (LT), as well as one and two workload below and above LT (LT-1, LT-2, LT+1, LT+2) were analyzed. During the next tests, HR and VO2/HR was identified at the same absolute workloads as during the first test.
RESULTS:
The results indicated a significant decrease in HR at LT workload (HRLT: 156 ±11 vs 151 ±9 bpm, $p<0,05$) and at workloads below LT (HRLT-1: 142 ±12 vs. 135 ±9 bpm, $p<0,01$; HRLT-2: 126 ±13 vs. 119 ±9 bpm, $p<0,01$) due to SP supplementation. Furthermore, VO2/HR at workloads below LT was improved. VO2/HRLT-1 and VO2/HRLT-2 increased by 6,4% ($p<0,01$) and 5,3% ($p<0,05$), respectivelly. At workloads above LT there were no significant changes in HR and VO2/HR. VO2 at a given workloads, as well as VO2max and HRmax did not change significantly after SP supplementation.
CONCLUSION:
Sodium phosphate supplementation leads to a decrease in HR and an improvement in oxygen pulse during low-intensity exercise (below lactate threshold) in endurance athletes. These results indicate an improvement in efficiency of myocardial and cardiorespiratory system, which may have a beneficial effect on exercise performance, especially during prolonged low-intensity exercise, for example during ultra-distance race in cycling, triathlon, running or cross country skiing.
*This study has been conducted in the framework of the grant awarded by the National Science Centre of Poland, No. 2019/33/N/NZ7/00376

THE EFFECTS OF WHEAT GLUTEN SUPPLEMENTATION IN COMBINATION WITH SUPERVISED RESISTANCE TRAINING ON METABOLIC AND INFLAMMATORY BIOMARKERS IN ELDERLY

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INTRODUCTION:
Adequate nutrition and moderate exercise both are thought as key roles in maintaining independence, quality of life and health especially for elderly. Due to the delayed protein digestion and absorption within a mixed meal in older adults, additional protein supplementation

may result in greater stimulatory effect muscle protein synthesis. Apart from whey proteins, the global sustainability of plant-based proteins also arouses new interest among consumers. We therefore aim to investigate the effects of wheat gluten ingestion right before and after resistance training on blood markers in elderly adults.
METHODS:
19 adults aged 65 years and above were recruited (age 72.1 ± 5.3 yrs, height 154.3 ± 7.7cm, weight 54.8 ± 8.8 kg). In a randomized, double-blind and placebo-controlled design, participants were received either 10 g of wheat gluten hydrolysate (WGH, n=10) or 10 g of placebo (PLA, n=9) right before and after each training session. Both groups attended supervised resistance training courses three times a week on non-consecutive days for 12 weeks. Resistance training was designed to train all major muscle groups using elastic bands for 45 minutes per session, and the training volume and intensity were progressively increased. Blood samples were collected in the morning by venipuncture after overnight fasting pre-, mid- and post- the 12-weeks intervention period. Blood metabolic biomarker (including metabolic panel and lipid panel) were estimated and inflammatory biomarkers, including as tumor necrosis factor-alpha (TNF-α), interleukin (IL)-6, and C-reactive protein (CRP) were measured using ELISA kits according to the manufacturer's protocol. Mixed design two-way analyses of variance (ANOVA) was used to determine differences among groups (WG and PL), and time (pre- mid, and post-) and the interaction between group and time. Analyses were performed using IBM SPSS 22.0 system.
RESULTS:
No participant left this study due to injuries or supplement-related adverse response. No significant differences were observed between groups in blood urea nitrogen (BUN) and creatinine (CRE). aspartate aminotransferase (AST), alkaline phosphatase (ALP) and alanine aminotransferase (ALT), TNF-α, IL-6 and CRP. Significant main effects were found on total cholesterol (TC) for group ($p=.046$, $\eta p2=.214$), and significant interaction was found between time and group ($p=.021$, $\eta p2=.202$) for triglyceride (TG). However, no differences were found within and between groups for HDL, LDL and TC/HDL ratio.
CONCLUSION:
The TC level in WGH group was significantly lower than PLA group after 12-weeks intervention. The 12-weeks resistance training using elastic bands in combination with WGH ingestion might evoke favored changes in lipid profile.

THE RELATIONSHIP BETWEEN BODY FAT PERCENTAGE AND JUDGING PERFORMANCE IN GERMAN WHEEL GYMNASTS

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INTRODUCTION:
In some sports which focus on aesthetic aspects such as e. g. figure-skating, gymnastics and dancing, there is a strong demand for athletes to be and look lean (Bayo, 2001; Findlay & Ste-Marie, 2004; Stokić, Srdić & Barak, 2005). This demand could lead to pressure on the athletes and cause health problems. It must be clarified whether this is also the case in wheel-gymnastics.
METHODS:
For this purpose, the body fat percentage and competitive results of 203 wheel-gymnasts (183 female, 20 male, age 21.17 ± 11.91 and 16.84 ± 4.90, body fat percentage 14.54 ± 3.4 and 8.00 ± 3.74) were assessed and tested for correlation between percent body fat and competitive results. Furthermore their body fat percentage was compared to that of athletes from aesthetic sports, and it was researched whether judges might have been influenced by percent body fat. For this purpose, technical difficulties in training and competition were compared for gymnasts with different percentages of body fat, at the same time taking into account the rating of the judges` performance according to the gymnasts and their satisfaction with the results.
RESULTS:
The difference between technical difficulty during training and competition correlates positively with body fat percentage ($p \leq .010$, $r = .268$). Gymnasts who are at the same time a) not content with judges' ratings, b) content with their own performance and c) had a higher percentage of body fat significantly differed from gymnasts where less than three of these parameters were true regarding the deductions to technical difficulty ($p \leq .000$, $\eta 2 = .323$).
CONCLUSION:
Findings suggest that the aesthetic aspect is important in wheel gymnastics. This should be taken into account by coaches and judges to prevent potential psychological or physical harm to the athletes as well as early dropout.
References
1. Bayo (2001); 2. Findlay & Ste-Marie (2004); 3. Stokić et al. (2005).

Philosophy and Ethics

Physical Activity Promotion

CASE STUDY ON IMPROVEMENT OF EXERCISE TEACHING ABILITY IN THE TRAINING COURSE OF KINDERGARTEN TEACHER

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INTRODUCTION:
Kindergarten teacher in kindergarten (including daycare and pre-school) are in charge of various education such as life guidance and exercise guidance. Programming physical activity is also an important task, and effective content for children is required. Teachers who create physical activity programs need to know a lot about various physical activities, and they need to know a lot of variations. For example, when performing physical activity using skipping rope, a general usage method (jumping a rope alone) is known. However, it is important to devise not only standard usage but also usage of pulling and passing through ropes to provide children with more effective programs. In this way, it is the ability required of the teacher to increase the variation of play by changing the setting of the equipment and adding arrangements to how to use it.
In the kindergarten teacher training course, general physical activity for young children are widely covered, but the thinking of changing the ability to arrange how to play and the use of equipment is not considered in depth. In addition, research on the ability of students to arrange exercise has not progressed.

This study was a practical study on improving the ability of students to program physical activity in a childcare worker training course (university).
METHODS:
The method proceeded as follows.
1) Present a lecture on the creation of a physical activity program for university students in the childcare worker training course (university). There, 9 examples were presented to improve the variation in how to use the equipment.
2) In the lecture to students, we conducted a questionnaire survey on variations in how to use equipment in physical activity (change of thinking). The questionnaire was given to 30 university students who took the lecture.
3) Based on the results, we considered the exercise arranging ability of university students in the nursery school training course.
RESULTS:
The number of valid responses was 22. Of the 22 people, 20 answered that their arranging ability regarding the use of equipment was greatly improved or slightly improved, and it was found that the effectiveness of this improvement in arranging ability was 90.9%.
CONCLUSION:
In this study, in addition to being able to focus on the ability of teachers to arrange exercise, which is important in providing physical activity programs to children, we also obtained findings for improving that ability. Since this study was limited to arranging the use of equipment, it is necessary to investigate the use of equipment and the arrangement of exercise in the future.

FACTOR ANALYSIS FOR ACTIVITIES IN COMPREHENSIVE COMMUNITY SPORTS CLUBS USING QUANTITATIVE THEORY TYPE TWO

SAKAGUCHI, H.1, AOYAGI, O.2, ANNOURA, T.1, SEO, Y.3, CHOI, T.4, HAN, N.4, HONG, T.4, KOO, K.5, NAM, Y.6

1> JAPAN UNIVERSITY OF ECONOMICS, JAPAN, 2> FUKUOKA UNIVERSITY, JAPAN, 3> CHOSUN UNIVERSITY, KOREA 4> JEJU NATIONAL UNIVERSITY, KOREA, 5> CHANGWON NATIONAL UNIVERSITY, KOREA, 6> DUKSUNG WOMEN'S UNIVE

INTRODUCTION:
Comprehensive community sports clubs (CCSCs) are one of the political measures that Japan started in 1995 to build a life-long sport society. CCSCs are community-based sport clubs that offer the chance to play various kinds of sports depending on the interests and athletic level of persons over a wide range of ages. Although the ideal would be that people in the community take the lead in establishing and managing CCSCs, it does not function like that. This means that local governments have no choice but to take the lead in the project in place of the community depending on that community. It would be best if more people who wished to exercise or play sports participated in CCSCs to develop and improve CCSCs further. There are two groups – those who play sports in CCSCs and those who do not among people who have a need to play sports. Thus, this study aimed to statistically investigate the factors distinguishing between those who play sports in CCSCs and those who do not among people who regularly play sports in Japan. Considering that the independent variables are nominal, Quantification Theory Type Two (QTTT) was used.
METHODS:
A questionnaire was conducted comprising the eight items of "gender," "age," "free time," "means of transportation," "confidence in own physical fitness," "lessons other than exercise or sports," "information about sport clubs from the media" in addition to the item of "whether belong to an CCSC or not." The survey was given to 1,361 people. Of these, the responses of the 649 people who answered that they regularly exercise or play sports were used for the statistical analysis. QTTT with belonging to a CCSC as a dependent variable was used after dummying the seven independent variables to find the significant factors out of the seven items. The total goodness of the fit was assessed by deviance analysis and the extent to which the independent variable is related to the dependent variable was evaluated by ranges of category weights and the significance of the partial correlations.
RESULTS:
The result of QTTT showed that the multiple correlation ratio was 0.309. This was significant ($p<0.001$) in deviance analysis.
Moreover, the correct discriminant ratio was 66.83%. The obtained category ranges were 2.02 in "free time on weekdays," 1.89 in "free time at weekends," 1.80 in "transportation time," 0.77 in "like or dislike of PE classes in elementary school," 0.65 in "means of transportation," 0.40 in "confidence of own physical fitness" and 0.36 in "gender," respectively. Again, the significant partial correlation coefficients were 0.200 in "free time at weekends," 0.188 in "free time on weekdays," 0.104 in "transportation time" and 0.086 in "means of transportation," respectively.
CONCLUSION:
Whether people play sports in a CCSC among those who regularly exercise or play sports depends on how much free time they have in their daily lives and the transportation time from their home to the place where they play sports.

THE RELATIONSHIP BETWEEN THE NUMBER OF PEOPLE WHO PLAY SPORTS TOGETHER AND VARIOUS FACTORS

IKEDA, T.O.1, SAKAGUCHI, H.2, ANNOURA, T.2, AOYAGI, O.3, HONG, Y.4, HAN, N.4, CHOI, T.4, NAM, Y.5, KOO, K.6, SEO, Y.7

1 NISHI-KYUSHU UNIV., JPN, 2 JAPAN UNIV OF ECONOMICS, 3 FUKUOKA UNIV., JPN, 4 JEJU NATIONAL UNIV., KOR, 5 DUKSUNG WOMENS UNIV., KOR, 6 CHANGWON NATIONAL UNIV., KOR, 7 CHOSUN UNIV., KOR

Introduction
Although people exercise or play sports with many people in PE classes or extracurricular activities when students, after graduating, they come to exercise or play spots with various numbers of people depending on their lifestyle or way of thinking. For their health, people jog alone or engage in radio calisthenics with many people early in the morning after gathering near a park or elsewhere. However, it is also possible to go jogging with many people and to engage in radio calisthenics alone at home. The question of the number of people with whom people exercise or play sports with is thought to relate various factors. Thus, the purpose of this study was to investigate the relationship between the number of people with whom people exercise or play sports and various factors.
Methods
The subjects were 1,397 Japanese people ranging in age from late teens to middle age. They were asked to answer a questionnaire consisting of 12 items that seem to be related to the number of people with whom they exercise or play sports together: gender, age, free time in daily life, self-assessment of own physical fitness, like or dislike of PE classes in childhood, lessons other than exercise, introversive/extroversive and the cost of sports or illness. Additionally, three questions on whether they want to play sports alone (ALONE), to play sports with two to four people (TWO TO FOUR) or to play sports with five or more people (FIVE) were also asked. After tabulating cross

tables between the former and latter items, a chi-squared test was conducted. If the chi-squared test were significant, subsequently adjusted residuals were also computed and a tendency of association was determined from the pattern of significant cells in the cross table.
Results
Among the items indicating a significant association, the following combination between items showed significant and different association pattern by number of people exercise: In terms of age, no significant association was found in ALONE, but a significant association was found in the combinations between people in their 20s and TWO TO FOUR, and between people in their teens and FIVE. The less free time they have on weekdays, the more ALONE. However, others did not show any such association. In regards to free time at weekends, significantly many ALONE chose less than one hour, and TWO TO FOUR about one hour. Again, many people of ALONE and TWO TO FOUR engaged in lessons other than sports. In the item of introversive/extroversive, many ALONE regarded themselves as introversive and the others introversive a little bit.
Conclusion
Many people who exercise or play sports alone have little free time in their daily lives irrespective of their age, enjoy lessons other than sports and think of themselves as introversive. Those who want to play sports with many others are young, have little free time, and have wide individual differences in lessons other than sports.

THE RELATIONSHIPS BETWEEN MINDFULNESS, PHYSICAL ACTIVITY, AND SEDENTARY BEHAVIOR IN COLLEGE STUDENTS

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PEKING UNIVERSITY

Introduction
Mindfulness plays a key role in the mental health of college students. Although there is an increasing number of studies examining the relationship between mindfulness and physical activity, the findings are mixed and inconclusive. Most of previous research has shown that there is a positive association between mindfulness and physical activity while some studies indicate no correlation between them. Additionally, so far there seems to be no direct evidence of a relationship between mindfulness and sedentary behavior in college students.
Methods
A cross-sectional study was conducted with 1252 undergraduate students (mean age = 19.6 years, 42% females) from a large public university in China. Participants were asked to complete questionnaires measuring PA, SB, and MD. Vigorous-intensity PA (min/week), moderate-intensity PA (min/week), light-intensity PA (min/week), total PA (MET-min/week), and sitting time (min/day) were derived from the International Physical Activity Questionnaire (IPAQ). A composite score of mindfulness was calculated using the Mindful Attention and Awareness Scale (MAAS). Five multiple regression models were performed with MD as the dependent variable and the vigorous-intensity PA, moderate-intensity PA, light-intensity PA, total PA, and sitting time as the predictors, respectively. Age, gender, and Body Mass Index (BMI) were included in all models as covariates.
Results
All PA variables including vigorous-intensity PA ($\beta = 0.035$, $p = .31$), moderate-intensity PA ($\beta = 0.017$, $p = .46$), light-intensity PA ($\beta = 0.012$, $p = .49$) and Total PA ($\beta = 0.034$, $p = .32$) were not significant predictors for mindfulness. However, higher sitting time was associated with lower levels of mindfulness ($\beta = -0.096$, $p < .01$). For the covariates, age, gender, and BMI were insignificant in all models (p's $> .05$).
Discussion
Physical activity level is not related to mindfulness while sedentary behavior has a negative relationship with mindfulness in college students. Our findings suggest that more attention should be paid to helping college students to reduce sitting time.

CORRELATIONAL STUDY OF THE FACTORS TO KEEP ON EXERCISING REGULARLY AFTER GRADUATING FROM UNIVERSITY

ITO, H.1, SAKAGUCHI, H.2, ANNOURA, T.2, AOYAGI, O.3, HONG, Y.4, HAN, N.4, CHOI, T.4, NAM, Y.5, KOO, K.6, SEO, Y.7
1KYUSHU UNIVERSITY OF HEALTH AND WELFARE,2 JAPAN UNIVERSITY OF ECONOMICS,3 FUKUOKA UNIVERSITY,4 JEJU NATIONAL UNIVERSITY,5 DUKSUNG WOMEN`S UNIVERSITY,6 CHANGWON NATIONAL UNIVERSITY,7 CHOSUN UNIVERSITY

INTRODUCTION:
The goal of PE classes in universities is not only to improve physical fitness and sport skills while at university but also to ensure students keep on being involved with sports for all their lives. However, even though students exercise regularly based on their PE classes or sport clubs during their time at university, after graduation, while exposed to various factors, whether they play sports or exercise regularly is determined by their own intentions. It is useful to clarify what factors are involved with regular exercise after graduation to consider the measures to ensure regular exercise and sports throughout the lives of students. Accordingly, this study statistically examined the factors that discriminate between those who regularly exercise or play sports and those who do not. However, especially in this study, Quantification Theory Type Two (QTTT, discriminant analysis with dummy variables as independent variables) was used because the independent variables are related and categories.
METHODS:
A total of 542 people ranging from 23 to 40 years of age were asked to answer questions comprised of eight items: gender, age, usual free time, self-assessment of own physical fitness, like and dislike of PE classes in elementary school, and lessons other than exercise. QTTT using regular exercise as a two-category dependent variable and eight questionnaire items as independent variables was conducted on the data. The goodness of the fit of the model was conducted using deviance analysis and the relationship between the dependent variable and independent variables using ranges of category weights and the significance of partial correlations.
RESULTS:
As a result of QTTT, the multiple correlation ratio was 0.393. This indicates a significant difference in the deviance analysis ($p<0.001$) and a correct discriminant ratio of 68.88%. The largest range was 2.499 in “Age,” followed by 1.510 in “Free time at weekends,” 1.426 in “Free time on weekdays,” 0.999 in “Lessons other than exercise,” 0.663 in “Confidence in own physical fitness,” 0.482 in “Gender” and 0.471 in “Like or dislike of PE classes in elementary school.” The smallest range was 0.268 in “Means of transportation." Moreover, the largest partial correlation was 0.205 (5.05, $p<0.001$) in “Lessons other than exercise,” followed by 0.196 (4.80, $p<0.001$) in “Free time at weekends,” 0.181 (4.40, $p<0.001$) in “Free time on weekdays,” 0.132 ($p<0.01$) in “Confidence in own physical fitness,” 0.110 ($p<0.01$) in “Age” and 0.094 ($p<0.05$) in “Gender.” This indicates significant differences.
CONCLUSION:

People who regularly exercise or play sports are males, confident in their physical fitness, and have lots of free time irrespective of whether this is on weekdays or at weekends. Regularly exercising or playing sports is regarded as being similar to cultural lessons. The time to go to where exercise is done or sport is played is not a decisive factor because of the development of transportation.

EXPERIENCING CO-CREATION OF HIDE-AND-SEEK GAMES VIA VIDEO CONFERENCE MOTIVATES VARIOUS PEOPLE INCLUDING ADULTS TO PLAY HIDE-AND-SEEK OUTSIDE

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Introduction
Hide-and-seek is one of the most popular physical activities in the world. The game encourage us moderate exercise and close communications regardless of age or physical abilities. In addition, we are able to keep the social distance much easier than the other sports while playing. During COVID-19 crisis, playing hide-and-seek contributes people's health around the world. Though hide-and-seek has much fun and many health benefits for us, most of adults have lost motivations to play it or have felt embarrassed by its childish impression. In this study, we tried to refurbish an image of hide-and-seek as fun for everyone thorough online workshop in which participants co-created new hide-and-seek games and played them with various people.
Methods
During the state of emergency, we organized an online workshop named "Online Hide-and-Seek Party." In this event, participants experienced co-creation of new hide-and seek games which can be played using a video conferencing system. After the event, we asked them what they found in their co-creation activities and hide-and-seek itself. In the upcoming months, we also held an "Outside Hide-and-Seek Party" several times and conducted interviews with participants. These outside events did not include specific co-creational activities.
Results
21 adults (aged 23-59) and 4 kids (aged 6-11) were gathered on a Zoom Meeting from around the country. In the online event, several games were created in 2 hours. Those games were including different kinds of physical activities (specific senses or body movements) suited for their rooms, goods and the field of view. Over 80% of them were satisfied with the online event. They noted that they deeply thought about essence of hide-and-seek and enjoyed discussion with group members as well as playing the games. Also they got new insights about difference in online hide-and-seek games and outside hide-and-seek games. After that, 8 of them (7 adults and 1 kid) joined the outside events. Their statement after the outside hide-and-seek game was much more concrete than the others who only experienced outside event.
Discussion
Hide-and-seek is still attractive enough to motivate people of all ages to play it, even though there are many kinds of sports and entertainments including digital contents. Both online and outside events proved that we can play and enjoy it enthusiastically with people of different ages. In the "Online Hide-and-Seek Party," the mission to create a new hide-and-seek game with limited environment (in the room, via video conference system) must have led participants to think deeply about the essence of hide-and-seek. Additionally, they could seek the fun for their own and understand individual needs during co-creational activity. Through these experiences, they became not to feel hide-and-seek childish and to recognize it as their favorite game. Such a change of mind seems to have made them more excited in the outside hide-and-seek games.

Physical Education and Pedagogics

NON-FACE-TO-FACE CLASS DESIGN AND OPERATION STRATEGY FOR UNIVERSITY STUDENT ATHLETES

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INTRODUCTION
Due to COVID-19, student athletes also conduct classes non-face-to-face. Students and professors in the new environment of non-face-to-face instruction experienced difficulties in changing lessons. The spread of online classes is a continuous phenomenon in the educational field. Despite the increasing demand for online classes, studies on the conversion of physical education classes with many practical subjects are insufficient.
METHODS
This study is to explore a plan for the transition from face-to-face classes to online classes. This study first considered prior research on online class conversion, and second, introduced flip and blended learning, which were introduced as innovative teaching methods in traditional face-to-face classes. Finally, a non-face-to-face instructional strategy was proposed for the management of physical education subjects.
RESULTS
As a result of the review of previous studies, [1] identified obstacles in the process of transition to online classes. 1) The necessity of redesigning the class structure, 2) Inadequate for existing teaching strategies, 3) Low preparation for online classes by professors and students, 4) limited understanding and support of online classes at universities, 5) Difficulties in designing activities other than classes were presented.
Second, for the analysis of flip learning activities, the instructional stages of flip learning were examined. Most of the flip-learning-related research that have been conducted show that the teaching stage is the stage of interaction and reflection of lessons that appear outside the classrooms of instructors and learners [2][3]. The main learning methods were found to apply educational skills, lectures, discussions, coaches and mentoring to the mixed on/offline education environment.
Third, it is a non-face-to-face instructional strategy for the management of subjects in the Department of Physical Education. In [4], it is proposed: 1) The government department of the gymnasium provides a variety of materials related to sports that can be used in universitys liberal arts classes. 2) Each university should provide a place for training and education to operate online lectures and improve professionalism for professors and lecturers. It should have responsibility for the management of student-centered education and training of talent. 3) The instructors suggested that they should constantly learn, strive, and have a challenging attitude to become professional.
DISCUSSION AND CONCLUSION

Flip and branded-learning can be applied to non-face-to-face curriculum operations such as practical classes in the Department of Physical Education. For professors to demonstrate their competencies, in the upcoming era of distance education, various education and training are required to identify obstacles in instructional design and successfully design instructional style.
1. Do (2020) 2. Bergmann & Sams (2012) 3. Bishop & Verleger (2013) 4. Kim & Chun (2020)

A STUDY ON THE TECHNICAL TYPES AND THE VIEWPOINT OF SETTING THE TARGET IMAGE OF "CLEAR HIP CIRCLE TO HANDSTAND" ON UNEVEN BARS

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INTRODUCTION:

Having a clear target image is important for coaches when teaching exercise. The "clear hip circle to handstand" of uneven bars in womens gymnastics, which is discussed in this study, is a technique that many athletes have learned as a basic technique. However, there are multiple techniques to achieve the task of that technique. Gymnasts must properly select and acquire the techniques that will lead to the development of their skills.

The purpose of this study is to investigate the problems in setting up a target image for teaching "clear hip circle to handstand" on the uneven bars from the perspective of phenomenological movement theory (Kaneko, 2002) and to improve the teaching methodology.

METHODS:

In this study, the analysis was conducted based on the video of "clear hip circle to handstand" by university gymnastics athletes and the content of questions about the senses (consciousness) of the athletes. The analysis was based on Kanekos theory of "Observation analysis" and "Communication analysis" (Kaneko,2005), and Meinels theory of "Impression analysis" (Meinel,1960). Among them, we paid particular attention to the rising phase from the inverted hung and clarified the characteristics of the movement.

RESULTS:

As a result of the analysis, two types of methods were confirmed as the characteristics of the movement from the inverted hung phase to the rising phase. One of the methods was to get a trigger for ascent by bending the wrist and head dorsiflexion (Type A). And the other method was to increase the shoulder angle without bending the wrists and head dorsiflexion (Type B). In addition, consideration was given to how the difference in the method affects the acquisition of advanced techniques.

CONCLUSION:

As a result of the consideration, the following became clear.

1) Athletes who do not have high "clear hip circle to handstand" skills or who have not mastered development skills mainly use the type A method, and many athletes who have mastered development skills use the type B method.

2) The movement used in "Inner front support on LB – clear hip circle through handstand with flight to hang on HB (Schaposchnikova)" was the type B method.

3) Looking at the acquisition of advanced techniques, it is suggested that athletes who have achieved "clear hip circle to handstand" in type A need to relearn the method in type B at an early stage.

Through the above discussion, the technique of "clear hip circle to handstand" to be learned on uneven bars was clarified, and suggestions for coaching methods were obtained.

SOCIO-MOTOR EXPERIENCE BETWEEN AFFECTIVITY AND MOVEMENT FROM HARRY POTTER AND LORD OF THE RING

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Teenagers today have little knowledge about how to move or play together. The adults who are part of sport culture must find an effective way to foster this essential ability.

Our research in Italy uses a "holistic model"based on fantasy literature to explore the relationships between the game identities and self identities of young people and the achievement of psycho-motor, emotional and social well-being in the realms of sport and education. Physical activity projects were carried out in schools and extra-curricular associations in Rome, combining outdoor activities and distance learning.

This holistic and malleable game model inspired by fantasy accounts of the journeys taken in The Lord of Rings and Harry Potter books. We know that many have a lot of resistance to the idea of using fantasy and play as a pedagogical tool, but the results obtained in this experience are surprising.

Our interventions and investigations they focused on promoting self-esteem, awareness, a sense of belonging, social integration, cooperation, well-being, and informned decision making: a basis for heathy and effective citizenship.

For teenagers creative thinking is the right stimulus to involve and compare the story of characters to their own journey through social and self- reflective identity analysis.

We observed how important is to engage students emotionally as well as cognitively and that enabling them to play with identity through relationships with peers.

There is a need today for a multidisciplinary synthesis of analog and digital values, especially in response to recent distance-living experiences. There is a need for a global reconceptualization of free-time and nature in the human experience.

METHODOLOGICAL IN-SERVICE TRAINING PROGRAMS FOR PE TEACHERS TO SUPPORT A LIFELONG ACTIVE LIFESTYLE

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EÖTVÖS LORÁND UNIVERSITY, HUNGARY

Introduction

An effective school consciously views its activities in terms of its students 'learning outcomes. School physical education achieves its goals if students also acquire the knowledge and attitude necessary to pursue a lifelong active lifestyle during the years of public education. For this, it is worth applying a methodology that increases learner's motivation worldwide. The methodology also recommends exploiting the benefits of activity-based forms of learning organization, differentiated individual work and the social nature of learning. In most cases, this also requires a change in the attitudes and practices of physical education teachers. To achieve this, several programs have been launched

around the world, basically aimed at increasing the motivation for physical education and exercise of students. In our study, our goal is to analyse these programs and to present our own program.
Methods
The initial sample of the research was provided by 17,400 publications (as of 2010) published in the Google Scholar search engine, with the search phrase “Autonomy Supportive Intervention Program for PE”. The analysis included longitudinal, multi-stage and multi-faceted physical education teacher training programs: based on the TARGET model; ASIP; ASIP-WB. Our analysis focused on the structure of the programs and the results of the efficiency measurement. Based on all this, our further goal was to develop our own PE teacher training program.
Results
Effective training programs consist of short (2 hours - 1 day) units in several elements with different content (theoretical foundation, practical modelling, individual problem solving, expert consultation, mentoring support, self-reflection-based professional group discussion). Professional aids and samples have a positive effect, these are available in many forms of data (oral, written, video) during the entire duration of the intervention (half a year or two years). Teacher development can be determined by measurements based on self-reports and detections by external observers, as well as by monitoring their perceived effects on learners (learning and motivational environment, psychological needs, motivation and amotivation).
Our own program is a 2-year reflective program with one day training every two months. We test the theoretical basis with practical examples. Knowledge sharing and social support take place on a common online platform. Its effectiveness is monitored by input and output measurements.
Discussion
Based on the programs, specific organizational, procedural and cognitive elements are discoverable. All of these are able to increase teacher autonomy support. There is a new aspect that has been included in the trainings in recent years, and which increases efficiency. This is the strengthening of teachers belief that the methodology supporting autonomy is easily introduced and applied.
Keywords: autonomy support education, physical education teacher training, student motivation

Physiology

LOCALISATION OF BONE MARROW CELLS IMPLIED IN TRANSCRIPTIONAL FHL2 FACTOR SYNTHESIS AFTER RUNNING

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INTRODUCTION:
The physical activity has incidences on musculo-skeletal system and is able to enhance performances or structures.
We have previously shown that running, for example, induce the synthesis of the multifunctional protein FHL2 in the bone marrow cells (BMC)[1]. This protein is involved in mechano-transductive signalling pathways (MTSP) driving the differentiation of bone marrow progenitors Mesenchymal Stem Cells (MSC). It contributes to the regeneration or the repair of mesenchymal tissues such as bone, cartilage, muscle, ligament, tendon, and adipose tissue[2]. MSC are found in yellow marrow of the diaphyseal part of long bones.
Hematopoietic Stem Cells (HSC) are responsible for the production of blood cells. They are immature cells and are found in the red marrow of ephyseal part of long bone. The FHL2 is also an actor for maintaining HSC quiescence or survival under pathological stress. The deregulation of expression of this protein may predispose to the development of hematopoietic disorders[3].
We hypothesized that running could impact differently FHL2 transcription in yellow and red BMCs and as consequence in diaphyseal and epiphyseal part of long bones.
METHODS:
12 Wiwtar male rats (7-week-old) were randomly allocated to one of the following groups: SEDentary (SED), RUNning (RUN) (n=6 per group).
The running training protocol was performed on the treadmill, 45 min per day, 5 days, for 8 consecutive weeks. RUN consisted in 7 repetitions of blocks of 3 min at 70 % Maximal Aerobic speed (MAS), followed by 2 min at 100 % MAS and 1 min of passive recovery. The animals were euthanized and then the radii were excised and fixed 1 day after the last training session. Bone samples were decalcified, embedded in paraffin and cut longitudinally with a microtome from diaphyseal proximal to distal epiphyseal. FHL2 identification in BMCs was performed by immuno-histo-chemistry. Slides were observed under an optical microscope and qualitative observation was realized.
RESULTS:
We don’t observe FHL2 labelling in the BMCs of SED, whereas a labelling appears in the BMCs of RUN. Even more, The FHL2 labelling is observed in the bone marrow cells of the diaphyseal part and not in the metaphyseal or epiphyseal parts of long bones.
CONCLUSION:
These results suggest that mechanical impacts generated by RUN activate a MTSP involving FHL2, in diaphyseal bone but not in ephyseal bone.
In reference to the presence of MSCs in the diaphyseal part of long bones and to the principal presence of HSC in epiphyseal part of long bone we suppose a specific activation of FHL2 transcription in CSM for the proliferation and the differentiation of these cells.
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EFFECT OF RESIDENCE AT ALTITUDE ON OXYGEN TRANSPORT PARAMETERS, BLOOD VOLUME AND PEAK OXYGEN CONSUMPTION IN ADOLESCENT ENDURANCE-TRAINING ATHLETES

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INTRODUCTION:
Total hemoglobin mass (Hbt) and blood volume (BV) determine the blood O2 transport capacity, which is typically related with peak O2 consumption (VO2peak) as a determinant of the aerobic performance [1]. Altitude hypoxia and endurance training affect Hbt and VO2peak

but their effects are poorly studied in athlete adolescent populations. Thus, this study was aimed to analyze the effect of altitude on hematological and VO2peak variables in male and female adolescent athletes from different endurance disciplines.
METHODS:
A total of 110 adolescents (21 females and 89 males) classified into Tanner's stages III and IV participated in the study. All were elite athletes engaged in endurance sports (skating, running and cycling) belonging to two groups of different altitude permanent residents: LA (low altitude: 966 m) and MA (moderate altitude: 2,640 m). Hematocrit (Hct), hemoglobin concentration ([Hb]), Hbt and blood, plasma and erythrocyte volumes (BV, PV and EV) were measured according to the CO-rebreathing method [2], and VO2peak and other cardiorespiratory parameters were evaluated after an incremental test.
RESULTS:
Sex differences were evaluated in skating practitioners and the results demonstrated that male adolescent athletes had significant higher values than females in all hematological parameters related to O2 transport and in VO2peak, both under LA and HA conditions. In male population engaged in skating, running and cycling disciplines the effect of altitude residence was evident in Hct, [Hb], Hbt and EV. Residents at MA had significant higher values in hematological parameters with increases ranging from 14% to 18% and in EV (5% to 24%). These increases matched the significant higher values of VO2peak measured in MA residents. However, BV and PV did not show statistical differences between LA and MA residents in any case. In male athletes, sport discipline did not influence the hematological variables nor most of the cardiorespiratory parameters.
CONCLUSION:
Sex differences in erythropoiesis are already evident at Tanner III-IV stages in both LA and MA residents. Moreover, male adolescent MA residents practicing endurance-training disciplines had an increased erythropoietic response and a higher VO2peak compared to those residing and training at LA. These findings match those reported for adult athletes [3] indicating that aerobic training in altitude elicits similar responses in adult and in Tanner III-IV stage adolescent athletes. Moreover, in male athletes, the responses are similar in the three aerobic sports studied. All these findings indicate that, irrespective to the sports discipline, the oxygen transport parameters and VO2peak are highly sensitive to chronic hypoxia expose because of residence at altitude.
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CHANGES IN THE HEART POSITION IN CHEST AND ABDOMINAL BREATHINGS WHILE STANDING AND 3-POINT INVERTED HANDSTAND POSITION

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INTRODUCTION:
We revealed that the heart significantly shifted to the left in water as compared with that out of water. Therefore, this research We measured breathing in two ways: from the chest and abdomen and in two positions: standing upright and in a 3-point handstand position. This study aimed to clarify the effect of breathing on heart placement.
METHODS:
Nine young, healthy males with no medical history of cardiac diseases (age: 21 years old, stature: 171 cm, weight: 67 kg, % body fat: 17 %, resting heart rate: 82 bpm) participated in this study. The amount of change in the horizontal directions of the heart position was measured, with the mitral valve as the starting point. The subjects performed one cycle of inhalation–exhalation and one cycle of maximum inhalation–maximum exhalation for breathing. All protocols of this study were approved by the ethics board at Kawasaki University of Medical Welfare and conformed to the Declaration of Helsinki. The authors declare that there is no conflict of interest regarding the publication of this article.
RESULTS:
The heart position is expressed by the amount of change from standing at rest. 【Standing upright】 In chest breathing, the heart shifted 15 mm to the right side during maximal inspiration and 2 mm to the left side during maximal expiration. In abdominal breathing, the heart shifted 14 mm to the right side during maximal inspiration ($p < 0.05$) and 3 mm to the left side during maximal expiration. 【3-point hand stand】 The heart shifted 3 mm to the left side during the 3-point handstand position as compared with standing at rest. In chest breathing, the heart shifted 7 mm to the right side during maximal inspiration and 6 mm to the left side during maximal expiration. In abdominal breathing, the heart shifted 9 mm to the right side during maximal inspiration and 8 mm to the left side during maximal expiration.
CONCLUSION:
The heart significantly moved to the right side during maximum inspiration of abdominal breathing as compared with standing, thereby greatly affecting the diaphragm during abdominal breathing. The heart did not significantly move during the 3-point handstand position. Thus, the rib cage did not move fluently because the diaphragm descends in the direction of gravity. The swing width during standing (maximum inspiration–maximum expiration was 17 mm for both chest breathing and abdominal breathing） significantly did not change. The swing width during the 3-point handstand position (maximum inspiration–maximum expiration on chest breathing was 13 mm and maximum inspiration–maximum expiration on abdominal breathing was 17 mm） also significantly did not change. Therefore, it was considered that the change in heart position during the standing and 3-point handstand positions was similar.
The swing width did not change during the standing and 3-point handstand positions.

INFLUENCE OF THE MENSTRUAL CYCLE ON MUSCLE GLYCOGEN UTILIZATION WITH HIGH-INTENSITY INTERMITTENT EXERCISE UNTIL EXHAUSTION IN EUMENORRHEIC WOMEN

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INTRODUCTION:
Premenopausal women experience changes in blood concentrations of estrogen and progesterone throughout the menstrual cycle. The menstrual cycle is divided into the early follicular phase (E-FP) (with low serum concentrations of both estrogen and progesterone), late follicular phase (L-FP) (with high serum estrogen but low progesterone concentrations), and the luteal phase (LP) (with high concentrations

of both estrogen and progesterone). Several studies have reported greater muscle glycogen utilization during moderate-intensity steady-load exercise in the LP than E-FP. However, the effects of high-intensity intermittent exercise until exhaustion and/or estradiol alone (L-FP) during the menstrual cycle have not been studied. Here, we investigated the effects of the menstrual cycle on muscle glycogen and circulating substrates during high-intensity intermittent exercise until exhaustion in eumenorrheic women.
METHODS:
Subjects comprised 11 eumenorrheic women (age, 20.2 ± 1.3 years; height, 161.1 ± 4.8 cm; weight, 55.5 ± 5.7 kg; body mass index, 21.4 ± 2.3 kg/m2), who were engaged in habitual, recreational exercise (aerobic exercise <120 min/time; 2-3 times/week). All subjects participated in high-intensity exercise until exhaustion on a cycle ergometer during the E-FP, L-FP and LP. Blood samples were collected and muscle glycogen concentration was evaluated by 13C-magnetic resonance spectroscopy before (Pre) and immediately after exercise (Post). Concentrations of estradiol, progesterone, blood glucose, lactate, free fatty acid (FFA) and insulin were assessed.
RESULTS:
Serum estradiol concentrations were significantly higher in the L-FP and LP than in the E-FP both Pre (E-FP, 38.3 ± 19.1 pg/mL; L-FP, 206.0 ± 114.5 pg/mL; LP, 180.3 ± 42.6 pg/mL; $p<0.01$) and Post (E-FP, 45.2 ± 16.9 pg/mL; L-FP, 245.6 ± 137.7 pg/mL; LP, 223.5 ± 68.0 pg/mL; $p<0.01$). Serum progesterone concentrations were significantly higher in the LP than E-FP and L-FP Pre (E-FP, 0.2 ± 0.2 ng/mL; L-FP, 0.5 ± 0.3 ng/mL; LP, 11.9 ± 4.6 ng/mL; $p<0.01$) and Post (E-FP, 0.5 ± 0.4 ng/mL; L-FP, 0.6 ± 0.4 ng/mL; LP, 10.0 ± 4.6 ng/mL; $p<0.01$). Muscle glycogen utilization by exercise was significantly greater in the L-FP (59.0 ± 12.4 mM) than E-FP (48.3 ± 14.4 mM) ($p<0.05$), with no differences between the E-FP and LP (49.8 ± 11.6 mM) and the L-FP and LP in muscle glycogen utilization with exercise. Blood glucose, lactate, FFA and insulin concentrations were not significantly affected by menstrual cycle phase Pre and Post (blood glucose, $p=0.16$; lactate, $p=0.76$; FFA, $p=0.23$; insulin, $p=0.72$).
CONCLUSION:
Our results suggest that the menstrual cycle might influence muscle glycogen utilization during high-intensity intermittent exercise until exhaustion in eumenorrheic women with habitual exercise activity.

EXAMINING TRANSCUTANEOUS CARBON DIOXIDE ABSORPTION AS A MODEL TO DIFFERENTIATE HYPOXIC AND HYPERCAPNIC EFFECTS OF BLOOD FLOW MANIPULATION

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INTRODUCTION:
The role of tissue hypoxia and hypercapnia toward affecting muscular adaptations during blood-flow restricted (BFR) training is unknown. While hypoxia is commonly cited as the major driver of BFR-induced adaptations, attribution as such ignores that oxygen (O2) and carbon dioxide (CO2) are affected simultaneously during blood flow manipulation. Promoting local tissue hypercapnia in the absence of hypoxia would provide an experimental model to understand adaptations resulting from the hypercapnic cascade rather than the restriction of oxygenated blood. Therefore, we sought to determine whether transcutaneous CO2 gas administration can independently alter CO2 blood levels without the need to restrict flow and alter O2 delivery.
METHODS:
On two separate days, participants (5f/13m; 26±4yr; 173±7cm; 73±11kg) rested supine for 90min while wearing an inflatable rubberized suit that was filled with room air (CON) or 100% CO2 (EXP) and then deflated for 30min. On a third day a subgroup (n=7) performed a time-matched protocol while inspiring a 5% CO2 gas mixture (GAS); as a positive control. VCO2, end-tidal CO2, PCO2 and PO2 were monitored at specific time points over the 2hr period via indirect calorimetry and venous blood samples drawn from an indwelling brachial catheter. A two-way (time x condition) RM-ANOVA was performed to determine effects on blood CO2 (and O2) over time, with the assumption that CO2 must first be absorbed through the skin to appear in circulation.
RESULTS:
Full-body transcutaneous CO2 exposure resulted in significant increases in VCO2 and end-tidal CO2 but not PCO2. VCO2 was elevated from baseline between minutes 60 and 110 ($p<0.01$) of the EXP visit (Δ=24-32ml/min). Post hoc analysis indicated a hyperventilatory response between minutes 90-100, which contributed to the increase in VCO2. End-tidal CO2 values differed from baseline during specific exposure periods (between 35-45 and 65-75min of exposure; Δ from baseline=1.4 ($p=0.04$) and 1.3 ($p=0.01$) mmHg). Maximal changes during the GAS visit were 120ml/min, 9.2mmHg and 5.3mmHg for VCO2, end-tidal CO2 and PCO2, respectively. No changes in VCO2, end-tidal CO2 or PCO2 were observed during the CON visit and no changes in PO2 were observed during CON or EXP conditions.
CONCLUSION:
Changes in expired CO2 while subjects were exposed to pure CO2 gas in a rubberize suit suggest CO2 can be absorbed through the skin but does not affect systemic circulation (PCO2). Although these results appear promising with respect to our intent to develop a method for creating a hypercapnic environment while maintaining oxygenation levels, the statistically significant alterations are less meaningful from a practical perspective as absolute changes were far below what we observed during the 5% CO2 inhalation or would observe during light exercise. While CO2 does appear to transfer through the skin and into circulation, this model does not accomplish our original goal of creating a hypercapnic environment that mimics BFR exercise.

EFFECTS OF SHORT-LASTING HIGH-INTENSITY INTERVAL EXERCISE UNDER HYPOXIC CONDITIONS ON GLUCOSE TOLERANCE AND BODY COMPOSITION

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INTRODUCTION:
We have reported that moderate-intensity endurance training under hypoxic conditions improves risk factors of metabolic syndrome over the last decade (Ogita 2013, Ogita 2017). Several studies have also demonstrated that high-intensity interval training has positive effects on metabolic disease. Taken together, we hypothesized that high-intensity interval training under hypoxic conditions would improve metabolic risk factors even more effectively. The present study therefore examined the effects of short-lasting high-intensity interval exercise (SHIIE) under hypoxic conditions on glucose tolerance and body composition.
METHODS:
Twenty healthy male subjects (mean age, 22±2 years) who were matched for baseline measurements were randomized into two groups: a normoxic group (NORM; n=9); and a hypoxic group (HYPO; n=10). Both groups underwent six 15s bout at 175%VO2max with 10s active rest

at 50%VO2max between each bout twice a day, 4 days/week, for 4 weeks. The HYPO group performed the training under hypobaric hypoxic conditions corresponding to 2500m above sea level. Before and after the training, body mass, %body fat, and preperitoneal fat thickness were measured. Also, 2-h oral glucose tolerance test (OGTT) was conducted.
RESULTS:
After the 4 weeks of training, body mass, %body fat, and preperitoneal fat thickness were decreased significantly in both groups. The area under the curves for glucose during the oral glucose tolerance test was not reduced in both groups, on the other hand, that for insulin weas significantly reduced in NORM ($P<0.05$), but not in HYPO.
CONCLUSION:
These results suggest that SHIIE under hypoxic conditions, used in this study, does not induce necessarily improvements of metabolic risk markers more effectively, when compared to those performed under a normoxic condition.
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Acknowledgement
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120 DAYS IN CONFINEMENT DURING THE 4-MONTH SIRIUS-19 ISOLATION PROJECT: EFFECTS OF AEROBIC EXERCISE ON CARDIORESPIRATORY KINETICS AND COGNITIVE FUNCTIONS

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INTRODUCTION:
Cardiorespiratory and cognitive parameters are affected during short- and long-term space travel, affecting safety, fitness, and human performance. Therefore, exercise countermeasures are investigated in space analog conditions concerning their feasibility, time-efficiency, and overall beneficial physical and cognitive performance effects. To date, positive effects of both continuous (CON) and interval (INT) aerobic exercise have been reported for cardiorespiratory parameters. In addition, positive effects of physical exercise on cognitive performance have been suggested. During a confinement experiment, we expected (I) adverse effects on cognitive performance due to confinement and (II) improvements in physical fitness due to the countermeasure, especially from INT.
METHODS:
Six participants (34 ± 6 years, 3 females) spent 120 days in confinement, conducting eight weeks of CON (50% maximum velocity), followed by eight weeks of INT treadmill exercise (30-88% maximum velocity) in a crossover design. Cardiorespiratory fitness was assessed with an exercise test protocol, including pseudo-random work rate (WR) changes (PRBS), constant WR phases, and incremental increases in WR until peak capacity. Tests were performed before the start, five times during, and once after the termination of the confinement mission. Heart rate (HR) was measured beat-to-beat, and oxygen uptake ($\dot{V}O2$) was assessed breath-by-breath. Kinetics information was derived by applying time-series analysis on the PRBS. Cognitive performance was assessed as the executive function 'inhibitory control', with the Eriksen Flanker task, performed within the exercise test during REST, constant WR at 3, 6, and 9 km h-1, and during recovery.
RESULTS:
Significantly lower values for peak values of HR ($p=0.025$), $\dot{V}O2$ ($p=0.012$), and respiratory exchange ratio (RER) ($p = 0.001$) were found during confinement. Kinetics of both HR and $\dot{V}O2$ revealed a significant time effect (both $p < 0.05$). CON and INT exercise both seemed to speed HR kinetics during the mission with slightly better effects for INT. Inhibitory control was neither altered during rest, at constant WR, nor at recovery throughout before, during, and after 120 days of confinement.
CONCLUSION:
Positive effects of INT and CON treadmill exercise from laboratory studies could be confirmed for HR kinetics during confinement but not for $\dot{V}O2$ kinetics. Possibly, the lack of general physical activity during confinement was merely compensated by the applied exercise countermeasure. While the implementation of cognitive testing within our treadmill exercise test was successful, reaction times (RT) and accuracy (ACC) of the Eriksen Flanker task were not significantly altered. However, descriptively slower RTs were observed during confinement compared to PRE and POST and might be attributed to less external stimuli, a decline in participants' mood, or general confinement effects.

EFFECT OF LONG-TERM HIGH-INTENSITY INTERVAL TRAINING ON GUT MICROBIOTA IN OVERWEIGHT AND OBESE ELDERLY ADULTS

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INTRODUCTION:
Aging and obesity are accompanied by a decline in physical fitness and changes in gut microbiota. Exercise affects gut microbiota in animals and humans. In healthy populations cardiorespiratory fitness is positively associated with increased gut microbiota diversity and butyrate-producing bacteria. Thus, we hypothesize that high-intensity interval training significantly improves cardiorespiratory capacity in older adults compared to endurance training, and that the concomitant increase in VO2max contributes to an increase in gut microbiota diversity and the proportion of beneficial flora. We compared the effects of a 12-week high-intensity interval training (HIIT), and moderate-intensity continuous training (MICT) on physical fitness and gut microbiota in overweight and obesity elderly people.
METHODS:
Twenty-four sedentary older adults (16 male and 8 female) with a mean age of 65.1± 4.1 years were randomly divided into a sedentary control group (CON, n=5), HIIT group (four 3-min, 90% of maximal oxygen uptake, n=9) and MICT group (25min, 70% of maximal oxygen uptake, n=10) for 12 weeks. Physical fitness indicators, VO2max and fecal sample were determined at baseline and post training. Macro genomic approach to detect changes in gut microbiota.
RESULTS:

Twelve weeks of HIIT and MICT improved VO2max (4.08 ± 2.33 and 1.84±1.63 ml/kg/min, respectively, p<0.05). The choice reaction time and one-leg stand time increased significantly after the training period in both the HIIT and MICT groups. No change was found in bacterial alpha and beta diversities after the exercise intervention. The dominant bacteria differed after exercise interventions, and significant differences in the gut microbiota function and metabolism of HIIT and MICT were focused on aminoacyl_tRNA biosynthesis, pyruvate metabolism and galactose metabolism.
CONCLUSION:
The results of our study suggest that 12 weeks of HIIT significantly increase VO2max compared MICT. Both HIIT and MICT effect gut microbiota function and metabolism in overweight and obese elderly adults.

RELATIONSHIP BETWEEN SKIN ADVANCED GLYCATION END PRODUCT VALUES AND LIFESTYLE HABITS OF FEMALE COLLEGE ATHLETES DURING THE PERIOD OF SELF-RESTRAINT FROM GOING OUT

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INTRODUCTION:
The COVID-19 infection outbreak occurred worldwide at the beginning of February 2020. In Japan, a state of emergency was declared for approximately 1 month, from April 2020, and a lockdown. There was concern that the amount of physical activity for university student-athletes who exercise frequently would be significantly reduced, leading to a disorder in their lifestyle. Therefore, this study aimed to investigate the lifestyle habits of female student athletes, who have exercise habits, and to investigate the relationship with skin advanced glycation end product (AGE) values after the period of refraining from going out.
METHODS:
The subjects were female university students belonging to a physical education university in Tokyo. First, a questionnaire was used, and we obtained answers on (1) lifestyle-related items, (2) exercise habits, (3) eating habits and (4) luxury grocery items (e.g. alcohol and tobacco). Next, we measured the skin AGE value in the latter half of September 2020 only for students belonging to the athletic club and obtained their consent. Regarding the measurement time, it was set on a schedule 3 months or more, after the end of the lockdown since the skin AGE value is not a short-term index but an index showing the condition 2–3 months ago.
RESULTS:
The results of the lifestyle-related questionnaire revealed that the lockdown reduced the time spent on club activities and allowed more time, but the rhythm of life deteriorated. Furthermore, there was concern that the habituation of nutritional supplementation for student athletes was insufficient. The average skin AGE value was 144.8±24.4 AU. Because it was not possible to measure the same subject before the lockdown, we made a comparison with reference to the previous results (156 ± 21.2 AU) of measuring AGEs of student athletes at the same university.
CONCLUSION:
In this survey, there were concerns that student athletes lacked knowledge about nutrition, or even if they had the knowledge, they could not make full use of it. Furthermore, we have been unable to conduct sufficient research to draw clear conclusions because it was a restricted environment during the lockdown or after the lockdown. However, we were able to find issues such as the input of knowledge about nutrition for college athletes and practical methods that utilise that knowledge. It can be said that continuous examination is necessary to utilise it for the conditioning of college student athletes in the future.

HIGH-INTENSITY EXERCISE TRAINING PROTECTS THE BRAIN AGAINST AUTOIMMUNE NEUROINFLAMMATION: REGULATION OF MICROGLIAL REDOX AND PRO-INFLAMMATORY FUNCTIONS

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INTRODUCTION:
Exercise training induces beneficial effects on neurodegenerative diseases, and specifically on multiple sclerosis (MS) and its model experimental autoimmune encephalomyelitis (EAE). However, it is unclear whether exercise training exerts direct protective effects on the central nervous system (CNS), nor are the mechanisms of neuroprotection fully understood. In this study, we investigated the direct neuroprotective effects of high-intensity continuous training (HICT) against the development of autoimmune neuroinflammation and the role of resident microglia.
METHODS:
We used the transfer EAE model to examine the direct effects of training on the CNS. Healthy mice performed HICT by treadmill running, followed by injection of encephalitogenic proteolipid (PLP)- reactive T-cells to induce EAE. EAE severity was assessed clinically and pathologically. Brain microglia from sedentary and HICT healthy mice, as well as 5-days post EAE induction (prior to the onset of disease), were analyzed ex vivo for reactive oxygen species (ROS) and nitric oxide (NO) formation, mRNA expression of M1/M2 markers and neurotrophic factors, and secretion of cytokines and chemokines.
RESULTS:
Transfer of encephalitogenic T-cells into HICT mice resulted in milder EAE, compared to sedentary mice, as indicated by reduced clinical severity, attenuated T-cell and neurotoxic macrophage/microglial infiltration, and reduced loss of myelin and axons. In healthy mice, HICT reduced the number of resident microglia without affecting their profile. Isolated microglia from HICT mice after transfer of encephalitogenic T-cells exhibited reduced ROS formation and released less IL-6 and monocyte chemoattractant protein in response to PLP-stimulation.
CONCLUSION:
These findings point to the critical role of training intensity in neuroprotection. HICT protects the CNS against autoimmune neuroinflammation by reducing microglial-derived ROS formation, neurotoxicity and pro-inflammatory responses involved in the propagation of autoimmune neuroinflammation.

Physiotherapy

STUDY IN EFFECTS OF CONTACT AND NO-CONTACT ELECTRICAL STIMULATIONS ON STRUCTURAL CHANGES OF FEMUR CAUSED BY MECHANICAL UNLOADING IN RATS

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INTRODUCTION:
The recently developed low-frequency therapeutic stimulator (Oshma Industries Co., Ltd.) was able to reach the stimuli to deeper regions by matching the high-frequency carrier wave with direct current. In transcutaneous electrical stimulation (TES), an electrical method (contact) that directly stimulates from the body surface is used. On the other hand, a new device (Sumida Denki Co., Ltd.) that enables the electrical stimulation（VPS） by Vector potential by putting the body inside the device without attaching a pad is currently being developed.The purpose of this study is to compare and examine the effects of different electric stimuli on the bone loss of femur associated with unloading in rats.
METHODS:
Forty-eight male rats (wistar strain, 7-week-old) were used as materials and they were divided into a hindlimb-suspended group (HS), a hindlimb-suspended and a TES group (TE), a hindlimb-suspended and VP electrical stimulation group(VP) and a Control(Co).
In TE, TEs, using 80kHz carrier wave, was performed from the front surface of the thigh under the conditions of direct current, 60V, 31Hz, and 200μsec. In VP, electrical stimulation was performed under the conditions of alternating current, 60V, 120mA, and 20kHz. In both VP and TE, the electrical stimuli were performed under the anesthesia for 30 minutes / day, 5 times / week, and the experimental period was 3 weeks. Each group was euthanized by carbon dioxide inhalation at the end of the experimental period, and the femur was removed and observed histologically.
RESULTS:
The cortical bone surface was most rough in HS when observing the central part of a diaphysis of each group by magnified with a scanning electron microscope. Positive reactions were widely observed in HS but were weak in the other groups, comparing the sections of each group that had been immunostained with RANKL.
CONCLUSION:
The reaction of RANKL was widely observed in HS, but almost no OPG was observed. RANKL is secreted from osteoblasts and promote their differentiation into osteoclasts by binding to RANK of the osteoclasts‘ precursor. On the other hand, OPG is called decoy-RANKL, and it is known that it suppresses osteoclast activity because it inhibits the reaction between RANKL and RANK by specifically binding to RANK. It was thought that these facts indicate that HS osteoclasts are active, which appears to be suppressed by various stimuli.The induction of bone fragility by hind limb suspension was suppressed by TES and VPS, suggesting that both various stimuli have the same level of inhibitory effect.

STUDY IN CHANGES OVER TIME IN STRUCTURES OF LUMBAR VERTEBRATE WITH HINDLIMB SUSPENSION AND ELECTRICAL STIMULATION

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INTRODUCTION:
It is known that the electrical stimulation is also utilized for the treatment of the osteoporosis, which promotes a bone formation and suppresses a bone resorption, and the various electrical stimulation methods have been used so far.
Most of them have to come into contact with electrodes, but the development of a new device that can be energized simply by putting the body inside the device is currently underway. We have already recognized, using this new device, the possibility of maintaining bone mass in the femur of hindlimb-suspended rats, and reported it at the Society last year, but the effect on the lumbar vertebra has not been verified. In this study, we observed the bone loss of the lumbar vertebra during short-term mechanical unloading and the effect of the new electrical stimulation method over time, and examined the effect of electrical stimulation on maintaining the bone mass of the lumbar vertebra.
METHODS:
In this study, we observed the bone loss of the lumbar vertebra during short-term mechanical unloading and the effect of the new electrical stimulation method over time, and examined the effect of electrical stimulation on maintaining the bone mass of the lumbar vertebra.
RESULTS:
The bone trabeculae of HS were already significantly reduced from the stage of HS1 than CO, and the difference between HS3 and CO3 was remarkable. However, although the trabecula of VP1 decreased considerably compared to CO1, there was a tendency to approach CO as it changed from VP2 to VP3. By the immunostaining of RANKL, the positive reaction of which group was seen, but it was recognized a lot in order of CO, VP, HS. There were few reactions of OPG adversely in order of CO, VP,
CONCLUSION:
In this study, the bone loss associated with hindlimb suspension in VP was remarkable at the early stage of the experiment, but it was suppressed as the experiment period became longer. This may mean that the trabecular bone fracture is more common than the bone formation in the early stages of the experiment, followed by gradual promotion of bone formation and suppression of bone resorption. It is considered that this result is consistent with the staining results of RANKL and OPG.
Conclussion
Therefore, it was understood that the effect of the electrical stimulation during the mechanical unloading was poor at the beginning and became remarkable with the passage of time.

EFFECT OF HIGH-DEFINITION TRANSCRANIAL DIRECT CURRENT STIMULATION ON BACK MUSCLE STRENGTH OF SWIMMERS

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INTRODUCTION:
High-Definition Transcranial Direct Current Stimulation (HD-tDCS) is an emerging technology that improves traditional tDCS by simultaneously providing different currents through several small diameter ring electrodes distributed in different parts of the scalp to enhance the focus of tDCS. The technology has already been introduced into sports science to explore its impact on the human bodys ability to exercise. Pull-up is a hanging exercise that relies on ones own strength to overcome ones own weight and work upward. It requires the joint participation of many back skeletal muscles and upper limb skeletal muscles, which can reflect the development level of back muscle strength. For swimmers, the horizontal body position, as well as the special technical characteristics that rely on the arm pull to drive the body forward, determines the importance of the back strength of swimmers, and the development of back strength has become a part of swimming training can not be ignored. This study aimed to explore the effect of single-session anodal high-definition transcranial direct current stimulation(HD-tDCS) on back muscle strength of swimmers.
METHODS:
In this single-blinded sham-controlled study, eight swimmers (age 19.63±0.74 years) were randomly assigned to either anodal stimulation group (AG, n=4) or sham stimulation group (SG, n=4) to receive 20min 2mA of anodal HD-tDCS or sham stimulation. The two groups completed a pull-up test before, immediately after and 30min after the stimulation. The effect of HD-tDCS on back muscle strength of participants was analyzed by one-way repeated measurement variance.
RESULTS:
There was no significant difference in pull-up changes before(AG=14.75±0.96, SG=15.50±3.41, P=0.709), immediately after(AG=13.25±3.10, SG=15.25±2.99, P=0.325) and 30min after(AG=13.25±3.50, SG=13.25±1.89, P=1.000) stimulation in anodal stimulation group compared with sham stimulation group. Intra-group comparisons showed that pull-up were not statistically significant before(PAG=0.458, PSG=0.901), immediately after(PAG=0.458, PSG=0.270), or 30min after(PAG=1.000, PSG=0.325) stimulation.
CONCLUSION:
HD-tDCS has no significant effect on the back muscle strength of swimmers, the reasons may be related to the test time, HD-tDCS parameters, individual differences and other factors.

THE EFFECTS OF EXERCISES ON LOWER BACK PAIN IN MIDDLE-AGED AND OLDER PATIENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION:
Many Studies have verified that the lower back pain (LBP) can be improved effectively following exercise. However, the effects of exercises on in middle-aged and older patients with LBP are still unclear. The present study aimed to examine the effectiveness of exercises on LBP parameters in middle-aged and older patients, using systematic review and meta-analysis.
METHODS:
The databases (Web of Science, Pub Med, EBSCO, CNKI etc.) were searched, and the randomized controlled trails (RCT) of different exercises (yoga, Tai Chi, resistance training, etc.) in the LBP impact visual analogue scale index (VAS), Oswestry disability index (ODI), and Roland Morris disability questionnaire (RMDQ) were included following the inclusion criteria. The participants' age ≥45 years old in the include studies. The methodological qualities of the included studies were evaluated using the PEDro scale. Statistical analyses were conducted using RevMan software.
RESULTS:
19 articles (24 RCTs, 1015 participants,) were included. The exercise time was 15-90 minutes, and the most were 30-60 minutes; Exercise frequency was 1-5 times per week; Exercise duration was 4-24 weeks, and the most were 12 weeks. 7 articles of aerobic exercise (7 comparison groups), 5 articles of Chinese traditional exercise (7 comparison groups), 4 articles of core stability exercise (4 comparison groups), 4 articles of resistance exercise (4 comparison groups) and 2 articles of comprehensive exercise (2 comparison groups). Resistance training, aerobic exercise, and no exercise were performed in the control group. Meta-analysis results showed that exercises can significantly decrease the VAS (SMD = -0.98, 95%CI: [-1.38, -0.58], p < 0.00001) and ODI (SMD = -2.07,95%CI: [-3.19, -0.96], p < 0.00001) in the middle-aged and older patients with LBP. There was no significant effect in RMDQ (SMD = -0.31, 95%CI:[-0.67, 0.05], p = 0.09).
CONCLUSION:
Exercise can effectively improve the VAS and ODI in the middle-aged and older patients with LBP. These findings verified that exercise can be performed in the middle-aged and older patients with LBP as a powerful supplement to medical intervention. Due to the high heterogeneity among these researches, the present study is still needed in the further.

CORRELATIONS BETWEEN PAIN AND PAIN DETERMINING FACTORS AFTER SNPE EXERCISE PROGRAM IN PATIENTS WITH DORSOPATHIES

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INTRODUCTION:
This study examined the relationships between pain and the pain determining factors such as muscular tension, postural alignment, and skeletal structure after Self Natural Posture Exercise (SNPE) exercise programs in adult patients with dorsopathies.
METHODS:
The subjects were 70 females (34.7±6.6 yrs, 20.7±2.5kg/m2) diagnosed with cervical or lumbar dorsopathies, and were divided into 3 groups; Cervical Experimental Group (CEG, n=36), Lumbar Experimental Group (LEG; n=16), and Control Group (CG; n=18). CEG and LEG exercised 80 min per session, 3 times a week for 12 weeks, while CG did not participate in any exercise program. Pressure pain threshold (PPT), muscle tone (suboccipital muscle, upper trapezius, lower trapezius, erector spinae muscles), postural alignment (shoulder balance, pelvic balance), and skeletal structure (cervical and lumbar Cobbs angle) were measured before and after the exercise program. The

change of measured values (Cdiff) before and after the program for all subjects were calculated and the relationships of Cdiff between variables were examined.
RESULTS:
The relationship between Cdiff of PPT and Cdiff of muscle tone in suboccipital muscle (r=.348, p<.01), upper trapezius (r=.415, p<.01), lower trapezius (r=.318, p<.01), and erector spinae muscles (r=.303, p<.01) was significant.
A relationship between Cdiff of shoulder balance and Cdiff of PPT in suboccipital muscle (r=.230, p<.05), upper trapezius (r=.190), lower trapezius (r=.372, p<.01), and erector spinae muscles (r=.267, p<.05) was identified. A relationship between Cdiff of pelvic balance and Cdiff of PPT in suboccipital muscle (r=.230, p<.05), upper trapezius (r=.190), lower trapezius (r=.372, p<.01), and erector spinae muscles (r=.267, p<.05) was also noticed.
A relationship between Cdiff of cervial Cobb's angle and PPT in suboccipital muscle (r=.084), upper trapezius (r=.033), lower trapezius (r=.280, p<.05), and erector spinae muscles (r=.080) was noticed. A relationship between Cdiff of lumbar Cobb's angle and PPT in suboccipital muscle (r=-.062), upper trapezius (r=-.065), lower trapezius (r=.187), and erector spinae muscles (r=.032) was identified.
CONCLUSION:
Based on the results, the correlations between Cdiff of pressure pain threshold and Cdiff of muscle tone were significant, and this relationship was stronger than other two variables such as the postural alignment and skeletal structure. This indicates that the positive changes of pressure pain threshold after the exercise program of SNPE can be more reliably explained by the muscle tone changes.
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Psychology

A STUDY ON THE BEHAVIOR AND COGNITIVE ROUTINE OF POOL PLAYERS DURING A COMPETITION

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INTRODUCTION:
This study analyzes the routines of pool players training for competition, before competition, during competition, and after the competition, and compares and analyzes which routines the players use and the situation in which the difference between the upper and lower ranking players appears.
METHODS:
Participants of the study were players registered with the Korea Billiards Federation in 2020, and the study was conducted on 8 male players and 8 female players, distinguishing between the upper and lower rankings. The research method was conducted after making an appointment for a 1:1 meeting by personally contacting the athletes through in-depth interviews and completing the consent form. In-depth interview data were analyzed through domain analysis and taxonomic analysis proposed by Spradley(1980).
First, while repetitively reading the data from the in-depth interview, I did a domain analysis to find the constituent factors of the cognitive and behavior routine in the interview and categorize the content. Second, was classified and analyzed. This is a work that systematically finds and categorizes related attributes in the interview according to the constituent factors of the cognitive and behavior routine found in the domain analysis. In other words, it is a process of finding and analyzing the sub-factors of the program after domain analysis, and categorizing the relationship between domains made in domain analysis. For the transcribed data, individual case records and individual multi-profiles were prepared for each study participant, and after coding, appropriate factors were derived for the research problem.
RESULTS:
As a result of the study, when the study started, it was expected that a comparison between the top ranking players and the bottom ranking players during training for competition, but the results were different from what the researchers thought. The difference between the upper rankers and the lower rankers is only seen in situations such as having problems during a competition or lack of concentration. It seems that there are players who prepare systematically when training or preparing for a competition, and some players focus only on basic skills and practice. It seems that there are many differences in the personal characteristics and dispositions of the players. If the players routine programs are defined as general routines and the same routine is used by several players, it is likely that the players personal use and attention will be poor.
CONCLUSION:
In the development of a routine program that will follow this study in the future, it is expected that a routine that utilizes the individuals strengths and secures the shortcomings will be developed when a routine program is created after grasping the players personal preferences and having sufficient conversations with them.

THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY INTENSITY AND DEPRESSION IN COLLEGE STUDENTS

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Introduction
It is reported that one out of four college students have depressive symptoms in China. Although previous studies suggest that physical activity is effective in reducing depressive symptoms in college students, most of them did not distinguish the physical activity intensity. Moreover, there are relatively few studies investigating the relationship between depression and sedentary behavior in college students.
Methods
A total of 1252 undergraduate students (average age = 19.6 years, 42% females) participated in this study. Participants were recruited from a public university in Beijing, China. Participants completed a set of questionnaires including the Center for Epidemiological Studies Depression (CES-D) assessing depressive symptoms on a 7-point Likert scale and the International Physical Activity Questionnaire - Short Form (IPAQ-SF) assessing the weekly time of vigorous-intensity physical activity (VPA), moderate-intensity physical activity (MPA), light-intensity physical activity (LPA), and the daily time of sitting. Four multiple regression models were conducted. In each model, depressive symptoms were the dependent variable while adjusted for age, gender, and Body Mass Index (BMI), which were obtained by self-report. VPA, MPA, LPA, and sitting time were independent variables in the four models, respectively.
Results

There was a significant negative correlation between the VPA and depression (β = -0.06, p = 0.03). However, the MPA (β = -0.03, p = 0.24) and LPA (β = -0.01, p = 0.60) had no significant association with depressive symptoms. In addition, sedentary behavior had a marginally significant positive association with depressive symptoms (β=0.05, p=0.06), indicating more sitting time was associated with higher levels of depressive symptoms.
Discussion
For college students, higher levels of VPA were associated with lower levels of depressive symptoms while MPA and LPA did not predict depressive symptoms. Universities may consider interventions designed to promote VPA as an effective way to improve college students' mental health.

A BAYESIAN ANALYSIS OF THE PHYSICAL ACTIVITY AND PSYCHOLOGICAL FACTORS AFFECTING PHYSICAL EXERCISE HABIT

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Background
Participation and motivation are important factors in physical activities related to health issues. Csikszentmihalyi's flow theory (1975) is a typical example of a motivational theory approached from an emotional aspect. It refers to an endogenously motivated state of deep, self-immersion in one activity—a flow—that gives optimal experience. The flow theory states that everything you can do with your body can be fun, and that the flow experience of using your physical abilities can be experienced by anyone, not just top athletes. Moreover, Deci and Ryan's self-determination theory (2000), states that self-determination (autonomy) in various activities leads to better performance and mental health. It suggests that a person becomes motivated if their innate psychological needs (perceived autonomy, perceived competence, perceived relatedness) are satisfied simultaneously. This study aimed to clarify and provide materials to make inferences and predictions about physical exercise habits, physical activity, and psychological factors. We attempted to clarify tendencies observed in the factors associated with individual differences using Bayesian analysis.
Method
A total of 575 adults (287 men and 288 women) participated in this study. Information about their physical exercise habits, physical activity, and basic psychological needs were obtained from self-reported questionnaires consisting of 15 items. Each subscale was rated on a 5-point Likert scale. We calculated the posterior distribution and efficiently sampled the posterior probability density function using Bayesian analysis, which linked cause and effect such that exercise motivation could be inferred from the measured data. The Bayesian models listed above were implemented in the RStan package of R software.
Results
According to the results, valid parameters for predicting physical exercise habits were previous physical exercise and autonomy for men and only autonomy for women. The results showed that in the 95% Bayesian equal-tailed credible interval (CI) for the parameters, for men, the expected a posteriori (EAP) estimates were 0.34 (post standard deviation [PSD] = 0.07, 95%CI = 0.20–0.47), and 0.52 (PSD = 0.10, 95%CI = 0.33–0.70) for previous exercise and perceived autonomy, respectively. For women, the corresponding estimate was 0.78 (PSD = 0.08, 95%CI = 0.61–0.94) for perceived autonomy.
Conclusion
These trends were positively correlated with age for men, but negatively correlated for women, that is, men become habitual in exercise with autonomy the older they get, and women need the other factor aside from autonomy the older they get. Furthermore, other factors must also be considered for Bayesian analysis to provide a rigorous approach for analyzing physical exercise habits, physical activity, and psychological factors to clarify uncertainty in the factors affecting physical exercise habit via posterior probabilities.

EFFECTS OF ACUTE STRETCHING ON COGNITIVE FUNCTION AND MOOD STATES OF PHYSICALLY INACTIVE YOUNG ADULTS

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IINTRODUCTION:
Sedentary behavior and physical inactivity are associated with numerous negative health concerns, including cognitive function [1]. Exercise intensity from stretching is very low, making it well suited to varied populations, including physically inactive people. In contrast, prior research has suggested that acute exercise improves cognitive function [2]. Furthermore, acute stretching is known to have beneficial effects on mood states [3]. In the present study, we tested the hypothesis that acute stretching would improve cognitive function and improved mood states in physically inactive people.
METHODS:
We recruited 19 male volunteers through posters and determined their physical activity level with a physical activity questionnaire (IPAQ Short-Version). They showed a mean level of physical activity of 179.6 minutes/week, confirming their relative physical inactivity. They were randomized to stretching condition (SC) and resting condition (RC) in a cross-over manner. The stretching program was 10-min whole body stretching using yoga techniques and poses. Before and after stretching or resting, they performed the Stroop task and completed the Short form of Profile of Moods Scale (POMS).
RESULTS:
In the SC, we observed decreases in Tension–Anxiety (pre: 4 (2-9) vs. post:2 (0-6), P = 0.002), Depression–Dejection (pre: 2 (0-4) vs. post: 1 (0-3), P = 0.003), Anger–Hostility (pre: 1 (0-3) vs. post: 0 (0-0), P =0.005), Fatigue (pre: 6 (3-8) vs. post: 2 (2-5), P = 0.001), and Confusion (pre: 6 (4-9) vs. post: 5 (3-6), P = 0.005) and an increase in the Vigor score (pre: 5 (1-6) vs. post: 6 (4-9), P = 0.01). The Stroop-interference, which was calculated by subtracting reaction time (RT) in the neutral trials from RT in the incongruent trials, decreased in the SC (pre 5.36 ± 6.72 ms, post -3.52 ± 8.18 ms, P < 0.001). In contrast, the Stroop-interference did not change in the RC (pre 1.93 ± 6.32 ms, post 0.07 ± 7.39 ms). We also observed a decrease in Stroop interference performance (P < 0.001). Furthermore, we observed a significant negative correlation between delta Vigor score and delta Stroop interference (r = -0.36, P = 0.03). In contrast, we observed no correlations between changes in Stroop interference and other mood states. These results suggest that a greater increase in the Vigor score was associated with better cognitive performance.
CONCLUSION:
The novel finding of this study was that acute stretching improved mood states and cognitive performance in physically inactive people. We suggest that the improved cognitive performance may be, at least partly, associated with the improved mood states.
1. Pedersen (2006), 2. McMorris (2016), 3. Sudo et al. (2015)

RESEARCH ON THE JAPANESE STUDENTS ABILITY ABOUT EXITING FROM THE WATER FOR DROWNING PREVENTION

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Failure to stay afloat or swim to safety are the most commonly given reasons for drowning. Some evidence suggests that victims drown because they cannot exit the water upon reaching the water's edge. The purpose of this research is to measure the real and perceived capacity of Japanese young adults to safely exit the water. Participants were young Japanese adults (N = 31) with a proven swimming capacity who were enrolled in an undergraduate Bachelor of Non-physical Education degree program. Of these, 26 were male (84%), and 5 were female (16%); 87% were 19–20 years of age; and the remaining 13% were 21 years of age and older. We conducted the research protocol of Moran (2014). Before commencing an aquatics education program, participants completed a pretest survey that was designed to provide a measure of self-estimated water competency and estimates of their capacity to exit the water under various conditions. Data were collected via a brief, self-completed questionnaire and through observation of participants performing a series of practical swim tests. Content validity for both the questionnaire and observations is claimed based on the investigator expertise. The questionnaire sought information on demographic characteristics (including age, sex, and ethnicity) and self-estimates of swimming competency using a 4-point scale: high, good, low, or no competence. Information was sought on any previous difficulties participants had experienced when getting out of the water and whether they had been taught exit activities at school or in any other setting. To test participants' perception of how difficult getting out of the water might be, a 4-point scale ranging from "with ease" to "with difficulty" was used to estimate self-competency in exiting shallow water and deep water when wearing swimwear, clothes, and a buoyancy vest. The second phase of the data gathering included the assessment of exiting competencies with varying degrees of difficulty—shallow water exit onto overflow pool deck, deep water flat-deck exit onto overflow pool deck, and deep water exit over a 0.30 m bulkhead. Each of these challenges was assessed initially when participants were fresh, as a baseline for comparative purposes, after they had swum continuously in swimwear for 15 minutes. In all, the practical testing involved three different challenges under four pre-exit conditions amounting to twelve trials per participant.
All participants were able to exit shallow and deep water when not fatigued, after a swim when wearing clothing or a buoyancy vest, but many failed to exit deep water over a 0.30 m ledge after swimming in a buoyancy vest (38%). Significantly more females than males found exiting deep water difficult. Most participants (both males and females) underestimated the demands of exiting deep water.

A SYSTEMATIC REVIEW ON THE EFFECTS ESTIMATION OF PSYCHOLOGICAL VARIABLES WITH TRAINING METHODS AND INTENSITY

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INTRODUCTION
Being a systematic review of previous studies, this study aims to estimate psychological effects of various exercises with different intensities, and, furthermore, to determine the optimal exercise method and intensity for psychological well-being.
METHODS
Using PRISMA Flow Chart (Moher, Liberati, Tetzlaff & Altman, 2009) as data collection design and methodology, studies published between 1976 and 2021 have been reviewed. PubMed was used as a database search engine, and keywords for searching included exercise, psychological variables, and psychological responses, which came up with 744 studies initially searched. In the process of reviewing abstracts and main body of the studies, hereupon, The Profile of Mood States (POMS) has only been used among assessment tools of dependent variables in order to analyze psychological variables comprehensively. Accordingly, six studies meeting the purpose of this study have finally been selected and presented in result tables.
RESULTS
First, it has been found that aerobic exercises and combined exercises had positive effects on mood. Among sub-variables of POMS, aerobic exercise has been found to have the greatest impact on depression followed by fatigue. Also, combined exercises including both aerobic and non-aerobic exercises influenced vitality the most among the sub-variables. Second, analysis results of exercise intensity show that moderate-intensity exercises have the most positive impact on mood comparing to high- and low-intensity exercises.
CONCLUSION
The results suggest that aerobic exercises with moderate-intensity would be the optimal for positive changes in mood. It is, therefore, advisable that effects of various methods of exercises including both static (e.g., yoga, stretching, etc.) and strenuous exercises (e.g., boxing, power lifting, etc.) on psychological variables be further studied along with determination of exercise intensity.

Sociology

A SURVEY OF EDUCATIONAL PROGRAM AND TRAINING TO IMPROVE THE COMMUNICATIVE COMPETENCE OF LIFEGUARDS

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INTRODUCTION:
Lifeguards need to communicate effectively with survivors or among lifeguards during a rescue operation is even more significant during the COVID 19 pandemic. We conducted a survey to find out how lifeguard students at university perceived the difference of their communication skills during their training before and during the pandemic. The aim of this study is to make good use of their awareness of different ways of communicating with others during lifeguard training so as to develop an educational program of lifeguard students at university under the influence of the pandemic.
METHODS:
Twelve students with two to four years of experience as a lifeguard enrolled in lifeguard courses at university answered two questionnaires. Here are the questions: (1) Were there any changes in lifeguard activities on campus and the local community while the pandemic

was happening? (2) Did you notice that the style of communication on a rescue operation during COVID 19 was different from one before the pandemic?
RESULTS:
As a result of the first question, 70% of students approved the general change in lifeguard activities such as reducing the amount of time they train and limiting the types of training they do every day, while students did not refer to the specific changes that occurred such as making use of drones for their lifeguard training. Furthermore, we saw that they realized what they could do and could not in restricted conditions, so they took a calm and positive attitude toward their lifeguard activities. Then, as a result of the second question, only 40% of students pointed out unusual communicative styles such as speaking at a distance, with a facemask and using networks. On the other hand, most of them showed that there was no big difference in the way they communicated as a lifeguard before and during the pandemic, whose statements indicated two significant findings. One is being aware of others, which means having consideration for others and making efforts to be accepted by them. This type of awareness is essential for lifeguards. They also realized that they needed to improve their language skill in order to communicate effectively during a rescue operation, which means lifesavers need to develop their ability to convey information with simple and accurate sentences.
CONCLUSION:
The survey showed that lifeguards students at university could take measures and apply their skills for use while the pandemic is present. In addition, it became clear that they understood the importance of improving their communicative competence including having consideration for others and language skills during a rescue operation. These findings should be especially adopted as concrete teaching methods for use in lifeguard educational programs during a pandemic.
This work was supported by JSPS KAKENHI Grant Number 21K11527.

SPORTS PRESS IN CONTEMPORARY SOCIETY: A FRAMEWORK FOR THE ANALYSIS OF BODY STEREOTYPES AND MOTOR EXPRESSION IN PHOTOGRAPHS

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Introduction
Sports information consumption is highly demanded in contemporary society. The media, specifically the sport press, is a source of information that exerts strong influence on the sports promotion in society. Therefore, aiming to find out whether photographs in the sport press convey stereotypes related to body models and motor expressions, it has been carried out a modified version of the "analysis of stereotypes present in photographs in Physical Education textbooks" category system, validated by González (2015).
Methodology
The main goal of modifying the analysis framework was to create a new system for the analysis of photographs in the sport press. It were carried out a pilot test, an experts consultation and an intercoder reliability as scientific criteria that endorse the ad hoc instrument development.
The pilot test was used to check the correct functioning of the new system. Its objective is to evaluate the validity and practical utility of the framework with the new changes introduced. The experts consultation involved two experts in content analysis and an expert in physical-sports activity. This consultation is important to corroborate the credibility of the instrument. For the intercoder reliability, three experts in the field of Physical Activity and Sport Sciences participated. In this test, the Cohëns Kappa values were higher than 0.80 for all variables and, therefore, the reliability of the category system was confirmed.
Results
As a result, an innovative system is created and structured in two parts: The first identifies the photographic technical characteristics and is arranged in two categories, being: type of shot and type of focus. Consecutively, the second part is subdivided into two dimensions of analysis: body dimension and motor expression dimension. The body dimension is operationalized in three subcategories: sex-grouping, disability and somatotype. In turn, the motor expression dimension is formed of five variables: type, discipline, field of practice, sports fame and brand. The different categories are divided into distinct objective indicators.
Discussion
The method allows the visualization of body and motor expression stereotypes present in the visual sport press and contributes to the social visibility analysis of the most disadvantaged groups. On the other hand, it is important that the media, as agents of socialization, consider the information they transmit, which may be contributing to the entrenchment of a stereotyped physical-sport activity.

Sport Management and law

ROAD RACING RISK-MANAGEMENT STRATEGY FACING CORONAVIRUS DISEASE 2019 (COVID-19)

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Introduction: The ongoing global epidemic of 2020 caused by the Coronavirus disease 2019 (COVID-19) has led to the implication of both preventative and population control measures to reduce the spread of infection. These preventative measures include reducing large gatherings and keeping social distance, Popular sporting events, such as running races, have been severely affected by the epidemic because they attract large crowds. How the organizers respond to this crisis has a significant impact on the running industry. The restrictions due to COVID-19 have led to an unprecedented situation that requires the management of sporting activities, such as running events to be reassessed for safety.
Methods: This research used the Failure Modes and Effects Analysis (FMEA) risk management framework to design in-depth interview questions. We invited running event organizers from three different response outcomes of running events: "continued as usual," "postponed," and "canceled." Grounded theory was applied to sequentially analyze the results with open coding, axial coding, and selective coding procedures.
Results: According to the FMEA, we identified eight critical points of "system analysis," nine of "failure analysis," five of "risk analysis," and 11 of "risk optimization strategies." In addition, the critical points of risk optimization strategies for the three types of responses were also cross-compared for similarities and differences.

Conclusion: We identified two essential response themes, which were "protect and monitor participants health and related epidemic prevention equipment and measures" and "industry alliance cooperation." The findings from this study suggest that epidemic prevention measures and participants safety is the top priority amongst event organizers. Furthermore, the organizers encouraged the formation of an alliance to work together to combat and mitigate the risks of infection during the epidemic crisis.

Sport Technology

USER ENGAGEMENT AND USABILITY OF A DIGITAL BEHAVIOR CHANGE INTERVENTION TO PROMOTE PHYSICAL ACTIVITY IN OLDER PATIENTS WITH TYPE-2 DIABETES AND CORONARY HEART DISEASE

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INTRODUCTION:
A physically active lifestyle can positively affect the disease progression and prevent secondary diseases and complications in patients with type-2 diabetes mellitus (T2D) and coronary heart disease (CHD) [1,2]. Digital behavior change interventions (DBCIs) may support patients in managing their own health-related behavior. Current evidence highlights the positive effects of DBCIs on activity-related behavior. Good usability and high user engagement are essential for DBCI efficacy [3]. This study examines user-based feedback regarding a web-based DBCI tailored to older patients with T2D and CHD.
METHODS:
The DBCI online coaching units of the motivational phase of the Health Action Process Approach (HAPA) were tested for usability and user engagement in a standardized laboratory setting. A mixed methods research design including the System Usability Scale, DBCI Engagement Scale as well as qualitative content analysis of verbal and written feedback was used.
RESULTS:
Sixteen subjects aged 65 to 85 years (mean ± SD = 70.6 ± 5.3) with T2D, CHD, or a self-reported inactive lifestyle participated in this study. Usability and user engagement were rated as very good and good (mean overall score ± SD = 83.9% ± 11.2% and 76.2% ± 10.8%, respectively). User interactions with the DBCI were analyzed and categorized into barriers, content, interaction and user interface.
CONCLUSION:
The qualitative analysis of user behavior and subjective feedback generated further insights, with more details on the individual coaching units. Users experienced involvement, joy, trouble, irritation and uncertainty in varying degrees during the interaction. Some functional and visual aspects caused difficulties. Overall, usability and user engagement ratings are sufficient for the intended use. Qualitative content analysis revealed potential for improving overall usability for the target group. Further research should investigate the effectiveness of the DBCI in changing activity-related behavior.
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MEASURING LOCOMOTOR TRAINING PERFORMANCE AND YO-YO IRTL1 TEST IN THE CASE OF YOUNG SOCCER PLAYERS

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INTRODUCTION:
Revolutionary changes in performance monitoring can be seen in the world of sport. Global positioning systems (GPS) offer new opportunities in different sports [1]. Locomotor performance is one of the key performance components in a match and is measured in relation to speed and distance. The Yo-Yo IRTL1 (YYIR1) test [2] comprises periods of progressively increasing intensity for assessing endurance in soccer. According to the authors, a distance of 2,200 m is average at the age of 17–18, depending on the player's position.
METHODS:
The present study involved U15, U16, U17, and U19 soccer players at the Illés Academy in Szombathely. We recorded data for 70 players in the sample. We used InBody 770 to record the players' body parameters. We used YYIR1 which is specific to soccer players, to assess the players' endurance. We used the Catapult OptimEye S5 sensor to analyze the weekly average standardized locomotor performance (weeks 42–47, 2019): TD (m), Total Time, Velocity Band 4-6 Average Effort Count and Distance, and Maximum Velocity. We processed the data using IBM SPSS Statistics 25 ($p<.05$).
RESULTS:
N=70; Body parameters: Height (1.76±0.07, m), Weight (64.79±8.66, kg), SMM (33.44±4.42, kg), PBF (7.93±2.90, kg), BMI (20.54±2.91). YYIR1 (2,155.00±310.94, m). Locomotor performance parameters: Total Distance (19,730.70±4,343.28, m), VB4 ADI (580.84±280.09, m) VB4 AEC (60.07±23.26, pc), VB5 ADI (306,14±143,98, m), VB5 AEC (24.79±10.95, pc), VB6 ADI (99.30±66,268, m), VB6 AEC (6.14±3,77, pc), Max. Velocity (26,81±1,49, km/h).
Using the one-way ANOVA, we observed that, with the exception of the VB6AEC all locomotor values were significant in the F-tests, this is why, with the averages for the different age groups showed significant discrepancies. At the same time, the YYIR1 values did not show any correlation with the locomotor parameters.
CONCLUSION:
We concluded that the internationally standardized YYIR1 test to measure a player's velocity endurance is completely independent from locomotor tests measuring the different speed zone distances and counts in the analyzed sample [3].
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EXPERIMENTS TO VISUALIZE MOTION OF OARS USING MOTION SENSOR FOCUSING ON BLADE WORK WHILE ROWING

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INTRODUCTION:
In rowing race, it is important to how crews transfer energy produced by them to water through oars [1]. In recent years, empower oarlock (nk0786, EMPACHER, Germany) that can be attached to a oarlock, a fulcrum of oars, has been developed, which provides feedback on oar angle, but there is no system by which how to move blades, which is at the end of the oar, can be evaluated. Therefore, the aim of this study was to attached a sensor to boats and oars to measure motion of the boat and how the oars are moved to develop a system by which blade work at rowing motion can be visualized.
METHODS:
Two moderately-trained rowers rowing ten strokes at full power on the boat. The sensor (TSND181, ATR-Promotions, Japan) was equipped with acceleration sensor, gyro sensor, and terrestrial magnetism sensor, and the attitude angle was estimated by using extended Kalman's filter. The sensors were installed to the boat and the left-hand oar (bow side) each with a sampling rate being set at 100 Hz to measure acceleration, angular velocity, and attitude angle (quaternion) at 3 axes (x, y, and z). In addition, in preprocessing of the data, data was divided by the types of parameter (acceleration, angular velocity, and attitude angle). A oarlock, which was attached to the rigger of the boat, was set as a fulcrum of the oar. Quaternion, which is obtained as time-series data by the sensor, of axis rotation and attitude of the blade (angle) were calculated from coordinates of the end of the oar (the point on the blade on extension line of the shaft) at the start of measurement. Rotation matrix was used to convert the coordinates of the end of the oar at the start of measurement (the initial coordinates of the oar) into that at current time. Rodrigues equation was used to convert quaternion q to Rotation matrix R (q).
RESULTS:
Using this system, confirmed that a blade rotates from horizontal to vertical when acceleration curve of the boat reaches the minimum level immediately before catch. In addition, acceleration curve rises during drive, indicating that the blade is in a vertical state. It was captured that the blade rotated from horizontal (10 degrees) to vertical position in air. In addition, it could be demonstrated how deep the blade was going to water when it is in water. Furthermore, showing motion in horizontal direction revealed the length of drive per stroke.
CONCLUSION:
By using this system, motion of oars in 3-dimensional space could be measured and feedback images for crews to review their blade work in a simple manner could be prepared. An instructor who used this system commented that reviewing the motion of oars in water was highly informative, and it was confirmed that use of this system is expected to provide merits for improving techniques to perform rowing motion.
1. Kleshnev (2011)

Sports Medicine and Orthopedics

RELATIONSHIP BETWEEN NONSPECIFIC LOW BACK PAIN AND PHYSICAL FUNCTION AMONG HIGH SCHOOL LONG-DISTANCE RUNNERS

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INTRODUCTION:
For long-distance runners, low back pain as well as lower extremity disorders are becoming more common. This study analyzed the relationship between regular physical assessment results and nonspecific low back pain among long-distance runners.
METHODS:
Subjects included 105 high school long-distance runners that were divided into low back pain group (20 individuals) and non-pain group (85 individuals). Low back pain in this study was defined as any back injury that caused a day off from practice during the study period, and those requiring medical attention were excluded. Physical assessments consisted of basic information; age, athletic history, height, weight, body mass index, and body fat percentage, muscle flexibility and joint mobility; the straight leg raising test, knee flexion angle in the prone position (prone knee bend), lower leg inclination angle, hip joint (extension and rotation) and ankle joint (planter flexion) range of motion (ROM) tests, and sole arch efficiency, which was calculated by dividing the height of the arch in the standing position (the height from the floor surface to the scaphoid) by the foot length, and muscular force; the hip abductor and extensor forces using a hand-held dynamometer, trunk muscle strength using the sit-up test (i.e., the number of times subjects could perform a sit-up from the floor in 30 s), and total lower extremity strength using the stand-up test (i.e., the maximum number of times subjects could stand from a 20-cm-tall chair with one leg in 30s).
All measurements were confirmed to be normally distributed, and paired t-tests and the 95% confidence interval (95% CI) were used to evaluate differences in each measurement between groups. All statistical analyses were conducted using SPSS 24.0J for Windows, with the significance level set at 5%. And effect size (r) was calculated, and the power of the test was also calculated using G Power 3.1.
RESULTS:
The LP had a shorter history of athletics (LP=3.2 years, NP=4.6 years, 95% confidence interval: -2.55, -0.28, r=0.45), a greater hip extension angle (LP=32.7°, NP=28.4°, 95% CI: 2.85, 5.61, r=0.67), a lower hip extension muscle strength (LP=3.1 kgf/kg, NP=4.0 kgf/kg, 95% CI; 0.19, 0.61, r=0.45), and a greater number of times during the stand-up test (LP=11.1, NP=8.1, 95% CI; 0.40, 5.56, r=0.45) than the NP.
CONCLUSION:
In inexperienced runners, excessive hip extension angle and insufficient hip extension muscle strength may be risk factors of LP. It is possible that excessive movement of the hip joint and the biarticular muscles may cause LP in inexperienced runners. Since it is not possible to

determine whether the pain was caused by excessive forward tilt and lumbar kyphosis or by myofascial stretching stress on the muscles of the lumbar back, future research on this topic should include exploring the factors of LP and verifying the relationship with running movements, in addition to continuing condition checks of running athletes.

EFFECT OF BILATERAL AND UNILATERAL NORDIC HAMSTRING EXERCISE WITH LOWER LEG SLOPE ON HAMSTRING ELECTROMYOGRAPHIC ACTIVITY

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INTRODUCTION:
Hamstring strain injury (HSI) frequently occurs in the biceps femoris long head (BFlh) during high-speed running. Although Nordic hamstring exercise (NHE) preferentially recruits the semitendinosus (ST), Soga et al. reported that NHE with an increased lower leg slope angle preferentially recruits BFlh toward the final phase of descent. Since the injury situation of HSI occurred in the late swing phase of the unilateral leg during high-speed running, unilateral resistance training is recommended to HSI prevention. The hamstring activity pattern of the unilateral NHE with lower leg slope is unknown. Therefore, purpose of this study was to investigate the hamstring activity pattern of unilateral NHE with lower leg slope.
METHODS:
This study adopted a crossover design. Fourteen male volunteers (age 22.2 ± 2.5 y, height 171.1 ± 4.9 cm, weight 66.5 ± 7.6 kg, mean ± SD) participated in this study. Participants performed bilateral (N40) or unilateral (N40U) NHE with the lower leg slope set at 40° to the floor. The measurements were value of peak electromyographic (EMG) activity of hamstring muscles (BFlh and ST) during NHE variations. The hamstring peak EMG activity during NHE variations was normalized by the value of hamstring peak EMG activity during maximum voluntary isometric knee flexion holding 45°. Statistical analysis was performed using two-way ANOVA (NHE variation factor vs. muscle factor) (significance level; $p < 0.05$).
RESULTS:
In N40U, the peak BFlh EMG activity was significantly higher than the peak ST EMG activity ($p < 0.05$). The peak BFlh EMG activity of N40U was significantly higher than that in N40 ($p < 0.05$). The peak ST EMG activity of N40U was significantly higher than that in N40 ($p < 0.05$).
CONCLUSION:
The results of this study showed that the unilateral NHE with the lower leg slope preferentially recruits BFlh. The unilateral NHE with the lower leg slope may be a HSI prevention exercise.

SOFT TISSUE AND CONCUSSION REPORTING PREVALENCE IN BRITISH AMERICAN FOOTBALL

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INTRODUCTION:
American Football is a growing sport in the United Kingdom, with 557 teams currently playing under the British American Football (BAF) Association. Despite increasing participation the injury profile of the sport is not well understood. In particular, the prevalence of concussion, which can result in extensive time out from the sport and serious health complications, is unknown. The BAF league have limited resources, with many teams lacking access to consistent medical personnel. In line with other research this might result in injuries being underreported.
Aim: To evaluate the behaviour of reporting injuries, including concussion in BAF.
METHODS:
Data was collected from 226 (mean age 24.0 ± 5.7) participants across the BAF league. Participants were approached via email and social media. The questionnaire was available on OnlineSurvey and the link shared via previous stated methods. The questionnaire consisted of nineteen questions used to investigate injury reporting. This included questions on player demographic (14 questions), concussion history (6 questions) and reporting behaviour (4 questions). Descriptive statistics were calculated to determine the rates of reported and underreported injuries.
RESULTS:
Concussion like symptoms were reported in 58.8% (n=133) of the participants. Formal diagnosis of concussion was reported in 36.4% (n= 82) of participants with 54.9% (n=54) of those indicating that they had experienced more than one concussion. Less than half of participants (44.7%, n=101) had suspected they'd had a concussion although this wasn't formally diagnosed. Of these 101 participants, 53 (52.5%), 29 (28.7%) and 6 (5.9%) reported that a suspected un-diagnosed concussion occurred once, twice and more than 5 times respectively. Interestingly, 62.8% (n=142) of participants had hidden injury symptoms from coaches or medical staff (male 64.61%, female 51.61%). Similarly, 23.5% (n=53) of participants had previously hidden symptoms of concussion from coaches or medical staff (male 26%, female 6.5%). Out of those players who hid their injury symptoms, 59.9% (n=85) downplayed the injury, 35.2% (n=50) ignored the injury and 4.9% (n= 7) denied any injury.
CONCLUSION:
This is the first study to provide an evaluation of the behaviour of reporting injuries, including concussion in BAF. This research indicated that amateur BAF players tend to under-report or mask symptoms of injury. It appears that there is a greater respect for concussion, with less soft tissue injuries being reported. The findings raise questions regarding the suitability of medical cover when the concussion took place. Injury reporting is the pivotal first step for athletes to access the necessary medical care. Investigating the influencing factors which underlie underreporting and lack of diagnosis is necessary to attempt to support development of player's knowledge and improve player welfare.

INFLUENCE OF ALTERED KNEE ANGLE ON ELECTROMYOGRAPHIC ACTIVITY OF HAMSTRING MUSCLES DURING NORDIC HAMSTRING EXERCISE ON INCLINE SLOPE PLANFORM

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INTRODUCTION:

Nordic hamstring exercise (NHE) is commonly prescribed for preventing hamstring injury [1]. Performing NHE on the incline slope of the lower leg support at 20° and 40° allows the participants to perform the movement through an entire knee angle [2,3]. Alteration of the knee and hip angle affects hamstring activity during hamstring exercise [2,3,4]. However, the magnitude of hamstring activity with changing knee and hip angle during NHE on incline slope planform is still unknown. Therefore, this study aimed to investigate an electromyographic (EMG) activity in the hamstring during NHE on incline slope planform with a variation of the knee and hip angle at isometric contraction to identify a preferable exercise for recruiting hamstring activity.
METHODS:
Thirteen male volunteers performed NHE with three different knee extension (120°, 130°, and 150°) and three different hip flexion angles (0°, 30°, and 45°) on incline leg support planform at 30°. An electrical goniometer was used to monitor the knee and hip joint angle for maintaining NHE at isometric contraction for 5 seconds. The electromyographic data obtained during each condition was normalized with the values collected during maximal voluntary isometric contraction of each muscle (nEMG). A multivariate analysis of variance with repeated measures using syntax was used to compare the normalized electromyography of each muscle across the different knee and hip angles. Significant main effects were followed up by Turkey post-hoc procedures. Significance was set at $P<0.05$.
RESULTS:
There was a significant main effect among the knee angles for the BFl, ST and SM ($p < 0.05$). There was an interaction between knee and hip angle for the BFl, ST and SM ($p < 0.05$). The nEMG activity values during hip 0° for the BFl, ST and SM at knee extension at 150° and hip 0° were significantly higher compared to the knee knee extension at 120° and hip 0° and knee extension at 130°and hip 0° ($p < 0.05$).
CONCLUSION:
The finding of this study showed that BFl, ST and SM EMG activities during isometric NHE on the incline slop planform at 30° at knee 150° and hip 0° might be better for recruiting hamstring activity. However, it is still unclear in other degrees of incline slope planform.

DETERMINATION OF BODY COMPOSITION, 25-HYDROXYVITAMIN D LEVELS AND HANDGRIP STRENGTH IN FEMALE POLE DANCERS

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INTRODUCTION:
Pole dancing is a growing popular recreational activity and has even gain recognition as an international competitive sport, however, it still remain under-researched, especially in the field of sports medicine. Given its increase popularity, it is important to understand its interaction with body composition and bone health in women. The aim of this study was to evaluate body composition, 25-hydroxyvitamin D levels and handgrip strength in women who regularly practice pole dance in Bogotá, Colombia.
METHODS:
Participants were recruited through social media or directly at pole studios and were evaluated between September and December 2020. They were between 18 and 39 years old, living in Bogota for at least one year and were practicing pole dancing no less than 2 hours/week for at least 2 months. Pregnant women were excluded. Body composition was assessed by dual energy X-ray absorptiometry, blood levels of 25-hydroxyvitamin D levels were obtained, and grip strength was measured by hand dynamometry.
RESULTS:
A total of 28 women were recruited. Based on their training level, they were divided in two groups: Amateur (Am=15) or Professional (Pr=13). Independent t-test and Mann-Whitney test were performed to assess differences between groups. Paired-Samples t-test and ANOVA were performed for intragroup differences. Groups were similar in age, Am group (30±5.6 years) and Pr group (32±5.1 years); P= 0.37. There was a significant difference in weight of the Am group (58.2±6.9) vs the Pr group (52.7±6); P=0.003. Body mass index was significantly higher in the Am group (23.2±1.8 kg/m2) vs the Pr group (21.4±2.2 kg/m2); P= 0.03; Fat Mass Index was significantly higher in the Am group (7.11±1.4 kg/m2) vs the Pr group (5.53±1.1 kg/mt2); P=<0.001, Muscle Mass % was lower in the Am group (65.70±3.8) vs the Pr group (69.60±7.5); P=0.03. Additionally, the Pr group showed significantly different bone mineral density in the arms (0.75±0.06 g/cm2), legs (1.06±0.05 g/cm2) and lumbar spine (1.19±0.07 g/cm2) being higher in the lumbar area (P = <0.001). Insufficient levels of vitamin D were found in 71.4% (=20) of the participants with no difference between the Am group (16.5±4.8 ng/mL) and Pr group (14.8±3.3 ng/mL); P=0.29. No relationship was found between solar exposure and vitamin D levels ($\rho = 0.06$ P = 0.73). Normalized handgrip strength (grip strength per body mass) showed a statistically significant difference between Am group (0.46 ± 0.07) and Pr group (0.52 ± 0.06); P=0.03.
CONCLUSION:
Overall, the adipose and muscular profile were better in the Pr group compared to the Am group; bone mineral density of the lumbar spine was higher than legs and arms in the Pr group; the participants showed inadequate vitamin D levels; handgrip strength was significantly higher in the Pr group compared to Am group.

HIGH-CONCENTRATION ARTIFICIAL CARBONATED SPRING LOWER LEG BATH AFFECTS MUSCLE TISSUE ELASTICITY USING ULTRASOUND REAL-TIME TISSUE ELASTOGRAPHY

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INTRODUCTION:
Facilitation of the blood supply and oxygen consumption in the muscle by a local immersion of the extremities into high-concentration carbon dioxide water (CO2-water, CO2≥1000ppm), suggests an improvement of muscle performance and flexibility (Yamamoto, 2007). In the present study, we investigated whether the lower legs bath into artificially made high-concentration CO2-water (CO2≥1000 ppm) influences muscle tissue elasticity using ultrasound real-time tissue elastography
METHODS:
The healthy male college students (n=8, 19-24yrs, 173.6±7.4cm, 67.7±14.1kg) participated in this study. The subjects were randomly divided into a tap-water group and CO2-water group, and a crossover test was conducted. The subjects immersed lower legs up to below the knee into tap-water or CO2-water at 35 °C for 10 minute. Subjective thermal sensation (TS) during the lower legs bath were recorded by every two minutes. The medial head of gastrocnemius muscle (MG) dominant muscle hardness was evaluated using ultrasound real-time tissue elastography and Borg's category-ratio scale in muscle (CR-10) at pre and post lower legs bathing. The strain ratio (SR) between the MG and the subcutaneous adipose tissue of calf was calculated. Statistical evaluation of the data was done by paired student's t-test. Significance level was set at the $p < 0.05$.

RESULTS:
TS in the CO2-water was significantly higher than in the tap-water (tap-water vs. CO2-water at 10 minute in bath, -0.38±0.52 vs 1.00±0.53, p<0.05). After lower legs bath, in the CO2-water compared with the tap-water, SR significantly increased (3.04±1.40 vs 7.23±3.51, p<0.05). CR-10 was not significantly difference between pre and after tap-water bathing. However, there was a significantly decrease post bathing in CO2-water (3.13±1.46 vs 2.13±1.54, p<0.05).
CONCLUSION:
We reported previously that the muscle blood flow in the immersed part was larger in CO2-water than tap-water of a same temperature. In addition to a local effect of CO2, suppression of muscular sympathetic activity may also contribute to the increase in local blood flow. Facilitation of muscle tissue elasticity shown in this study might be caused by the increased muscle blood flow. The present results suggested that the high-concentration artificial CO2-water lower leg bath improves the muscle elasticity of the immersion part.

Statistics and Analyses

IMPORTANCE OF DISGUISING STROKES IN A GAME BETWEEN TWO TENNIS EXPERTS (FEDERER AND DJOKOVIC)

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INTRODUCTION:
Tennis games, especially those of high levels, are not just the matter of ball speed and placement but tactics as well. In order to create tactical advantages, players try to "disguise" their intentions and confuse opponents. Williams et al. (2009) showed that due to manipulated (misleading) dynamics of the movement in hips, shoulders, and arm/racket regions, anticipation accuracy of the stroke direction can significantly decrease in skilled players. Hitters could influence point dynamics by mimicking elements of the genuine movement (Panten et al., 2019), to trigger opponents' incorrect anticipatory movement (Pollick et al., 2001). We tried to answer how frequently and how effective disguising can be used by analyzing highest ranking game, the 2019 Wimbledon final, played by two tennis greats. Our hypothesis was that disguised strokes can be efficient enough to make the opponent move initially to the opposite direction of the ball, creating advantageous point dynamics (APD)
METHODS:
Analysis was based on video footage of two sets (second and third of the match) with contrasting scores (6-1 and 6-7), taken from the official Wimbledon YouTube channel. Frame by frame analysis of only ground strokes was done. For each groundstroke, we determined whether it was with disguised intention or not. A disguised stroke was defined as the one containing cues indicating initial stroke intention (ISI) of the ball direction in the pre contact phase, but with the actual post-contact trajectory being different (Helm et al., 2017). To judge the ISI, we analyzed (1) hitter's pre-contact movement time efficiency, direction and mechanics from the split step to the deceleration and set up (Murphy et al., 2016; Lofting and Hagemann, 2014) and (2) hitter's pre-contact mechanics from the moment of posting the loading foot to the zone of impact (Landlinger, 2010 (forehand); Reid and Elliott, 2002 (backhand)). Based on the data on how receivers predict the ISI of the hitters (Ward et al. (2002); Singer et al. (1996)), we were attentive to the loading foot position, hip and shoulder external rotations in judging the hitter's ISI. To investigate the effectiveness of disguising stroke, we analyzed receiver's anticipatory movement (correct or wrong), and point dynamics following the disguised stroke
RESULTS:
In the 1st set analyzed, 38.8% of all ground strokes made by two players were with disguised intention. For the 2nd set, disguised stroke frequency was 26.2% of all 214 ground strokes. Winners of both sets made opponents move more frequently to the opposite direction of the ball following their disguised strokes than the undisguised strokes. 51% of disguised strokes created an advantageous point dynamics (winners or advantage), significantly higher that for the undisguised strokes (40%).
CONCLUSION:
Two expert players showed that with disguising ISI they could impose tactical superiority and create advantageous point dynamics. Suitable training program of disguised shots should have competitive utility

TIME-EFFICIENT VIDEO ANALYSIS OF MODERN-DAY ELITE BASKETBALL: AN D METHODOLOGY WITH RELIABILITY ANALYSIS AND PRELIMINARY RESULTS

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INTRODUCTION:
Quantifying physical demands of basketball is critical to effective load management. Video methods remain the gold standard for classifying sport-specific movements but are time-consuming and prone to rater bias. McInnes 1995 definitions [1] are commonly used with video methods to classify movements but could be enhanced to better suit modern-day basketball. The purpose of this study was to develop a simplified, time efficient method for quantifying physical demands of modern-day basketball play using video analysis.
METHODS:
The definitions of McInnes [1], which defines eight movement types (stand/walk, jog, run, stride/sprint, low/medium/high intensity shuffle, jump), were expanded to improve precision to elite basketball. For example, we added, 'often moving in a general direction rather than a clearly defined target' to aid classification of low intensity shuffle. Additionally, "transitions" were added as the frequency of movement transitions may contribute to player load. To further reduce coding time, a second method was developed using simplified categories to represent whole-body loading relative to bodyweight: 1) below bodyweight (B-BW), bodyweight (BW), above bodyweight (A-BW). Six US collegiate men's basketball players were video recorded during two practices. Two video cameras (GoPro Hero9, 30 Hz) were placed at half-court and baseline. Three raters conducted the coding. Movement counts (Method 1) and duration of loading (Method 2) were calculated for each player. To determine inter-rater reliability [2], raters coded all six players during the same segment (700 s) and Intraclass correlation coefficient tests were conducted.
RESULTS:
Excellent reliability was determined for frequency of stand/walks (0.82), jogs (0.85), stride/sprints (0.89), low intensity shuffles (0.82), medium intensity shuffles (0.77), and jumps (0.99). Reliability was good for runs (0.63) and fair for high intensity shuffles (0.43). Reliability was excellent for B-BW (0.97), BW (0.98) and A-BW (0.98). Preliminary results revealed 39% of all coded movements were stand/walks

followed by runs. Centers had higher frequency of jumps than other positions and forwards jogged and ran more frequently and made more movement transitions.
CONCLUSION:
Video coding using simplified categories provides a general assessment of player loading that is accurate and reliable. Video coding with simplified categories may be useful when higher level technology for estimating player load, like sensor systems, are not available or when the more time-consuming movement count method is not feasible.
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CHARACTERISTICS OF THE KICK MOTION TO PASS A BALL IN COLLEGE SOCCER TEAM

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INTRODUCTION:
It has been reported that continues moving after passing a ball is important for improving the teams performance during a soccer game. We took particular note of the kick motion used to pass a ball during a soccer game in this respect and explored the characteristics of the kick motion from the perspectives of "dynamic kick" using walking and running motions, and "stationary kick" without these motions. Based on video data from 10 soccer matches, the frequency and rate of dynamic and stationary kicks were analyzed, and the differences between a college team, the Asian country national team, and two European country national teams were compared. From the comparison, we investigated the characteristics and technical problems of the kick motion to pass a ball in college soccer team.
METHODS:
To investigate the characteristics and technical problems of the kick motion to pass a ball in college soccer team, the frequency and rate of dynamic and stationary kicks were analyzed based on video data from 10 soccer matches. In addition, the pass completion rate was calculated with every match, and the effects of the technical problems on teams performance were analyzed. Teams of the analysis object were a college team (CO), the Asian country national team (AN), and two European country national teams (EN1, EN2), and the differences between CO, AN, EN1, and EN2 were compared.
RESULTS:
The number of passing a ball for 90 minutes were 280 in the CO, 447 in the AN, 373 in the EN1, and 530 in the EN2. The frequency and rate of dynamic kick were 115 and 41% in the CO, 268 and 60% in the AN, 183 and 49% in the EN1, 303 and 57% in the EN2. The frequency and rate of stationary kick were 137 and 49% in the CO, 125 and 28% in the AN, 141 and 38% in the EN1, 168 and 32% in the EN2. The rate of dynamic kick was lowest and stationary kick highest in the CO, compared with the national teams of each country. In addition, the pass completion rate was 58% in the CO, 85% in the AN, 84% in the EN1, and 86% in the EN2, with the lowest rate in the CO.
CONCLUSION:
Results reveal that the rate of dynamic kick was lowest, stationary kick highest, and the pass completion rate lowest in the CO. These results suggest that increasing the frequency and rate of the dynamic kick to pass a ball during a soccer game is important for the college soccer team, and improving the technical skill level of the dynamic kick using walking and running motions is an essential when seeking to enhance the competitive abilities of soccer players.

EXAMINING POSITIONAL DIFFERENCES IN THE AVERAGE IN-SHIFT LOCOMOTOR DEMANDS IN ELITE MEN'S ICE HOCKEY

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INTRODUCTION:
There is a paucity of literature regarding actual in-shift locomotor demands in ice hockey (Douglas & Kennedy, 2020). Therefore, the aim of the present study is to describe the in-shift locomotor demands in elite men's ice hockey, along with exploring positional differences.
METHODS:
Seventeen male ice hockey players competing in the top Swiss league provided data for this study. A total of 342 shifts were collected during two pre-season games. For analysis, only shifts lasting between 25s and 50s and played without stoppages were used, resulting in n=82 forward- and n=38 defenseman-shifts. To assess locomotor demands, following metrics were used: Average speed, distance covered above >17 km/h, number of high-intensity accelerations using the variable acceleration threshold method recently developed by Sonderegger et al. (2016) and mechanical power as suggested by Hoppe et al. (2018). Mechanical power combines acceleration and velocity in one single metric representing the integration of the product of the instantaneous acceleration multiplied with its underlying velocity at each data capture. Descriptive statistics were used to describe in-shift movement demands. In order to facilitate comparisons between groups accounting for differences in shift durations, data were further expressed on a per-minute basis. Magnitude-based inferences and effect sizes (ES) with 90% confidence limits were used to assess differences.
RESULTS:
Forwards shown a likely higher average speed (13.9±2.8 vs. 12.9±2.7 km/h; ES = 0.36) and covered more distance >17 km/h (127.9±62.1 vs. 103.6±56.5 m/min; ES = 0.40) compared to Defensemen. There were no clear differences in the number of high-intensity accelerations and mechanical power (2.28±1.67 vs. 2.14±1.96 n/min resp. 10231±2871 vs. 9818±2948 AU/min; both ES = 0.14), indicating smaller positional differences than previously documented considering speed-based metrics only (Douglas & Kennedy, 2020).
CONCLUSION:
The large standard deviation found between shifts suggest that the average shift demands does not reflect the highly fluctuating game-intensity adequately. Thus, comparing average in-shift movement demands provide limited information regarding the most intense playing phases. Therefore, further studies should explore positional differences within the most intense playing phases.
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Training and Testing

BIOELECTRICAL IMPEDANCE ANALYSIS (BIA) IN PROFESSIONAL FOOTBALL PLAYERS: A NEW INDEX FOR MUSCLE STATUS ASSESSMENT

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INTRODUCTION:
The bioimpedance analysis (BIA) allows if applied to sport, being non-invasive and easily repeatable, not only to assess the body composition of the subjects but also to monitor their conditioning level. Through the BIA, quantitative estimates relating to muscle development and hydration are obtained. It has already been stated, in numerous studies, that only "pure" bioelectric parameters (Reactance, Rz, Impedance, Xc and above all Phase angle, Pa), without the need to resort to specific algorithms, are essential indicators of anabolic-catabolic equilibrium and hydroelectric status. Indeed, the use of algorithms makes the analysis less reliable. This work proposes a new index (derived from Pa) to evaluate muscle development, which is little influenced by the hydration and body mass of the subjects.
METHODS:
671 Italian professional and semi-professional footballers were divided into three groups according to their level: Top Level (T) militants in Serie A and in Serie B (N = 242), High Level (H) militants in Serie C (N = 226), and Medium Level militants in Serie D (N = 203). Each player was tested with BIA 101 Akern analyzer, according to standard procedure, during the competitive season. Anthropometric parameters were taken into consideration (age, weight, height, BMI). The quantitative value estimates from Bodygram Pro Akern software (FFM, TBW, HYD, BCM, and FM absolute and percentage of body mass); bioelectrical parameters (Rz, Xc, Pa, and the new LMI index). For each of the data, a comparison was made between the three groups, highlighting differences expressed as a percentage and level of significance with p-value (minimum level of significance $p < 0.001$).
RESULTS:
It is evident that both the calculated values (TBW, FFM, FM, BCM) and the purely bioelectrical ones (Pa and LMI) are greater in the T group considering the higher level, as well as the Rz results lower, being inversely correlated to a better hydration. The values with the most significant differences are LMI: 7.5% between T and H, 13.8% between t and M, 5.9% between H and M.
CONCLUSION:
As was easy to expect, elite footballers, i.e., those belonging to group T, have more significant muscle development and a higher Pa. But this is highlighted in a more evident and sensitive way through the LMI index, highlighting how the BIA can be a handy tool to evaluate the athletic condition during the season. BIA is a non-invasive method, easy to use and of simple interpretation. Particularly if we consider the bioelectrical parameters such as Pa or, better our new proposal: the LMI index, because it frees itself from data such as hydration and total body mass; in fact, hydration can also vary according to the timing of the measurement; body mass can affect Pa, distorting the real change in muscle mass.

WORLD-CLASS MALE CHOPPERS' CHARACTERISTIC TECHNIQUES IN REAL TABLE TENNIS COMPETITIONS: NOTATIONAL GAME PERFORMANCE ANALYSIS

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INTRODUCTION:
In the table tennis, choppers are in the minority, but it is a style of play that can be used at the world-class. For example, 39-year-old chopper of China won the All-China Table Tennis Championships tournament in 2019 by defeating young, powerful Chinese players in succession. He is now considered the best chopper in the world.
Therefore, this study's purpose was to conduct a notational game performance analysis for the world-class male choppers, and to acquire new information about defensive players' techniques and tactics.
METHODS:
We selected four world-class male choppers for a notational game performance analysis. We selected six singles matches per player, a total of 24. Techniques were divided into the four classifications: 1) service, 2) topspin, 3) backspin and 4) other. These four classifications were then subdivided into 42 categories.
Only the four choppers' numbers of shots in a rally were counted. In each classification, an usage rate was obtained by dividing the amount of hits using each technique by the number of total hits.
RESULTS:
The mean ± SD values of the number of hits per rally to among the four players in scoring rallies, we found no significant difference, but Chopper A's mean value was significantly lower than those of other players in losing rallies.
Cumulative results of the usage rate for each number of shots per rally were ended with either scoring or losing rallies by the seventh shot in over 90% of them.
Usage rate by category were the services were no significant difference. The topspin were Chopper B had a significantly lower usage rate than Chopper A, C and D. Moreover, Chopper A and C also had significantly lower usage rates compared with Chopper D. The backspin were Chopper D had a significantly lower usage rate than Chopper A, C and B; Chopper A and C also had significantly lower usage rates compared with Chopper B. In "other", the four players revealed no significant difference.
CONCLUSION:
Chopper A had fewer mean rallies than other choppers and launched attacks against opponents earlier than other choppers. We assume that at the first and second strokes, Chopper A hit the backhand smash using a kind of topspin that other choppers do not usually use[1], so he could attack from a position where opponents think that he could not cover with their forehands.
It was found that he was using various other topspin techniques, and although his topspin losing rate was higher than the other players, he still continued to use them to put pressure on his opponents.
For players and coaches, Chopper A's results from this analysis will be useful in training choppers to improve their competitiveness.
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BILATERAL KICKING ACCURACY IN LADIES GAELIC FOOTBALL ASSOCIATION

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INTRODUCTION:
Different sports have different types of kicking needed to succeed in that specific sport. In FIFA Football it has been shown that highly skilled players are better at bilateral tasks (Carey 2001). Being able to use both sides of your body equally in symmetrical sport is a potential advantage. Ball & Horgan (2013) found that in Gaelic football "on average 205 kicks were performed in a game, kicks comprised 74% general play and 50% of these are hook kicks". Little is known about kicking accuracy among Ladies Gaelic Football Association (LGFA) footballers, thus our aim is to measure the Bilateral Kicking Accuracy to detect any differences comparing the dominant and non-dominant leg.
METHODS:
33 participants (29 right footed, 23±5 (mean±SD) years old; on average been playing for 15±5 years) kicked 5 size-4 balls from 5 different field points, using both dominant (25 kicks) and non-dominant leg (25 kicks). Point C was right in front of the goalpost (midline, 20 meters away, at 90 degrees); A and E were field points 20 meters apart from the centre of the goalpost and symmetrically positioned to point C, at 30 degrees (narrowest target from kicking point), B and D were 20 m apart from the centre of the goalpost and symmetrically positioned to point C, at 60 degrees. Testing was carried out on a regular pitch with standardised goals, the ball size/weight was the standard one within the LGFA. The 20 m distance that the participants kicked from was selected after the analysis of six college games, in which this distance was the most commonly seen to kick from (unpublished data). An accurate kick score was a kick on target (above the bar, between the posts).
RESULTS:
Participants kicked 16.0±4.3(SD) out of 25 kicks on target while using their dominant leg compared to an average of 8.9±5.9 while kicking with their non-dominant leg (p=0.0001). While kicking from point C the target size was the largest one and footballers were significantly more accurate with their dominant leg (3.7±1.3 out of 5 kicks compared to their non-dominant 1.9±1.6, p=0.000). At angle B and D combined the dominant side accuracy was significantly higher compared to the non-dominant one (6.5±2.0 vs 3.8±2.7 kicks out of 10,p=0.0001). From points A and E (combined score) the dominant side accuracy was significantly higher compared to the non-dominant (5.9±2.2 vs 3.2±2.5 kicks out of 10,p=0.0001).
CONCLUSION:
Ladies Gaelic Football Players are more accurate with their dominant leg than their non-dominant leg for all 5 points. While coaching girls in the LGFA, coaches should focus on developing bilateral kicking skills.
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THE EFFECTS OF HEART RATE VARIABILITY ON SIMULATED TIME TRIAL PERFORMANCE.

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INTRODUCTION:
During multi-day tour races (e.g., Tour de France), competitive road cyclists must complete individual time trial (ITT) events. Performance during these time trials are crucial in the final outcome of tour races. ITTs are physiologically demanding and require cyclists to endure high workloads (~90% of VO2max and ~350W) for approximately 60 minutes. A cyclist's ability to perform during ITTs may be informed by monitoring their physiological status. Heart rate variability (HRV) is promising tool for the detection of physiological readiness and may predict performance decrements for cyclists. It is currently unclear if an abnormal morning HRV status is indicative of a compromised autonomic nervous system inhibiting maximal performance during an ITT event. This study aimed to determine if an abnormal HRV status would have negative effects on ITT performance in recreational cyclists.
METHODS:
Recreational male (n=25, 43.2±8.5 years, 77.27±8.95 kg) and female (n=2, 37±6.75 years, 68.18±4.09 kg) cyclists completed up to six simulated indoor ITTs over ten weeks. Participants were asked to complete simulated ITTs under two HRV conditions: within HRV normal values and HRV abnormal values. Participants recorded daily morning HRV readings upon waking, in the supine position via the smartphone application HRV4Training photoplethysmography. Each participant performed all ITTs on their personal indoor bike trainer and bike without external race simulation (e.g., Zwift). All cycling performance data (i.e., distance, average heart rate (HR), peak HR, average power (W), peak W, peak speed, average speed and RPE) were recorded on personal bike computers and entered into a Qualtrics survey. 126 ITTs (HRV conditions: normal = 68, abnormal = 58) were assessed for relationships between HRV status and performance outcomes using a linear mixed-effects model. Statistical significance was set to 0.05 and Cohen's D determined effect sizes (ES).
RESULTS:
No performance variables reached statistical significance, but small-to-medium ESs were identified in some parameters. Meaningful ESs were found for distance covered during HRV conditions (Normal: 14.1± 1.18 km, Abnormal: 13.6± 1.21 km, p= 0.16, ES= 0.29), peak speed (Normal: 24.1± 1.68 km/h, Abnormal: 23.3± 1.74 km/h, p= 0.23, ES= 0.28), and peak power (Normal: 372± 30.18 W, Abnormal: 353± 30.97 W, p= 0.05, ES= 0.58).
CONCLUSION:
Although there were no significant differences due to individual HRV, abnormal HRV had a small negative effect on distance covered during a TT, which is critical since distance is an essential determinant of overall cycling performance. The decrease in performance seemed to be driven by decrements in peak speed and power. Inter-performance markers of physiological (HR) and psychological intensity (RPE) were not indicators of a decreased performance. Future research with a larger sample is needed to confirm if abnormal HRV results in poorer time trial performance.

AGE OF BENCH PRESS PEAK PERFORMANCE IN ELITE POWERLIFTERS

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INTRODUCTION:
Knowledge of age of peak performance (APP) in bench press competitions may provide important information regarding career longevity for powerlifters and coaches. Generally, higher intensity sports have lower APPs than endurance sports and gender differences have been reported in several studies1. The purpose of this study was to assess trends in athlete ages and APP of elite powerlifters competing in unequipped bench press competitions. We hypothesized that bench press competitors would have a relatively late APP in both genders.
METHODS:
The best annual performances between 2011-2019 consisted of 5,493 male and 3,342 female elite powerlifters (70,664 unique events) were collected from the International Powerlifting Federation classic bench press database. Additional information collected included: year of event, weight class, year of birth, bodyweight, and rank. Best performances were converted to Wilks, which was used to compare athletes between weight classes. Ages of athletes ranked in the top 3 of their weight class (T-3) were compared over time and with lower-ranked athletes using 1-way ANOVA and unpaired t-tests, respectively. APP for each gender was determined using a cubic regression model.
RESULTS:
The mean age of male athletes increased over time from 34.3+/-9.8yo in 2011 to 36.1+/-16.5yo in 2019 (p=.0002) while the mean age of T-3 athletes had not significantly changed from 33+/-8.4yo to 31.59+/-6.6yo during the same period (p=.22). The mean age of T-3 athletes (32.4+/-7.8yo) was significantly younger than lower-ranked athletes (35.3+/-15.5yo) (p=.0024). Conversely, the mean age of female competitors has decreased over time from 35.1+/-12.8yo in 2011 to 34.4+/-14.9yo in 2019 (p=.036), a trend also observed in T-3 athletes from 37.4+/-9.8yo to 31.7+/-9.2yo (p=.0027). Age of peak performance for males was 34.6yo (r2=.31) with 95% of peak performance maintained until 44.8yo and for females was 34yo (r2=.14) with 95% of peak performance maintained until 44.3yo.
CONCLUSION:
The ages of top female competitors have steadily decreased while the ages of top male competitors have remained stable. Male and female competitors have late APP and maintain elite performance over several years. Thus, bench press competitions may be a viable option for athletes and coaches who prioritize career longevity.
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TEST-RETEST RELIABILITY OF A PHYSICAL FITNESS SELF-TEST INTEGRATED IN A SMARTPHONE TRAINING APPLICATION

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INTRODUCTION:
The smartphone training application ready (App ready; Swiss Armed Forces Training Command, Bern, Switzerland) was introduced in 2019 to prepare young people physically for recruitment and basic military training. Based on a fitness self-test, a personal training plan is compiled in the App ready. The aim of this study was to test the reliability of the App ready's self-test, where the user is guided exclusively by the App ready.
METHODS:
Test-retest reliability of the self-test was investigated with 44 vocational students (18 female and 26 male; 16.6±0.9 years, 64.4±11.5 kg, 172.3±9.9 cm) during their sports lesson with seven days between the two measurements using their personal smartphone (11 using Android operating system (AOS) and 32 using Apple OS (iOS)). They performed a countermovement jump (CMJ; both hands hold the smartphone to the chest, then jump as high as possible, one attempt), a trunk muscle strength test (TMST; hold the body on forearms and feet as long as possible while lifting the feet alternately off the floor every second, one attempt) and a one-leg stand (OLS; hold the single-leg position for as long as possible, close the eyes after 10 seconds, after another 10 seconds place the head in the neck with the eyes closed, one attempt per leg). The App ready uses the smartphone's built-in accelerometer to assess the flight time of the CMJ, whereas the duration of the TMST and the OLS is measured by a timer.
RESULTS:
The results showed a significantly different test-retest CMJ (455±77 ms vs. 485±93 ms, p=0.04) and an ICC (95% confidence interval) of 0.58 (0.25-0.77). The reported CMJ in AOS-devices had a lower ICC (0.38 (-0.53-0.81)) compared to the iOS-devices (0.71 (0.40-0.86)). Additionally, the CMJ recorded with the AOS-devices showed a significantly higher CMJ in week two compared to week one (p=0.04), whereas no such time-effects were observed using iOS-devices (p=0.32). Overall, the TMST showed an ICC of 0.90 (0.83-0.95) and the OLS an ICC of 0.60 (0.25-0.78) and both results did not differ between the two weeks (p=0.31 and p=0.81, respectively).
CONCLUSION:
Good ICC were observed in the TMST and moderate ICC in the CMJ and OLS. The CMJ is a complex movement and familiarization might affect the maximal CMJ performance. In addition, quality of built-in sensors and data processing may differ greatly in the very heterogeneous smartphones within the AOS resulting in less reliable results. To increase reliability of the CMJ, it may be useful to use the mean values of three attempts. Test-retest reliability of the OLS was comparable (r=0.50) and of the TMST even higher (r=0.77) compared to the results of Wyss et al. [1]. To conclude, with the goal to test yourself independently, without additional equipment and to receive a tailored training plan, the self-test of the App ready can be recommended.
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LONG TERM CONCURRENT HEAT STRESS DOES NOT IMPROVE UPON PERFORMANCE GAINS BY RESISTANCE TRAINING

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INTRODUCTION:

Natural performance enhancement, muscle hypertrophy and muscle rehabilitation on an expedited timeframe is highly coveted in sports and recreational fitness industries. Some studies have indicated that heat stress can improve muscle hypertrophy when used in combination with resistance training (RT), while some have shown no changes. Improvements in performance aspects such as strength, speed and agility in response to long term RT are well established, however, the additive effects of heat stress on performance enhancements by RT has been sparsely investigated.
We therefore investigated the effects of full body heat stress applied concurrently during high intensity RT on muscle mass, strength, speed, agility and force in males.
METHODS:
A cohort (n=18) of recreationally active, anthropometrically matched males were assigned to two groups, HEAT (n=8, age= 23.3 ±.3.1, body mass (BM) = 75.6 ± 14.5kg, height = 175.6 ± 8.8 cm) and CON (n=10, age= 21.0 ± 2.7, BM = 76.0 ± 11.3kg, height = 177.2 ± 9.6 cm). Each group undertook an identical,10 week, full body RT program three days a week. The control group trained in thermoneutral conditions (23°C, RH 25%), while the HEAT group trained in a climate chamber at 40°C, RH 30%. Strength (1RM leg and bench press via maximal repetition test), speed (5 and 10 m sprint time), agility (T-test), force (peak force during squat jump and ballistic push up) as well as body composition (DXA scan) were assessed at pre-, mid- and post-intervention. Core temperature, HEAT (average peak temperature =38.18 ± 0.27 °C) and CON (37.97 ± 0.32 °C), and muscle temperature (at a depth of 3.5 cm in the vastus lateralis), HEAT (36.79 ± 1.55 °C) and CON (35.94 ± 1.51 °C) were also measured.
RESULTS:
Leg press 1 RM increased from pre intervention to post in both CON (50.25 ± 13.99 kg, $p<0.05$) and HEAT (32.75 ± 5.89 kg, $p<0.05$) while bench press 1RM showed no improvement. However, the relative strength (1RM divided by total muscle mass) improved only in bench press in both groups from pre intervention to post with CON (0.12 ± 0.009 kg.kg MM-1, $p<0.05$) and HEAT (0.06 ± 0.008 kg.kg MM-1) with relative leg press strength showing no improvement. Agility improved in the HEAT group at five weeks (0.3 s ± 0.16 s, $p<0.05$), however it was not different from pre intervention at post intervention. Agility did not improve in the CON group. No improvements were observed in 5m or 10m sprint time, or peak force generated in squat jump or ballistic push up in either group. Total upper body muscle mass increased in each group at post intervention, CON (1507.0 g ± 293.1 g, $p<0.05$), HEAT (806.6 g ± 213.9 g $p<0.05$) along with total muscle mass, CON (1760.8 g ± 306.4 g $p<0.05$) and HEAT (971.0 g ± 335.1 g $p<0.05$). Lower body muscle mass did not increase in either group. Total fat mass did not alter in either group pre to post intervention.
CONCLUSION:
These results indicate that, overall, heat stress applied concurrently with long term RT does not improve upon performance gains.

EFFECTS OF USING PERCEIVED EXERTION TO PREDICT MUSCLE FATIGUE DURING RESISTANCE TRAINING

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INTRODUCTION:
Muscle fatigue appears in daily life and relates to injury risks and sports performance because of the accompanying impairments in the force and/or power generating capacity [1,2]. The rating of perceived exertion (RPE) scale is a perceptual-based assessment method that was developed to monitor exercise intensity [3]. The interdependence between physiological and perceptual responses during exercises indicate that the RPE may be a valid method of assessing muscle fatigue [4]. Therefore, the aim of this study was to develop a prediction model for muscle fatigue by using RPE and velocity during single-joint resistance exercise.
METHODS:
Fifteen healthy male adults underwent different fatigue levels of unilateral elbow flexion (EF) and knee extension (KE), consisting of 30% (L), 60% (M), and 90% (H) volume at 65% of one-repetition maximum. The electromyographic signal, perceived exertion and velocity were measured by using surface electromyography (sEMG) (Kissei-Com Tech, Japan), Borg CR-10 scale, and linear encoder (Fitronic, Slovenia) respectively. Moreover, muscle fatigue was quantified by spectral fatigue indices (FInsm5) by using sEMG signal. Prediction models were built by using multiple regression analyses. The predictors were the RPE score obtained during exercise and the mean velocity, while the output variable was the FInsm5. A repeated ANOVA followed by Bonferroni post-hoc test was used to test for main and interaction effects between variabls. Significance was set at $p<0.05$.
RESULTS:
The prediction models were significant ($p<0.01$) and determination coefficients are large in both EF ($R2 = 0.552$) and KE ($R2 = 0.377$) exercises. Significant differences in RPE ($p<0.05$) were observed between L (EF: 3.13±1.66, KE: 3.67±2.18), M (EF: 5.87±2.50, KE: 6.13±1.63) and H (EF: 8.00±1.79, KE: 8.10±1.48) conditions. Similar results were observed in FInsm5 (L: 1.11±0.06, M: 1.24±0.10, H: 1.37±0.14, $p<0.01$) during EF exercise. With regards to KE, a significant increase in FInsm5 ($p<0.01$) was observed compared H with L (L: 1.01±0.07, M: 1.04±0.07, H: 1.11±0.11) condition. A significant increase in RPE ($p<0.01$), FInsm5 ($p<0.01$) and decrease in velocity ($p<0.01$) were observed throughout the H condition in EF, whereas a velocity decrease was not observed in KE.
CONCLUSION:
The current study has demonstrated that FInsm5 and RPE change correspondingly and has demonstrated that RPE is a useful tool for assessing muscle fatigue during single-joint resistance exercise. Further, two prediction models for muscle fatigue were obtained and can be used in sports and clinical situations by using RPE and velocity. However, fatigue in the lower body was more difficult to induce and predict because of the muscle fiber distribution differences in arm and leg. These differences might cause peripheral perturbation changes, which could potentially affect fatigue responses. Consequently, more caution should be paid when predicting muscle fatigue in the legs compared with arms.
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EFFECTS OF AN ELASTIC RESISTANCE BAND INTERVENTION IN ADOLESCENT HANDBALL PLAYERS

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INTRODUCTION:
The importance of throwing for success in handball is well documented (1). Adolescent players are reported to perform an average of 100.9 passes and 10.1 throws during a 2 x 25-minute game (2). For the improvement of functional and in-game throwing performance (i.e., throwing velocity), elastic resistance bands have been proposed as a simple and effective training tool in addition to regular handball

training (3). The aim of the present study was to investigate the effects of a triweekly 9-week shoulder strengthening program using elastic resistance bands during handball training compared to regular handball training only. The present study fills the gap of knowledge of male youth handball players, as previous studies were either performed with female players or with the program being in addition to regular handball training making it unclear whether the effects can be attributed to the elastic band training or the overall increased training load.
METHODS:
Thirty-two male sub-elite adolescent handball players were assigned into an intervention (INT: n=16; age: 17.0±0.7 yrs; BMI: 24.7±3.5 kg/m2; height: 180.4±7.6 cm) and a control group (CON: n=16; age: 16.9±0.9 yrs; BMI: 22.5±3.3 kg/m2; height: 181.4±6.6 cm). The participants of the INT-group executed a 9-week shoulder strengthening program triweekly in the first 20-30 minutes of their 90-minutes training session, while the CON-group executed an alternative handball-specific training routine during the same time. The elastic resistance band program consisted of eighteen upper-body exercises including the movement directions of the shoulder (i.e., anteversion, retroversion, internal rotation, external rotation, abduction, and adduction) with three sets of 8 reps in week 1, 4 and 7, three sets of 10 reps in week 2, 5 and 8, and three set of 12 reps in week 3, 6 and 9. Strength endurance of the shoulder girdle was assessed with the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST). Maximal isometric strength (MIS) of the internal rotators was tested with a custom-built dynamometer, while throwing velocity was measured as a standing throw with no run-up.
RESULTS:
Significant main effects of Test (i.e., pre- to post-training enhancements) were detected for the CKCUEST ($p < 0.001$, $0.54 \leq \eta p2 \leq 0.57$) and throwing velocity ($p = 0.001$, $\eta p2 = 0.34$). Further, we found a significant (throwing velocity: $p = 0.004$, $\eta p2 = 0.25$) and a tendency toward (MIS of the internal rotators, non-throwing arm: $p = 0.068$, $\eta p2 = 0.12$) a significant Test × Group interaction, both in favour of the INT-group.
CONCLUSION:
The combination of a shoulder strengthening program using elastic bands and regular handball training can be recommended compared to regular handball training only to increase measure of shoulder strength endurance, maximal shoulder strength, and throwing velocity in sub-elite male adolescent handball players.
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2) Chelly et al., J Strength Cond Res, 2011.
3) Aloui et al., J Strength Cond Res, 2018.
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THE RELATIONSHIP BETWEEN THE FIELD GOAL IN BASKETBALL AND THE FACTORS OF EXPERIENCE OF SPORT EVENTS, PAST BASKETBALL EXPERIENCE, GENDER AND STANDING HEIGHT

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INTRODUCTION:
Skill tests for basketball are also used in basketball classes at PE related universities to measure basic skills. However, since students in PE related universities have their own favorite sport events, this situation may influence the measurements in those skill tests. Additionally, past basketball practice, gender, standing height and other factors are also thought to affect performance in basketball skill tests. If these are involved with skill performance in addition to the learning effect from classes, the grading of classes must be done while considering those effects. Thus, the present study aimed to statistically examine the relationship between them. However, as students playing an identical sport event undergo the same training, to take these associations into consideration, the mixed linear model was used.
METHODS:
A field goal skill test was administered to 244 F-university students who belong to a PE major course with all taking basketball PE classes. The field goal test was conducted four times in the following manner: the students performed a shot as many times as possible freely from anywhere beneath the basket using one ball in a 30-second period. They received the rebound of their shot and used that ball for their next shot. They were free to use any shooting method. Two points were given if the shot was successful, one point was given if unsuccessful but the ball touched the ring of the basket and zero points were given if unsuccessful. Their sport club, gender, stature, the years of experience in playing basketball in elementary, junior high and high school were also checked. The sport clubs were comprised of four categories: basketball, ball games other than basketball, sport events other than ball games and no club. These data had a nested structure of category nesting clubs, which are nesting repetition by individuals so that we used the mixed linear model by using them as random effects.
RESULTS:
The comparison of deviances of an only-random-effect model (deviance = 6364.5) and a model including all variables (deviance = 6250.1) indicated that the full model had a significant fitness of modeling (chi-squared = 114.45, df = 5, $p<0.001$). The estimated variances of random effects were 36.446 in individuals, 11.918 in clubs, 29.373 in categories and 23.357 in residuals, indicating that a 0.1% significant difference was detected in all three factors. The partial regression coefficients of fixed effects were 4.318 in males (to = 4.073, df = 233, $p<0.001$), 0.298 in stature (to = 5.095, df = 227, $p<0.001$), 0.961 in elementary school basketball experience (to = 2.452, df = 229, $p<0.05$), 1.456 in junior high school experience (to = 2.332, df= 229, $p<0.05$), and 1.489 in high school experience (to = 1.986, df = 156, $p<0.05$). Namely, inspection of the partial coefficient of fixed effects revealed that all were significant.
CONCLUSION:
The field goal basketball skill is complicatedly influenced by many factors.

MEASURING THE LEG EXPLOSIVE POWER FOR VOLLEYBALL PLAYERS

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INTRODUCTION:
In volleyball, the ball must be passed over a net of a certain height in a way that it will land on the other team's court. This task requires the players not only to have the right height, but also the ability to raise their center of gravity (Gulkai et al, 2021).

Jumping, or raising the center of gravity and body weight, is performed with the leg explosive power. The present study focuses on the methods of measuring the leg explosive power, which significantly determines the athletic performance of volleyball players. The study is aimed at comparing the performance of the players in two different tests (Sargent, Force Platform).
METHODS:
We have selected second division volleyball players to include in the study (Male: N=8, age 25+2,9; Female: N=8, 21.6+2.1). The study began with an analysis of the players body composition using the INbody720 device (Height, Weight, PBF, SMM). After warm-up, the players had to make two consecutive countermovement jumps on the PJS-4P60S force platform (FCMJ), and then they made the three-step jump (FDrop), typical of volleyball, on the force platform. In addition to jumps on the force platform, the players again made the same jumps by a wall, according to the Sargent test (SCMJ, SDrop). We used a HILTI laser meter device for accurate measurement. The data was evaluated using correlation matrix analysis.
RESULTS:
The average results of the tests made on the force platform by men was 48.1+9.14 cm in FCMJ, and 58.35+12.35 in FDrop, while the same results for women was 37.5+4.40 cm and 40.08+4.45 cm, respectively. In terms of the Sargent test, the average SCMJ results for men was 59.67+12.91 cm, and SDrop jump was 66.7+13.50 cm, while averages for women were 41.34+4.92 cm and 47.36+3.58 cm, respectively. There was a strong correlation between the FCMJ and SDrop (r=0,908), and between the FDrop and SDrop (r=0,944), and between the FDrop and SCMJ (r=0,891) scores. The percentage of body fat (PBF) showed an inverse correlation with FCMJ (r= -0,621) and FDrop jump (r= -0,579). We also analyzed the FCMJ and FDrop jump speed (m/s) and relative strength (W/kg) of the players. Both values were strongly correlated with the FCMJ jump height (r= 0,999; r= 0,959).
CONCLUSION:
The performances in the two tests showed a strong correlation; however, during the Sargent test, the players achieved a better average result of 7.3 cm in the CMJ, and an average of 8.15 cm in the Drop jumps. The results obtained during the Sargent test are more representative of the performance during the game. While the design of the force platform may have some negative effect on the results (due to it not being on ground level), the device provides an opportunity to measure the speed and strength of the jump. Thus, the combined application of the two types of tests can be more efficient for measuring and developing the players' leg explosive power.

ASSOCIATION BETWEEN BODY HEIGHT AND CODS AND RA TESTS' PERFORMANCE IN ELITE TEAM SPORTS PLAYERS

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INTRODUCTION:
Previous articles (Šimonek et al., 2017 and others) showed sports disciplines in team sports as a factor affecting the change of direction speed (CODs) and reactive agility (RA). On the other hand, some authors suggested morphological features related to both abilities (Koltai et al., 2021). However, little is known concerning for whom (morphological conditions) and by what means (practicing conditions) CODs and RA mostly occur. There are no studies analyzing the role of body dimensions regarding the type of sports affecting CODs and RA at the same time. Bearing in mind the inconclusive results of previous studies, we attempted to answer the question whether body height moderates the impact of the type of sport on COD and RA. Therefore, the aim of this work was to evaluate the moderating role of body height in the effect of sport discipline on CODs and RA. In addition, we could evaluate whether the conditioned CODs and RA are the same for both abilities or they differ.
METHODS:
The study sample comprised 31 players from female Polish basketball and handball national extraleagues. The Five-Time Shuttle Run To Gates Test (planned and unplanned) was used based on a 'stopngo' movement pattern (Popowczak et al., 2020). Furthermore, we measured the body height and body weight of athletes using an InBody system 230 and GPM 101 antropometr. A two-way analysis of variance (ANOVA) was employed with two factors and two levels each: sport discipline (basketball and handball) and body height (higher and lower). Post-hoc t-tests were calculated where the ANOVAs indicated significant influence.
RESULTS:
Analysis of variance allowed us to find different effects of both factors (sport discipline, body height) in relation to CODs and RA. Body height was weakened by the discipline factor in relation to the CODs and RAs. In the case of RA, the effect of both factors was significantly greater and statistically significant (r = 0.05) than for the CODs
CONCLUSION:
The obtained results indicate the importance of body height as a sports discipline moderator on the obtained results of reactive agility and CODs tests determined using the "stopngo scheme. On the other hand, the differentiation of CODs and RA scores seemingly depend on the sport discipline. This will enable coaches differentiate agility tasks based on body height, and not necessarily on the type of sport.
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CAN A MATCHDAY COOLING PROTOCOL TO MITIGATE SELF-PACING IN ELITE YOUTH FOOTBALL PLAYERS COMPETING IN THE HEAT?

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INTRODUCTION:
Competing in hot environmental conditions has a detrimental effect on performance. Individual performance data of elite football players suggest the adoption of a self-pacing strategy under stressful thermal conditions, sacrificing certain performance metrics (i.e., %high meta-

bolic load distance (%HML) and number of sprints (S)) to preserve their ability to perform high intensity activity when needed. Laboratory studies in the heat have demonstrated appropriately timed cooling methods can improve simulated standardized testing performances. To our knowledge, there have been no published studies investigating the effects of a matchday cooling protocol on the individual performance data of elite youth football players competing in increasingly stressful environmental conditions.
METHODS:
This is a retrospective analysis of 9 members of a men's youth national team (mean+/-standard deviation, age:17 +/- 0.2yrs). Data were collected from 11 international matches including a regional World Cup Qualifying Tournament and the FIFA Men's U17 World Cup. Weather data (temperature and relative humidity) were recorded from the sideline every 5 minutes during the match and averaged. Wet Bulb Globe Temperatures (WBGT) were modeled from observed data. Matches were divided into WBGT high (WBGTH, ≥28C) and WBGT warm (WBGTW, <28.0C). Matchday cooling protocol included precooling, percooling, and post cooling for all matches. Performance data was obtained using a validated global positioning system (GPS) unit system. Data collected were Distance per Minute (DM), Number of Sprints (S), Number of Accelerations (A), High Metabolic Load Distance (HMLD), and %HML. Data were analyzed with a mixed ANOVA model where player and match were controlled. Outcomes were standardized to 90 minutes played, unless otherwise noted.
RESULTS:
There was a statistically significant difference between WBGTH and WBGTW (29.9C+/-2.4 vs 26.9C+/-0.6, p=0.028). There were no statistically significant differences between WBGTH and WBGTW in DM (99.15m/min+/-2.45 vs 101.41m/min+/-2.74, p=0.554), HMLD (1195.01m+/-63.92 vs 1258.78m+/-70.08, p=0.518), %HML (13.2%+/-0.53 vs 13.6%+/-0.58, p=0.645), S (26.83+/-2.04 vs 28.58+/-2.22, p=0.577), A (31.18+/-3.42 vs 30.03+/-3.73, p=0.824), or minutes played (87.39min+/-1.09 vs 87.13min+/-1.18, p=870).
CONCLUSION:
This retrospective study suggests that when using a specific cooling protocol there were no differences in performance variables between moderate and high WBGT environments in elite youth footballers. Further investigation using practical cooling protocols using a wider range of WBGT is encouraged. A need exists to expand results to include core body temperature readings. Comparing team statistics correlated with winning matches may also help elucidate if individually maintained metrics lead to team success.
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Parris and Tyler (2018)

LINEAR RELATIONSHIP BETWEEN THE HEART RATE AND RATING OF PERCEIVED EXERTION DURING GRADED PEDALING EXERCISE

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INTRODUCTION:
The rating of perceived exertion (RPE) scale was developed by Borg1) and Onodera et al.2). They clarified that there is a positive correlation between the RPE during systemic exercise and the heart rate.
METHODS:
This study included 80 healthy male university students, and none of them had prior experience of a cardiopulmonary exercise test. According to the conditions indicated by the Ministry of Health, Labour, and Welfare, these subjects were classified into the exercise group and non-exercise group (n= 40, each) (mean age, 21.0 ± 1.2 years and 21.2 ± 1.4 years; mean height, 170.7 ± 4.2 cm and 172.3 ± 4.2 cm; and mean weight, 67.5 ± 8.0 kg and 64.0 ± 9.4kg, respectively). For the cardiopulmonary exercise test, a bicycle ergometer was used, and electrodes for electrocardiogram guidance were attached to the chest of the subject. The electrocardiogram was monitored until the end of the experiment, and pedalling was performed at 50 watts/minute.
RESULTS:
The linear regression analysis revealed a significant positive correlation between the RPE when driving the bicycle ergometer and the heart rate of all the subjects ($y = 3.881x + 76.823$; $r = 0.966$; $p < 0.001$). However, the relationship between the RPE and the heart rate was significantly different from 1:10. Even though the number of subjects in this study was more than that in a previous study3), the results were similar to that of the previous study ($y = 4.573x + 67.725$). Moreover, most of the subjects' RPE was between 17 and 20 and heart rate was between 140 and 150 beats/min just before the end of the exercise. There was no difference in the relationship between the RPE and heart rate between the exercise group and the non-exercise group ($y = 4.784x + 67.094$ vs. $y = 4.526x + 66.004$). Furthermore, there was no significant difference in the estimated maximal oxygen uptake between them (45.2 ± 4.6 vs. 48.5 ± 12.5 mL/kg/min).
CONCLUSION:
The results of this research show that it is necessary to verify the validity of the RPE scale when estimating the heart rate each time while riding the bicycle. Future studies with more number of subjects and those clarifying the actual condition of the relationship between the RPE and measured heart rate are warranted.

LOWER AND UPPER QUARTER Y-BALANCE TEST PERFORMANCE IN YOUTH: VALIDITY, RELIABILITY AND NORMATIVE VALUES

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INTRODUCTION:
The Lower (YBT-LQ) and Upper (YBT-UQ) Quarter Y Balance Test has been widely used for the assessment of dynamic balance and shoulder mobility/stability, respectively [1,2]. However, investigations on the validity, reliability and normative values of the two tests in youth are lacking. Therefore, we conducted several studies to determine validity and reliability for both tests as well as to provide reference data.
METHODS:
Several convenient samples including children and adolescents with an age range of 10 to 17 years conducted both, the YBT-LQ and the YBT-UQ. Absolute (cm) and relative (% leg/arm length) maximal reach distances per reach direction and the composite score were used as outcome measures. Discriminative validity was analysed using one-way ANOVA and the ROC curve (i.e., calculating the area under the curve [AUC]). Intraclass correlation coefficient (ICC3,1) and standard error of measurement (SEM) were calculated to assess relative and absolute test-retest reliability, respectively. Further, age- and sex-specific percentile values (i.e., 10th to 90th percentile) were computed.

RESULTS:
Concerning discriminative validity, youth athletes showed significantly better YBT-LQ ($p < 0.001$, $d = 0.86–1.21$) and YBT-UQ ($p < 0.001$, $d = 0.88–1.48$) performances compared to age- and sex-matched untrained subjects. Further, AUC-values indicated a chance of ≥74% (YBT-LQ) and ≥ 71% (YBT-UQ) to discriminate between youth athletes and controls. Regarding test-retest reliability, the measure of relative reliability ranged from "moderate-to-good" to "excellent" (i.e., ICC3,1>0.75) and the proxy of absolute reliability was rather small (i.e., SEM ≤ 7.6%), both irrespective of age cohort, reach leg or arm, and reach direction. With respect to normative values, curvilinear shaped curves were observed for the 10th, 50th, and 90th percentiles and were more strongly marked in boys than in girls.
CONCLUSION:
Based on our results, the YBT-LQ and the YBT-UQ seem to be useful test instruments to discriminate between trained and untrained healthy youth performance for dynamic balance and shoulder mobility/stability, respectively. Further, both tests are reliable and suitable to detect meaningful changes in dynamic balance and upper quarter mobility/stability in healthy youth. Lastly, teachers, coaches, and therapists can use the obtained age- and sex-specific normative values to evaluate the level of dynamic balance and of shoulder mobility/stability in healthy youth.

THE INFLUENCE OF AGE ON ASSOCIATIONS BETWEEN TYPES OF BALANCE PERFORMANCE IN HEALTHY CHILDREN, ADOLESCENTS, AND YOUNG ADULTS

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INTRODUCTION:
Balance performance is considered to be task-specific as indicated by small and non-significant correlations between types of balance (e.g., static and dynamic) [1]. However, balance is still developing in youth and therefore associations between types of balance performance may differ with age. Yet, studies in this regard are scarce and their comparability is limited as they focused either on single age-groups (e.g., children) [2] or certain types of balance (e.g., static and dynamic but not proactive balance) [3] and have applied different balance tests [2, 3]. Thus, the aim of this study was to analyze associations between types of balance performance in groups of children, adolescents, and young adults and statistically compare these relationships between age groups.
METHODS:
Three types of balance performance (i.e., static, dynamic, proactive) were tested in 30 children (7.6 ± 0.6 years), 43 adolescents (14.7 ± 0.5 years), and 54 young adults (22.8 ± 0.8 years) using identical testing procedures. To analyze associations between types of balance performance within each age group, Pearson's correlation-coefficients (r) were calculated. Further, associations between types of balance were statistically compared between age groups.
RESULTS:
Overall, the observed r-values were small ($-.302 \leq r \leq .245$) and non-significant ($p > .05$) for associations between types of balance in all age-groups investigated, except for the relationship between static and proactive balance in young adults ($r = .319$, $p < .05$). Statistically significant differences between age groups were only found for two out of 21 comparisons. More specifically, the association between dynamic and proactive balance was lesser in young adults ($r = .161$) compared to adolescents ($r = -.276$, $p = .017$) and children ($r = -.302$, $p = .023$), whereas associations between static and proactive balance were larger in young adults ($r = .319$) compared to adolescents ($r = -.131$, $p = .029$).
CONCLUSION:
Our results support the concept of task-specificity of balance in children, adolescents, and young adults indicating that a person's performance in one type of balance (e.g., static) does not provide clues about this person's ability to perform in another type of balance (e.g., dynamic). Further, the still developing postural control system in youth and thus age seems to have only limited influence on associations between types of balance performance in healthy youth as observed r-values were in most instances similar between age groups. Therefore, types of balance performance should be trained and tested individually in healthy children, adolescents, and young adults.
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EXERCISE DURATION - URGENT NEED FOR AN INDIVIDUALIZED PRESCRIPTION CONCEPT

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INTRODUCTION:
Both, exercise intensity and duration have a crucial impact on acute physiological responses and training adaptations (2, 3). However, concepts allowing an individualized exercise duration prescription for any intensity are extremely rare (1). Therefore, goal of this pilot study was to investigate the acute metabolic and cardiorespiratory responses during constant load exercise (CLE) until exhaustion and individual markers of duration such as maximum duration (tmax) as well as distinct duration phases and duration thresholds (DTh) associated with a selective degree of acute homeostatic disturbance according to Platonov (2).
METHODS:
11 participants (9 males, 2 females; 26,5 ± 3,2 yrs; 1,77 ± 0,09 m; 77,9 ± 11,3 kg; 50,7 ± 6,9 ml/kg*min VO2max) performed a maximal incremental exercise test (IET) and then a CLE test until tmax at a target intensity of 10 % of maximum power output (Pmax) below the second lactate turn point (LTP2) from IET. Heart rate (HR), blood lactate (La) and spirometric parameters were measured during all tests. Duration thresholds were determined by linear regression break point methods (CPX Vienna).
RESULTS:
Maximum duration was markedly different across subjects (range of 40 to 90 min) despite the same relative intensity. According to the concept of Platonov (2), 3 distinct duration phases could be observed: 1) phase of familiarization (until DTh1), 2) phase of stable performance with two sub-phases 2a (until DTh2) and 2b (until DTh3), and 3) phase of compensated fatigue (until tmax). DTh2 and DTh3 averaged over all parameters showed markedly wide ranges when expressed in absolute terms (min) but small ranges when expressed in

relative terms (% tmax) across subjects (DTh2: 12,9 - 33,2 min = 31,9 - 40,6 % tmax; DTh3: 25,7 - 62,7 min = 64,1 - 71,8 % tmax) indicating a high variability in exercise capacity (ability to sustain exercise) despite the same relative exercise intensity.
CONCLUSION:
An exercise duration prescription which is not related to individual tmax may lead to undesired acute responses at any intensity and, supposedly, to unplanned stages of fatigue, recovery times and training adaptations. Furthermore, prescribing a fixed exercise duration (in min) for a group of subjects may result in heterogeneous training stimuli and explain different responders to training interventions. Therefore, beside exact intensity prescriptions, an individual prescription of exercise duration is urgently needed for scientific studies and practice (1).

A STUDY ON MOTOR ABILITY OF INFANTS ATTENDING THE FOOTBALL CLASS

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INTRODUCTION:
The purpose of this study was to measure the motor ability of infants (3-5years old) attending the football class (Not a professional teams institution) and suggest effective trainings for the football coach based on this results.
METHODS:
The participants were 39 infants (3 years old; 5 infants, 4 years old; 24 infants, 5 years old; 10 infants) attending the football class. The measurement contents were time of 25m sprint, length of standing long jump, distance of ball throwing, length of forward bending, time of standing on one leg on the board, time of keeping posture, time of continuous 10 jumping, and grip strength. We compared these measurements with the results of general infants of the same age.
RESULTS:
As a result, 3 years old infants were time of 25m sprint; 8.06±0.97s, length of standing long jumping; 80.00±16.12m, distance of ball throwing; 3.60±1.02m, length of forward bending; 9.00±2.19cm, time of standing on one leg on the board, 1.80±0.75s, time of keeping posture; 13.60±7.39s, time of continuous 10 jumping; 5.98±1.00s, and grip strength; 5.00±0.89kg. Compared to general 3 years old infants, the score was better for contents that require special physical motor manipulation, such as time of 25m sprint, length of standing long jumping, distance of ball throwing, and time of continuous 10 jumping. 4 years old infants were time of 25m sprint; 6.93±0.75s, length of standing long jumping; 86.04±16.26m, distance of ball throwing; 5.75±2.33m, length of forward bending; 12.13±4.77cm, time of standing on one leg on the board, 7.67±6.82s, time of keeping posture; 34.42±17.37s, time of continuous 10 jumping; 5.65±1.06s, and grip strength; 6.63±1.13kg. The results were similar to 3 years old. 5 years old infants were time of 25m sprint; 6.42±1.05s, length of standing long jumping; 102.50±17.78m, distance of ball throwing; 9.20±4.96m, length of forward bending; 11.30±3.49cm, time of standing on one leg on the board, 4.20±1.25s, time of keeping posture; 41.20±22.19s, time of continuous 10 jumping; 6.27±3.10s, and grip strength; 9.05±1.93kg. At this age, there is little difference between general infants and the participants. In this football class, several types of training using "Agility Ladder" are regularly practice.
CONCLUSION:
The effect is considered to be a factor that caused the difference between the general infants and the participants. The effect was particularly pronounced at the age of 3 and 4 years old. This age is when the nervous system will be more developed. “Agility Ladder” probably contributed to its development. In conclusion, the measurements of contents that require ability in physical manipulation were excellent as trends in motor ability of infants attending the football class that participated in this study. As a factor, it is thought that "Agility Ladder" which is being conducted as a training contributes.

THE EFFECTS OF HIP FLEXOR AND QUADRICEPS STRETCHING ON PELVIC TILT AND HAMSTRING RANGE OF MOTION IN NCAA DIV II SOCCER PLAYERS

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INTRODUCTION:
University soccer players perform repetitive hip flexion and sit for extended time putting them at risk for developing anterior pelvic tilt and lower crossed syndrome (LCS). Sherrington’s Law of Reciprocal innervation posits that tight hip flexors and quadriceps compromise the antagonist muscles leading to impaired gluteal strength and synergist hamstring dominance. This shift increases the risk of hamstring injuries, despite regular flexibility training.
Thus, this study investigated the prevalence of pelvic tilt and examined the relationship between muscle activation and range of motion (ROM). Further, we examined the effects of hip flexor and quadriceps stretching on pelvic tilt and hamstring ROM.
METHODS:
NCAA Div. II soccer players (N= 15; age= 20.4±1.8 y; height= 1.8±0.3 m; mass= 75.6±4.3 kg) attended one lab session (~55 mins). After a standardized warm-up, measures included: 1) Pelvic tilt, assessed with markers placed on the ASIS and PSIS with subject standing in a relaxed position; 2) Hip flexor and quadricep tightness, assessed with the Thomas Test; importantly neutral pelvic position was fixed prior to assessment; 3) Hamstring ROM, assessed with an active straight leg raise; 4) Gluteal strength and hamstring synergistic dominance, assessed with a single leg Cook bridge. For steps 1-3 bilateral sagittal plane photographs were taken, and images analyzed using Kinovea software. After a 5-min rest the process was repeated. Next, a bilateral contract-relax PNF stretch protocol (3 sets) was applied to the hip flexors and quadriceps. Test measures 1-4 were repeated a third time; thus, participants were their own controls. Repeated measures ANOVA were used to identify changes between the three measurement cycles, with pairwise comparison follow-up tests where appropriate. Alpha was set at 0.05. Frequency analysis was used to estimate changes in hamstring synergistic dominance.
RESULTS:
Anterior pelvic tilt was within the normal range and did not change with the stretch intervention ($p>0.05$). The Thomas test showed no hip flexor tightness, but there was a significant shift (5%; $p<0.05$) in knee joint ROM, suggesting changes in quadricep tightness. Despite the change in quadricep ROM, there was no change in hamstring ROM ($p<0.05$). Prior to PNF, 70% reported hamstring synergist dominance which reduced to 53% after the PNF intervention.
CONCLUSION:
The lack of anterior pelvic tilt was surprising given the amount of hip flexion and extended sitting these athletes do. Because the amount of pelvic tilt was within normal values, hip flexor tightness was not present and as such Sherrington’s Law of Reciprocal innervation would be

unlikely. Nevertheless, hamstring synergist dominance reduced dramatically after the stretch intervention. Thus, although PNF stretching did not increase hamstring ROM, it appeared to promote better muscle strategies for hip extension; this could have important implications for performance and injury reduction.

THE INFLUENCE OF THE OVAL, LANE AND SIMULTANEOUS ENTRY ON RESULT AND PACING STRATEGY OF SPEED SKATING MENS 1500M

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INTRODUCTION:
To explore the influence of the oval (plateau or plain), the lane (inner or outer), and simultaneous entry (long distance or sprint) on the result and pacing strategy in speed skating mens 1500m.
METHODS:
Multi-factor analysis of variance, independent sample T test, Spearman correlation coefficient method, paired T test and other statistical methods are used to analyze the relationship and differences between the oval (plateau or plain), the lane (inner or outer), and/or simultaneous entry (long distance or sprint) and the results of the top 8 athletes of the ISU event in the 2019-20 season.
RESULTS:
Among the three factors of oval, lane, and simultaneous entry, only the altitude will improve the athletes performance of 1500m, an increase of about 2.52%（2.65s）. Both the oval and the simultaneous entry will affect the athletes 1500m pacing strategy. Athletes tend to adopt a more positive strategy when competing in plateau; the sprint athletes have a faster opening, but a slower ending.
CONCLUSION:
Now is the world and our mens 1500 meters level of the highest period. Among the oval factors, the highland oval can significantly improve the athletes performance of 1500m; Athletes tend to adopt a more positive pacing strategy in the plateau than in the plain. In the process of preparing for the 2022 Winter Olympic Games, we can predict the competitive level of the opponent through the plateau competition results and carry out targeted preparation. Different lanes do not affect the athletes 1500m performance and pacing strategy but may affect the athletes final lap speed. There is no obvious difference between the sprint and long-distance athletes on the result of 1500m, but the sprint athletes have a faster opening and a slower ending, and the long-distance athletes have a faster final lap and a smaller drop between each lap.

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