3rd International Congress on SOLDIERS' PHYSICAL PERFORMANCE

Boston, USA · 18-21 August 2014

Westin Boston Waterfront Hotel

Final Program and Abstracts

Hosted by the United States Army Research Institute of Environmental Medicine

www.icspp2014.com

PROGRAM › Schedule At-A-Glance

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
0730		Registration & Exhibits	Registration & Exhibits	Registration & Exhibits
0800		0800-0900 **Keynote Speaker** *MG Caravalho (USA)*	0800-0900 **Invited Speakers** *Deuster & O'Connor (USA)*	0800-0900 **Research Consensus**
0830				
0900		0900-0915 **Break** 0915-1115 **Concurrent Symposia**	0900-0915 **Break** 0915-1115 **Concurrent Symposia**	0900-1000 **Invited Speaker** *Häkkinen (Finland)*
0930				
1000				1000-1015 **Break** 1015-1215 **Concurrent Symposia**
1030				
1100		1115-1230 **Lunch** 1115-1230 **Poster Session II**	1115-1230 **Lunch** 1115-1230 **Poster Session III**	
1130				
1200				1215-1330 **Lunch** 1215-1330 **Poster Session IV**
1230		1230-1330 **Invited Speaker** *Greeves (UK)*	1230-1330 **Invited Speaker** *Taylor (Australia)*	
1300				
1330		1330-1345 **Break** 1345-1545 **Thematic Free Communications/ Poster**	1330-1345 **Break** 1345-1545 **Thematic Free Communications/ Poster**	1330-1430 **Invited Speaker** *Bigard (France)*
1400	1400-1800 **Registration**			1430-1445 **Break** 1445-1645 **Thematic Free Communications/ Poster**
1430				
1500				
1530				
1600	1600-1730 **Thematic Poster Session**	1600-1700 **Invited Speaker** *Kraemer (USA)*	1600-1700 **Invited Speaker** *Gibala (Canada)*	
1630				
1700				1700-1800 **Roundtable Discussion**
1730				
1800	1800-1930 **Opening Ceremony** *(Military Uniform Recommended)*			
1830				1830-2200 **Closing Ceremony** *(Military Uniform Recommended)*
1900				
1930	1930-2130 **Welcome Reception and Exhibits** 1930-2100 **Poster Session I**			
2000				
2030				
2100				
2130				

TABLE OF CONTENTS

WELCOME > A Message from the Co-Chairs

On behalf of the Planning and Organizing Committee, it is our great pleasure to welcome you to Boston, MA, for the 3rd International Congress on Soldiers' Physical Performance (ICSPP)! We are confident that this Congress will foster important scientific exchange and dialogue centered on improving military physical performance and readiness.

Dr. Bradley Nindl
Co-Chair

It is an honor to be a part of the ICSPP legacy. The 1st ICSPP was organized by the Department of Biology of Physical Activity at the University of Jyvaskyla and the Finnish Defence Forces in cooperation with the Conseil International du Sport Militaire (CISM) in 2005. The success of the Congress and the need for developing greater scientific understanding about soldiers' performance was the catalyst for Finland organizing the 2nd ICSPP in 2011. Since that time, it has been established that the purpose and challenge is to have a Congress every three years.

With over 300 attendees from more than 30 countries, there will be 210 scientific presentations over four days. These include invited keynote lectures, symposia, featured science sessions, oral and poster free communication sessions, thematic poster sessions, and a Warfighter Readiness Roundtable. These presentations will focus on a fundamental premise that Soldiers are the center of warfighting capability and the human service member is the prime resource and key enabler of all warfighting systems.

Ms. Marilyn Sharp
Co-Chair

As countries around the globe respond to current and emerging threats to their National Security, it is increasingly clear that we must ensure optimal human performance of our military personnel. By taking advantage of the science and applications of physical fitness and injury prevention research, we can leverage our increased understanding for the optimal application of physical readiness processes while minimizing the injury risk potential. We believe that the continued scientific and evidence-based dialogue across international partners will prove to be transformative in identifying the most effective strategies for human performance optimization in the 21st century.

We would like to express our thanks to the invited speakers, presenters, exhibitors, Scientific Advisory Committee and everyone who has assisted with the Congress, including Isom Global Strategies for their excellence in planning support and the arrangements of all aspects of the Congress.

We trust your ICSPP experience will stimulate a creative exchange of ideas and your visit to the culturally and historically rich city of Boston will be rewarding.

COMMITTEE MEMBERS

Planning and Organizing Committee Members

Co-Chairs

Dr. Bradley Nindl (USA)

Ms. Marilyn Sharp (USA)

Members

Mr. Mark Bither (USA)
Dr. Keijo Häkkinen (Finland)
Dr. Bruce Jones (USA)
Dr. Bob Kenefick (USA)
Dr. Heikki Kyröläinen (Finland)
LTC Robert Roussel (USA)
LTC Matti Santtila (Finland)
Dr. Edward Zambraski (USA)

Scientific Advisory Committee Members

LTC Anne Andrews (USA)
Dr. Brent Alvar (USA)
Dr. Neal Baumgartner (USA)
Dr. Dan Billing (Australia)
COL Nikki Butler (USA)
MAJ Robert Carter (USA)
LTC Mounir Chennaoui (France)
Dr. Patty Deuster (USA)
LTC Antonio Duarte (Brazil)
Mr. Jason Dudley (USA)
Dr. Chip East (USA)
Dr. Yoram Epstein (Israel)
Dr. Karl Friedl (USA)
Dr. Pat Gagnon (Canada)
Dr. Ryland Gaskins (USA)
Dr. Julie Greeves (UK)
Dr. Herb Groeller (Australia)
LTC Andrei V. Gurvich (Russia)
Dr. Travis Harvey (USA)
LTC Yuval Heled (Israel)
Dr. Jay Hoffman (USA)
Dr. Susan Jaenen (Canada)
Dr. Karen Kelly (USA)
Dr. William Kraemer (USA)
Dr. Helena Larsson (Sweden)
Ms. Lydia Law (Singapore)
Dr. Jason Lee (Singapore)
COL Dieter Leyk (Germany)
LTC Anders McDonald Sookermany (Norway)
Mr. Brian McGuire (USA)
Dr. Scott Montain (USA)
Dr. Jill McQuade (USA)
Dr. Dani Moran (Israel)
COL Francis O'Connor (USA)
Mr. Frank Palkoska (USA)
Dr. Diana Purvis (USA)
Dr. Tim Sell (USA)
Dr. Jeff Schiffman (USA)
LTC Andre Siqueira (Brazil)
Dr. David Swain (USA)
Dr. Nigel Taylor (Australia)
COL Deydre Teyhen (USA)
Mr. Taco Visser (Netherlands)
Dr. Tom Williams (USA)
Dr. Thomas Wyss (Switzerland)
Dr. Miyo Yokota (USA)
MAJ Zakharov (Russia)

GUBERNATORIAL GREETING

OFFICE OF THE GOVERNOR
COMMONWEALTH OF MASSACHUSETTS
STATE HOUSE • BOSTON, MA 02133
(617) 725-4000

DEVAL L. PATRICK
GOVERNOR

August 2014

Dear Friends:

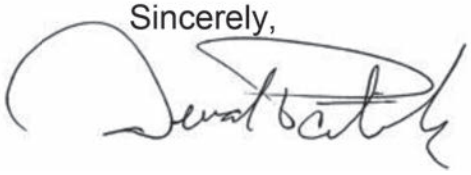
On behalf of the Commonwealth of Massachusetts, I send warm greetings as you gather for the Third International Congress on Soldiers' Physical Performance. Welcome to Boston!

The International Congress on Soldiers' Physical Performance (ICSPP) has been at the forefront of soldier medicine, its practice, research and education. The ICSPP brings together scientists, military members, policy makers, and health specialists to discuss important topics pertaining to soldiers' health. It is an opportunity to develop ideas and partnerships across various sectors and industries. I urge you to take full advantage of the important information and invaluable networking opportunities available to you at this year's Congress.

I am proud of all the Veterans participating in this year's Congress and appreciate your willingness to share your inspirational experience with us. We honor and thank you all for your service and sacrifice.

During your time in Boston, I encourage you to visit and enjoy our many museums, historic sites, and fantastic restaurants. Please accept my best wishes for a successful and enjoyable Congress.

Sincerely,



MAYORAL GREETING

CITY OF BOSTON • MASSACHUSETTS

MARTIN J. WALSH
MAYOR

August, 2014

Dear Friends,

It is my distinct pleasure to extend a warm welcome as you gather for the ***3rd International Congress on Soldiers' Physical Performance***. I would like to thank you in advance for collaborating and recognizing the importance of optimizing the mental, physical and emotional well-being of our military.

The City of Boston is the home to the greatest medical centers and research hospitals making it the perfect place to host such a significant conference. The training and physical performance criteria offered at the ICSPP is an imperative part of assuring our soldiers' optimum health as well as substantial protection mechanisms to aid against diseases and injury. I applaud all of the guest speakers who will share their knowledge and scientific research while advocating for services that optimize performance and increase endurance. I stand by all citizens when I say thank you for your participation and contribution to this dynamic forum and to the soldiers that proudly and honorably protect us daily.

On behalf of the City of Boston, I invite you to enjoy the many historic and contemporary sights, sounds, and tastes of our city while you are visiting. It is a pleasure to have you and we wish you a productive and successful experience.

Sincerely,

Martin J. Walsh
Mayor of Boston

HARBOR FOYER EXHIBITORS

ARMY WELLNESS CENTERS
Booth No. 103 in Harbor Foyer
phc.amedd.army.mil/organization/institute/dhpw/pages/armywellnesscentersoperation.aspx

Army Wellness Centers provide standardized primary prevention programs designed to promote and sustain healthy lifestyles and improve the overall wellbeing of Active Duty Service Members, adult Family Members, Retirees, and Department of the Army (DA) Civilians by leveraging state-of-the techniques and equipment.

COSMED USA, INC.
Booth No. 104 in Harbor Foyer
cosmed.com

COSMED is a European Company with headquarters based in Italy manufacturing Cardio Pulmonary and Metabolic Diagnostic Equipment. Innovative products and technological "firsts" in the market have characterized its history. COSMED products are aimed for either professional or medical use for many different applications like: Hospital, Clinics, Primary Care, University & Education in Human Physiology, Clinical Nutrition, Commercial Weight Management, Sport Institutions and Health Club Industry.

HEALTHY LEARNING
Booth No. 106 in Harbor Foyer
www.healthylearning.com

Healthy Learning publishes instructional materials for health, fitness, medical and wellness professionals on a variety of topics, such as health, sports medicine, and exercise. Many of its titles are produced in cooperation with a number of leading institutions including: ACSM, ACA, AMSSM, ECA, Institute for Lifestyle Medicine, IHRSA, MFA, and MWA.

NATICK SOLDIER RESEARCH DEVELOPMENT ENGINEERING CENTER, COMBAT FEEDING DIRECTORATE (NSRDEC, CFD)
Booth No. 105 in Harbor Foyer
nsrdec.natick.army.mil

Combat Feeding provides the Department of Defense (DoD) with a joint service program responsible for Research, Development, Integration, Testing, and Engineering for Combat Rations, Food Service Equipment Technology, and Combat Feeding Systems.

PERFORMANCE TRIAD
Booth No. 100 in Harbor Foyer
phc.amedd.army.mil/topics/healthyliving/perftriad/Pages/default.aspx

The Performance Triad (Triad) represents Healthy Sleep, Physical Activity, and Nutrition – three key components that are critical for the health, wellbeing, and readiness of the Army's Soldiers, Retirees, Family members, and DA Civilians. While each component is independently important, optimal health is achieved when all three are addressed simultaneously.

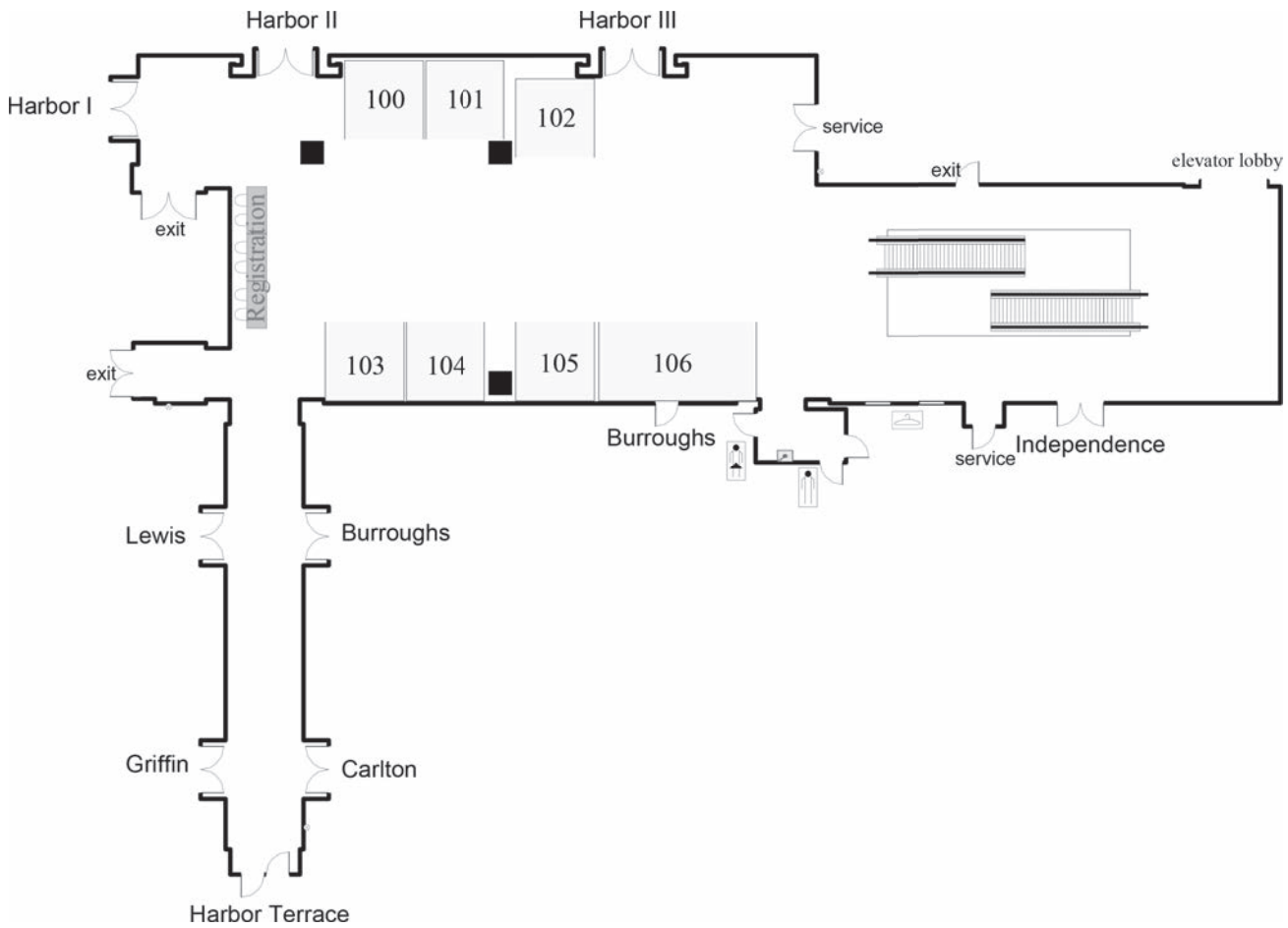
U.S. ARMY PUBLIC HEALTH COMMAND
Booth No. 101 in Harbor Foyer
phc.amedd.army.mil/Pages/default.aspx

Promote health and prevent disease, injury, and disability of Soldiers and military retirees, their Families, and Department of the Army civilian employees; assure effective execution of full spectrum veterinary service for Army and Department of Defense veterinary missions.

USARIEM
Booth No. 102 in Harbor Foyer
www.usariem.army.mil

USARIEM's mission is to optimize warfighter health and performance through medical research. USARIEM functions as a world-class laboratory for Environmental Medicine, Applied Physiology, Soldier Performance and Military Nutrition. USARIEM's research partnerships with top rated hospitals, worldwide universities and industry leaders makes us the DoD's premier human performance optimization organization.

HARBOR FOYER FLOOR PLAN *(Conference Level)*



GALLERIA HALL EXHIBITORS

ALINE
Booth No. 1 in Galleria Hall
www.aline.com

ALINE was formed to improve the way people move from the ground up. We're a movement of thousands of elite athletes, medical professionals, retailers and everyday people that want to enhance their life through better performance and health.

JOURNAL OF ORTHOPAEDIC & SPORTS PHYSICAL THERAPY (JOSPT)
Booth No. 19 in Galleria Hall
www.jospt.org

JOSPT publishes scientifically rigorous, clinically relevant content for physical therapists and others in the health care community to advance musculoskeletal and sports-related practice. Now in its 35th year, JOSPT aims to be the preeminent source of scientific evidence to optimize musculoskeletal and sports-related rehabilitation and health in the global community.

KINDUCT TECHNOLOGIES
Booth No. 16 in Galleria Hall
www.kinduct.com

Kinduct Technologies develops innovative high performance software and content with a focus on user engagement, data collection and measurement. Kinduct's SaaS-based enterprise software helps transform how organizations communicate and coordinate health, wellness and human performance initiatives to promote positive behavioral change and successful outcomes.

NATIONAL STRENGTH AND CONDITIONING ASSOCIATION
Booth No. 11 in Galleria Hall
www.nsca.com

The National Strength and Conditioning Association (NSCA) is an international nonprofit educational organization. As the worldwide authority on strength and conditioning, the NSCA supports and disseminates research-based knowledge and its practical application to improve athletic performance and fitness.

NOVEL INC.
Booth No. 12 in Galleria Hall
www.novelusa.com

novel provides load distribution measurement systems including the emed barefoot sensor platform, pedar in-shoe system and the pliance system for applications such has load carriage, hand and socket pressures. All systems utilize calibrated capacitive sensor technology to provide the most accurate data available for applications in research and clinical practice.

TRX TRAINING
Booth No. 4 in Galleria Hall
www.trxforce.com

TRX Training is the leader in the functional fitness industry. Thousands of people at all fitness levels now train on the TRX: From everyday people who just want to feel and look their best to some of the world's most elite professional and tactical athletes.professional and tactical athletes.

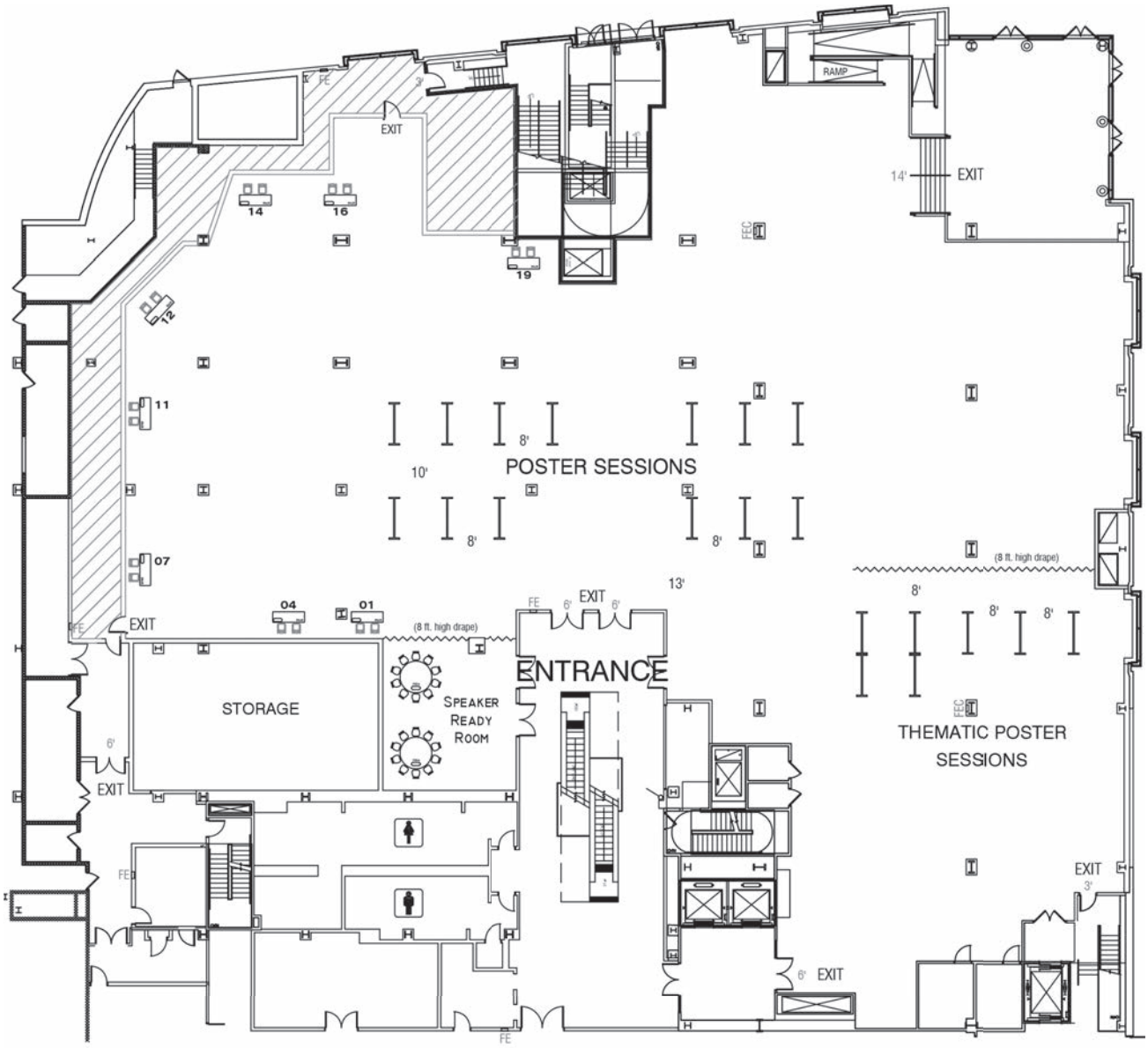
WELLCOACHES CORPORATION
Booth No. 14 in Galleria Hall
www.wellcoachesschool.com

Wellcoaches leads the way in establishing health and wellness coaches in healthcare, corporate and consumer wellness. This certification is endorsed by the American College of Sports Medicine.

WOODWAY USA
Booth No. 7 in Exhibit Hall
www.woodway.com

Woodway is the manufacturer of the world's finest treadmill, specializing in high end, custom designed and hand built treadmills for fitness training, rehabilitation, and human performance. As a company they have been at the forefront of testing and training technology for over 35 years.

GALLERIA HALL FLOOR PLAN *(Galleria Level)*



Rev. 8/12/14

10' 0 10' 20' 30'

Willwork, Inc.
Exhibit & Event Services
Experience the Energy

19 August

Invited Keynote Speaker

Major General Joseph Caravalho, Jr, MD
Commanding General
US Army Medical Research and Materiel Command
Improving, Restoring, and Maintaining Soldier Health: Performance Triad Vision

Major General (Doctor) Joseph Caravalho, Jr., graduated in 1979 with a Bachelor of Arts in Mathematics from Gonzaga University in Spokane, WA. He was commissioned a Second Lieutenant through the Army ROTC Program. In 1983, he graduated with a Medical Doctorate from the Uniformed Services University of the Health Sciences School of Medicine, and was commissioned a Captain in the Medical Corps.

Clinically, MG Caravalho held positions as a staff internist, nuclear medicine physician, and cardiologist. He served as Chief of Cardiology at Tripler Army Medical Center (AMC), Honolulu, HI, and as Deputy Commander for Clinical Services at Womack AMC, Fort Bragg, NC. His operational medical experience includes assignments as Surgeon, 1st Battalion, 1st Special Forces Group (Airborne), Okinawa, Japan; Physician Augmentee, Joint Special Operations Command, Fort Bragg; Surgeon, 75th Ranger Regiment, Fort Benning, GA; Deputy Chief of Staff, Surgeon, U.S. Army Special Operations Command, Fort Bragg; and as the Assistant Chief of Staff, Health Affairs, XVIII Airborne Corps, Fort Bragg. He also commanded the 28th Combat Support Hospital and the 44th Medical Command (Rear) (Provisional), both at Fort Bragg. He has two deployments in support of Operation Iraqi Freedom, most recently serving as the Surgeon for both Multi-National Force-Iraq and Multi-National Corps-Iraq. After his last deployment, he served as the Commanding General for Great Plains Regional Medical Command (RMC), and then, following USAMEDCOM reorganization, for both Southern RMC and Brooke AMC, both at Fort Sam Houston, TX. Before coming to the U.S. Army Medical Research and Materiel Command, MG Caravalho served as Commanding General, Northern RMC, Fort Belvoir, VA.

MG Caravalho is a graduate of the Command and General Staff College and the Army War College. He earned the Special Forces and Ranger tabs and was awarded the Expert Field Medical Badge. He completed the Army Airborne and Flight Surgeon schools, as well as the Navy Dive Medical Officer and SCUBA courses. He holds current certification in nuclear cardiology. His military awards include the Distinguished Service Medal with Oak Leaf Cluster (OLC), Legion of Merit (OLC), Bronze Star Medal, Defense Meritorious Service Medal, Army Meritorious Service Medal (6 OLC), Joint and Army Commendation Medals, and the Army Achievement Medal (3 OLC). He is also a member of the Order of Military Medical Merit.

MG Caravalho has been married for over 29 years and has two adult children.

19 August

Dr. Julie Greeves

Head of Research, Occupational Medicine
UK Ministry of Defence, Army Recruiting and Training Division (UK)

Physiological Implications, Performance Assessment and Risk Mitigation Strategies for Women in Combat-Centric Occupations

Dr. Greeves is Head of Research in Occupational Medicine at HQ Army Recruiting and Training Division, commissioning and conducting research to reduce the risk of training injuries in soldiers and recruits. Previously, she spent over 11 years investigating musculoskeletal health in soldiers and aircrew at QinetiQ. Her research interests include the pathogenesis of stress fractures, mechanical loading and bone health, and sex differences in injury risk and physical performance. Dr. Greeves has published in peer-reviewed journals and supervises four Ph.D. students. Dr. Greeves is currently responsible for a large research program investigating the role of vitamin D and iron on musculoskeletal injury risk, immune health, and physical performance, and has established the Bone Research Unit at two training establishments housing state-of-the-art DXA, pQCT, and HR-pQCT medical imaging modalities. She represents ARTD on the Surgeon General's Cold Injuries Working Group; the Training, Exercise, and Medicine Advisory Group; and the Defense Food and Nutrition Working Group, and is an appointed member of the Non-Freezing Cold Injuries Steering Group. She is also a member of the American Society of Bone and Mineral Research, the Bone Research Society, the American College of Sports Medicine, and the International Bone and Mineral Society.

19 August

Dr. William Kraemer

Professor, Kinesiology, Physiology and Neurobiology
University of Connecticut (USA)

Physiological Readiness and Resilience: Scientific Underpinnings for the Pillars of Military Preparedness

Dr. Kraemer is full professor in the Department of Kinesiology and the Department of Physiology and Neurobiology at the University of Connecticut, Storrs as well as at the UConn School of Medicine in Farmington. Dr. Kraemer is a Fellow in the American College of Sports Medicine and is a Fellow and past president of the National Strength and Conditioning Association, he received its Outstanding Sports Scientist Award in 1992 and its Lifetime Achievement Award in 1994; the former was named in his honor in 2006. Dr. Kraemer serves on numerous scientific journal editorial boards, including for Medicine and Science in Sports and Exercise and the Journal of Applied Physiology. He serves as Editor-in-Chief of the Journal of Strength and Conditioning Research, editor for the European Journal of Applied Physiology, and associate editor for the Journal of the American College of Nutrition. He has authored or coauthored over 400 peer-reviewed manuscripts on resistance exercise and training, exercise endocrinology, muscle physiology, and sport science and has published 10 books. He was awarded the University of Connecticut's Research Medal in 2005 and the UConn Alumni Association's Research Excellence Award in Sciences in 2009.

20 August

Dr. Nigel Taylor

Associate Professor, Centre for Human and Applied Physiology, School of Medicine
University of Wollongong (Australia)

Protection versus Physiology: Interactions Among Physiological Regulation and Protective Equipment

Dr. Nigel Taylor has over 30 years of research experience in human stress physiology, with particular emphases upon exercise and environmental physiology and, in particular, human temperature regulation. He is the current Chair of the Section on Thermal Physiology of the International Commission on Comparative Physiology (International Union of Physiological Sciences). Dr. Taylor is the Reviews Editor for the European Journal of Applied Physiology and an International Editorial Board member of six other refereed journals. His publication record includes more than 90 refereed journal publications, seven monographs, over 30 chapter contributions, and over 65 technical reports to government and commercial organizations. At present, he has an active research collaboration with the Defence Science and Technology Organisation (Melbourne, Australia), as well as collaborative links with the University of Portsmouth (U.K.), Louis Pasteur University and Centre National de la Recherche Scientifique (France), Kobe University (Japan), and the KTH Royal Institute of Technology (Sweden).

PROGRAM › Invited Speakers *(continued)*

20 August

Dr. Patty Deuster

Director and Professor, Consortium for Health and Military Performance
Uniformed Services University (USA)

Human Performance Optimization (HPO) Strategies: Integrating Research, Education, and Clinical Services' Line of Efforts for Soldier Readiness

Dr. Deuster is a professor and Director for the Consortium for Health and Military Performance (CHAMP), the Defense Center of Excellence for Human Performance Optimization Translation, at the Uniformed Services University of the Health Sciences (USU). She obtained an AB in Mathematics and Computer Science and an MA in Physical Education from the College of William and Mary, a Ph.D. in Nutritional Sciences and Physiology from the University of Maryland, and an MPH with an emphasis in epidemiology from USUHS. Dr. Deuster chairs the Department of Defense (DoD) Dietary Supplement Subcommittee, is a member of the DoD Food and Nutrition Subcommittee, and serves on the DoD Human Performance Optimization Health Sciences Advisory Committee. She is one of the leads on the DoD Operational Supplement Safety Initiative. She is a Fellow of the American College of Sports Medicine (ACSM), a Certified Nutrition Specialist, and has over 170 peer-reviewed papers and numerous book chapters and books relating to nutrition, dietary supplements, and physical performance. In addition, she has developed multiple educational materials related to human performance and total force fitness; many are posted on the CHAMP Human Performance Resource Center website (hprc-online.org).

20 August

COL Francis O'Connor

Associate Director, Consortium for Health and Military Performance
Professor and Chair, Military and Emergency Medicine
Uniformed Services University (USA)

Human Performance Optimization (HPO) Strategies: Integrating Research, Education, and Clinical Services' Line of Efforts for Soldier Readiness

Dr. O'Connor, Professor and Chair, Military and Emergency Medicine, and Associate Director for the Consortium on Health and Military Performance, Uniformed Services University, has been a leader in sports medicine education and research for the military for over 20 years. Dr. O'Connor has authored over 60 peer-reviewed articles in scientific journals and numerous book chapters, technical reports, and health promotion resources for the military.In addition, Dr. O'Connor is the editor of eight texts on sports medicine, including the Textbook of Running Medicine; Sports Medicine for the Primary Care Physician, 3rd Edition; and ACSM's Sports Medicine: A Comprehensive Review. He has been on the boards of several leading organizations in sports medicine, including the American College of Sports Medicine and the American Medical Athletic Association, and is a past president of the American Medical Society of Sports Medicine. A Colonel in the United States Army, Dr. O'Connor is a graduate of the United States Military Academy at West Point. Prior to his recent posting at Uniformed Services University in the Department of Military Medicine, he served one year as a Command Surgeon with Special Operations in the Middle East.

20 August

Dr. Martin Gibala

Professor and Chair, Department of Kinesiology
McMaster University (Canada)

Physiological Adaptations and Military Applicability to Low-Volume, High-Intensity Interval Training in Health and Disease

Dr. Martin Gibala is a professor and Chair of the Department of Kinesiology at McMaster University in Hamilton, Canada. He is an exercise physiologist interested in the regulation of energy metabolism at the molecular to whole-body level in both healthy and diseased states. Dr. Gibala also conducts applied studies that examine the impact of physical training and nutrition on human performance. His research on the physiological and health adaptations to brief, intense interval training has garnered significant scientific attention as well as widespread media coverage. Dr. Gibala is a past recipient of the SIRC Award for Outstanding High Performance Sport Research in Canada, and he coauthored the most recent consensus statement on sports nutrition for the International Olympic Committee. Dr. Gibala has received three awards for teaching excellence from the McMaster Students Union, as well as the President's Award for Excellence in Graduate Student Supervision.

21 August

Dr. Keijo Häkkinen

Professor, Head and Vice Dean, Department of Biology of Physical Activity
University of Jyväskylä (Finland)

Concurrent Strength and Aerobic Training Modes for Developing Physical Performance

Dr. Keijo Häkkinen is professor and head of the Department of the Biology of Physical Activity at the University of Jyväskylä, Finland. He was qualified for scientific competence for the academic chairs of the professorship in Biomechanics in 1989, Exercise Physiology in 1991, and the Science of Sport Coaching and Fitness Testing in 2001 at the University of Jyväskylä. He obtained a docentship in Biology of Exercise Training in 1992 at the University of Oulu, Finland. He has to his credit about 350 international peer-reviewed research articles, 50 articles in congress proceedings and chapters in books, 10 refereed reviews and books, and over 150 domestic publications. His research interests are broad within the field of the biology of physical activity, but his major area of focus is on neuromuscular and hormonal responses and adaptations during strength training, as well as during combined strength and endurance training, in men and women at different ages and from various sports. He has given numerous presentations at international scientific congresses and seminars, and has contributed to the organizing process of over 25 International Congresses. He is a chair and founding member of the International Scientific Committee of International Conference Series on Strength Training.

21 August

MG Xavier Bigard

Professor, French Agency Against Drugs in Sports
Vice President, French Association of Sports (France)

Are There Ethical Limitations for Improving Physical Performance in Soldiers?

Major General Xavier Bigard is a physician, physiologist, and professor at the Val-de-Grâce School, the French university of military medicine. He was involved in researching the human response to military environments, for which his research team examined the musculoskeletal response to physical training, the influence of hypobaric hypoxia on muscle plasticity, the extent of muscle injury after prolonged exercise, and the biological mechanisms of muscle regeneration. Specific attention was paid to medical tolerance of physical training in the Army. His team was also involved in examining the influence of the military environment on nutritional requirements, and the role played by nutrition on a soldier's performance. Major General Bigard joined working groups involved in ethical reflections about the use of new performance-enhancing technologies to increase warfighters' ability to complete their mission safely and effectively. Previously, Major General Bigard was in charge of the Department of Human Factors in the Research Center of the Health Service for the Army (CRSSA), and was appointed as Deputy Director of the French Armed Forces Biomedical Research Institute (IRBA). He is now the scientific advisor to the president of the French Anti-Doping Agency (French ADA) and president of the French Society of Sports Medicine.

1400-1800	*Harbor Foyer (CL)*	Registration
1600-1730		**THEMATIC POSTER SESSION**
	Burroughs (CL)	***Use of Dietary Supplements in Military Training and Operations*** Moderator: Joseph Knapik (USA) *Prevalence of Dietary Supplement Use in the Military* Joseph Knapik (USA) *Relationship of Dietary Supplement Use to Physical Activity in United States Armed Forces Personnel* Krista Austin (USA) *The Use of Caffeine to Improve Physical and Cognitive Performance During Sustained Operations* Tom McLellan (Canada) *Protein Supplementation for Improving Body Composition, Muscle Strength and Recovery* Juha Hulmi (Finland) *Banned Substances in Dietary Supplements* Josh Kazman (USA) *Performance-Enhancing Dietary Supplements and Other Health Related Factors Associated with Adverse Medical Outcomes in Active Duty U.S. Army Soldiers* Esther Dada (USA)
	Carlton (CL)	***Chronic Exertional Compartment Syndrome in the Military*** Moderator: Pieter Helmhout (Netherlands) *The Effectiveness of a Center-Based Versus a Home-Based Training Program Aimed at Changing Running Style in Patients with Chronic Exertional Compartment Syndrome* Pieter Helmhout (Netherlands) *The Diagnostic Value of Intramuscular Compartment Pressure in Chronic Exertional Compartment Syndrome: New and Improved Criteria* David Roscoe (England) *Differences in the Biomechanics Between Patients with CECS and Asymptomatic Controls* Andy Roberts (England) *Forefoot Running Improves Pain and Disability Associated with Chronic Exertional Compartment Syndrome* Angela Diebal (USA)
	Harbor Ballroom (CL)	***Human Factors Considerations for Wearable Systems to Enhance Soldier Performance*** Moderator: Angela Boynton (USA) *Wearable Sensor System for Monitoring Soldier Body and Equipment Dynamics* Angela Boynton (USA) *Exoskeleton Devices and Soldier Performance: Lessons Learned* Karen Gregorczyk (USA) *Wearable Technologies to Reduce Soldier Burden* Christopher Orlowski (USA) *Human Factors Issues Associated with Warrior Web Prototype Devices* H. Philip Crowell (USA) *Human Factors Assessment of a Physiological Status Monitoring System for CBRNE Operations* William Tharion (USA)

1600-1730 *(continued)*	*Lewis (CL)*	***New Frontiers in Portable Data Collection of Biomechanical and Physiological Soldier Performance*** Moderator: Jennifer Neugebauer (USA) *Biomechanical Applications of Activity Monitors for Quantifying Soldier Performance* Jennifer Neugebauer (USA) *Quantifying Soldier Burden During Load Carriage in the Field Environment* Nicky Armstrong (UK) *Visual Attention Patterns During Close Quarter Battle Training – Impact of Operational Experience and Target Sytems* Daniel Billing (Australia) *Development of a Human Factors Assessment Toolset for New Zealand Soldier Systems* Graham Fordy (New Zealand) *Electronic Data Collection Device for Occupational Fitness Testing (e-FIT)* Philip Newton (Canada)
	Galleria Hall (GL)	***Sleep: The Ultimate Operational Enabler*** Moderator: Nancy Wesensten (USA) *Sleep/Wake Rhythms Alternations During Military Operations* Fabien Sauvet (France) *Sleep Extension: Benefits on Performance and Alertness During Total Sleep Deprivation and Recovery* Pierrick Arnal (France) *Can We Predict How Sleep Loss Impairs Human Performance?* Jaques Reifman (USA) *Managing Sleep to Sustain Operational Readiness* Nancy Wesensten (USA)
1800-1930	*Harbor Ballroom (CL)*	**Opening Ceremony** *(Military Uniform Recommended)*
1930-2130	*Galleria Hall (GL)*	Welcome Reception and Exhibits
1930-2100	*Galleria Hall (GL)*	**POSTER SESSION I**
		Performance Triad *Changes in Body Composition 6-Months Post Implementation of the Performance Triad Pilot Program: A Brief Analysis* Anne Andrews (USA) *Mobile Messaging for the Promotion of the Performance Triad* Jeanette Little (USA) *Improving Performance Through Obesity Prevention: Project Fit4Duty* Elena Spieker (USA) *Leveraging Technology to Optimize Soldier Health and Performance* Deydre Teyhen (USA) *Perceived Relationships Between Sleep, Activity, Nutrition and Mission Readiness or Combat Effectiveness Among United States Army Soldiers* Laura Vasquez (USA)

1930-2100 *(continued)*	*Galleria Hall (GL)*	***Health Promotion/Fitness/Nutrition***

Design and Verification of Group Food Rations During Field Training
Aleksandra Bebnowicz (Poland)

Assessment of Protein-Energy and Mineral Nutritional Status of Soldiers Serving in the Armored Units of the Polish Army
Jerzy Bertrandt (Poland)

Generalized Ligamentous Laxity May Be a Predisposing Factor for Musculoskeletal Injuries
Noreffendy Bin Ali (Singapore)

Follow-Up Assessment of Warrior Fitness Training Program Graduates – How Did They Differ from Direct-entry Recruits and How Are They Doing Now?
Jennifer Born (Canada)

A User-Friendly Mobile App for Predicting Potable Water Needs: The Soldier Water Estimation Tool (SWET)
Nisha Charkoudian (USA)

Implementing a New Physical Fitness Evaluation in the Canadian Armed Forces: The Force Program in Numbers
Patrick Gagnon (Canada)

Recovery of Trunk Extension and Flexion Strength One Year After Spinal Fusion Surgery
Arja Häkkinen (Finland)

Changes in Markers of Bone Turnover and Sclerostin During Short-Term Military Training
Rachel Izard (England)

The Impact of Sleep Quality on Physical Fitness and General Health Functioning
Josh Kazman (USA)

Retrospective Evaluation of Health Reports of the Disqualified Recruits for Military Service Between 2008-2010 in Turkish Armed Forces
Necmettin Kocak (Turkey)

Effect of Sport Consumption and Dependence on Stress Management in French Soldiers Deployed Six Months in Afghanistan
Alexandra Malgoyre (France)

Telehealth Coaching to Promote Bone Health and Nutrition in Deployed Soldiers
Mary McCarthy (USA)

Pregnancy Postpartum Physical Training's Effect on Health, Wellbeing, and Performance
Jess Rawlings (USA)

Improving the Health and Wellness of the Army Family: Army Wellness Center Clients' Progress Towards Their Health and Wellness Goals
Luis Omar Rivera (USA)

Differences in the Cardiovascular Autonomic Function Between Fighter Pilots and Sergeants of Brazilian Air Force
Grace Sá (Brazil)

The Struggle for Balance and Quality of Life as a Warfighter in Norwegian Special Forces – A 18 Months Longitudinal Study
Magnhild Skare (Norway)

Development of an Incentive Program to Encourage Fitness Over and Above the Minimal Operational Standard
Michael Spivock (Canada)

Military Field Labs in the Royal Netherlands Army: A Promising Concept
Taco Visser (Netherlands)

Deployment Stress, Its Impact on Swedish Peacekeeping Soldiers in Northern Afghanistan
Niclas Wisen (Sweden)

Health and Fitness Promotion for Desk Warriors: Do We Have the Right Tools?
Alexander Witzki (Germany)

PROGRAM › Tuesday, 19 August

0730-0800	*Harbor Foyer (CL)*	Registration
0730-1600	*Galleria Hall (GL)*	Exhibits
0800-0900	*Harbor Ballroom (CL)*	**INVITED KEYNOTE SPEAKER** ***Improving, Restoring, and Maintaining Soldier Health: Performance Triad Vision*** Major General Joseph Caravalho, Jr, Commanding General, US Army Research and Materiel Command (USA) *Introduction of Speaker* COL Thomas Eccles, Commander, US Army Research Institute of Environmental Medicine (USA)
		0900-0915 Break
0915-1115		**CONCURRENT SYMPOSIA**
	Burroughs (CL)	***Physical Performance, Musculoskeletal Injuries and Women in the Military: State of the Science and Recommendations for the Way Ahead*** Chair: Bradley Nindl (USA) *Physiological and Medical Aspects That Put Women Soldiers at Increased Risk for Overuse Injuries* Yoram Epstein (Israel) *Risk Factors for Musculoskeletal Injuries in Deployed Female Soldiers* Tanja Roy (USA) *Sex-Specific Applicant Physical Selection Standards May Be Appropriate* Jace Drain (Australia) *Performance Differences on Combat Proxy Tasks in U.S. Marines: Are Females Ready for the Fight?* Karen Kelly (USA) *Physical Training Strategies for Performance Optimization in Women in Combat-Centric Occupations* Bradley Nindl (USA)
	Carlton (CL)	***Minimal Footwear – A Return to Basics*** Chair: Irene Davis (USA) *Biomechanical Differences Between Running in Minimal Footwear and Traditional Footwear* Irene Davis (USA) *Injuries with Minimal Footwear Running* Sarah Trager Ridge (USA) *Safe Transitioning to Minimal Footwear Running* Neil Fleming (USA)
	Harbor Ballroom (CL)	***AltitudeOmics to Advance Warfighter Performance at High Altitude*** Chair: Robert Roach (USA) *The Integrative Physiology of Human Adjustment to High Altitude: Implications for the Warfighter* Robert Roach (USA) *The Integrative Physiology of Breathing at High Altitude: Implications for the Warfighter* Andrew Subudhi (USA) *Fatigue at High Altitude: Where Does It Come From and What Can the Warfighter Do About It?* Rosie Twomey (UK) *New Insights into Lung Blood Flow That Could Determine Warfighter Success at High Altitude* Andrew Lovering (USA)

0915-1115 *(continued)*	*Lewis (CL)*	***Senior Leader Physical Performance in Joint Professional and International Military Education Setting*** Chair: Thomas Williams (USA) *US Army War College Senior Leader Education and Performance: 30 Years of Enhancing Senior Leaders* Thomas Williams (USA) *An Interdisciplinary Approach to Physical Fitness Testing in the Armed Forces* Anders Sookermany (Norway) *Obesity: A Strategic and Leadership Challenge for the Chilean Army* Jean Pierre Irribarra (Chile) *Leadership in a Culture of Fitness in the Chilean Army* Cristian Vial Maceratta (Chile) *Senior Leader Practical Awareness Education and Gait Retraining for Increased Human Performance* Thomas Williams (USA) *Improved Accuracy of Running Footwear Recommendations Through Technology* Thomas Williams (USA)
	1115-1230 Lunch and Poster Session II	
1115-1230	*Galleria Hall (GL)*	**POSTER SESSION II** ***Thermoregulation/Basic Research*** *Circulating MicroRNAs as Biomarkers of Muscle Injuries* Sébastien Banzet (France) *A Partitioned Approach to Reducing Thermoregulatory Strain Whilst Wearing Fully-Encapsulating Chemical Protective Equipment and Exercising in Desert-Like Conditions* Christie Garson (UK) *The Effect of Ambient Humidity on Performance During Simulated Desert Partrols* Mikael Gronkvist (Sweden) *NF- B Transactivation Regulates MCP-1 Gene and Protein Expression in C2C12 Myotube Cultures after Acute Skeletal Muscle Injury* Kevin O'Fallon (USA) *The Effect of Nutrition on Core Temperature* Hilde Teien (Norway) *Impact of Intense Exercise and Sleep Deprivation on Blood Metabolic Parameters and Heat Shock Protein Expression Following Lethal Heat Exposure in Rats* Yong Chiat Wong (Singapore) *Thermal Sensation as an Alternate Indicator of Thermal Strain During Exercise* Miyo Yokota (USA)

1115-1230 *(continued)*	*Galleria Hall (GL)*	***Load Carriage/Injury*** *Biomechanical Effects of Small Shifts in Load Distribution* Angela Boynton (USA) *Quantifying Offloading Capabilities of a Load Distribution System* Marina Carboni (USA) *Greater Loading in Warfighters Exhibits Slower Target Identification and Reduced Segmental Coordinative Coupling During a Dynamic Marksmanship Task* Scott Ducharme (USA) *Running Gait Re-Training in a Soldier Following Femoral Neck Stress Fracture: A Case Study* Donald Goss (USA) *Incidence and Impact of Injuries from Sports, Exercise-Related Activity Among Active Duty Military Personnel* Keith Hauret (USA) *Changes in Tibial Density and Geometry in Infantry Recruits Following Initial Military Training* Rachel Izard (England)
		Hormonal/Metabolic/Cognition *Influence of the Experimental Environment on Physical and Cognitive Performance of Soldiers* H. Philip Crowell (USA) *Gut Microbiome Metabolism of Dietary Polyphenols of In Vitro Studies* Kenneth Racicot (USA) *Neuromuscular Performance and Hormonal Profile in a Two-Week Military Training Period in Garrison and Field Conditions* Mika Salonen (Finland) *Vascular Response to 1 Week Sleep Restriction. A Metabolic Response* Fabien Sauvet (France) *Sound-Related Emotions and Self-Management Methods During Emergencies* Jukka Seppänen (Finland) *Using Oculomotoric Parameters to Determine Task Demands in Ideal Type Military Tasks* Alexander Sievert (Germany) *The Relationship of Intolerance of Uncertainty and Ambiguity to the Preservation of Working Memory Capacity* Jason Spitaletta (USA) *Simulating Ideal Type Workplaces to Determine Military Specific Cognitive Demands* Alexander Witzki (Germany)
1230-1330	*Harbor Ballroom (CL)*	**INVITED SPEAKER**
		Physiological Implications, Performance Assessment and Risk Mitigation Strategies for Women in Combat-Centric Occupations Dr. Julie Greeves, Army Recruiting and Training Division (UK) *Introduction of Speaker* Ms. Marilyn Sharp, US Army Research Institute of Environmental Medicine (USA)
1330-1345 Break		

1345-1545		**THEMATIC FREE COMMUNICATIONS/POSTER**
	Burroughs (CL)	***Injury, Performance and Assessments*** Moderator: Matti Santtila (Finland) *Comparison of Abdominal Fat and Cardiorespiratory Fitness in US Air Force Personnel* Neal Baumgartner (USA) *Factors Associated with Male Obesity: A Case-Control Study of Young Adult Males* Noreffendy Bin Ali (Singapore) *A Systematic Review on the Association Between Performance of Military Tasks and Injuries in Military Populations* Elizabeth Clearfield (USA) *How Important is Initial Employment Training in the Development of Physical Performance?* Herbert Groeller (Australia) *The Relationship Between Stretcher Carry Performance and Decline in Physical Capacity Assessments* Kane Middleton (Australia) *Lumbar Loads in Standing and Seated Postures During Common Military Lifting Tasks* Kane Middleton (Australia) *Thermal Impact of US Army Body Armor Protection Levels (BAPL)* Adam Potter (USA) *Physical Impairment Effects on Marksmanship, Grenade Throwing and Weapon Loading* Jennifer Swoboda (USA)
	Carlton (CL)	***Health/Fitness*** Moderator: Dieter Leyk (Germany) *The Impact of Dermal Calcium Loss and Deployment on Soldier Bone Health* Mary McCarthy (USA) *The Influence of Strength and Power During the Performance of High Intensity Military Tasks Under Heavy Load Carriage* Tunde Szivak (USA) *Physical Fitness of Young Soldiers: Number of Risk Factors Reduces Endurance, Agility and Strength Performances* Dieter Leyk (Germany) *Physical Fitness Levels and Outcomes on the Canadian Special Operations Regiment Assessment Centre* Conor MacDonald (Canada) *Iron Status and Initial Military Training in the US Army and Israeli Defense Forces* James McClung (USA) *Can a Culture of Fitness Contribute to Increasing the Health, Fitness and Operational Readiness of Our Militaries?* Michael Spivock (Canada) *Healthy Eating, Activity, Lifestyle Training Headquarters (H.E.A.L.T.H.): Preliminary Evidence on an Internet/Population-Based Behavioral Weight Management Program for the U.S. Army* Tiffany Stewart (USA) *United States Army Soldiers' Perceived Barriers to Optimal Sleep, Activity and Nutrition* Laura Vasquez (USA)

1345-1545 *(continued)*	*Lewis (CL)*	***Thermoregulation*** Moderator: Jason Lee (Singapore) *Practical Real-Time Assessment of Thermal Work Strain from Measures of Heart Rate for CBRNE Operations* Mark Buller (USA) *Cardiovascular and Thermal Responses During a 3-Day Metabolically Demanding Cold Weather Military Operation* John Castellani (USA) *Strategies for Increasing Evaporative Cooling During Simulated Desert Patrol Missions* Ursa Ciuha (Slovenia) *Sustaining Thermoregulation by Microclimate Cooling: Limitations and Developments* Karl Jochen Glitz (Germany) *Self-Reported Signs & Symptoms of Cold Exposure During Basic Military Training in Relation to Race and Habitual Cold Exposure* Julie Greeves (UK) *Fidelity of Laboratory Trials in Simulating Winter Patrols* Igor Mekjavic (Slovenia) *Fluid, Electrolyte and Thermoregulatory Responses to Ad Libitum Water Replacement Using Two Different Water Delivery Systems* Heinrich Nolte (South Africa) *Evaluating the Associated Heat Strain from Working in Different Body Armour Vests* Min Sze Pearl Tan (Singapore)
	Galleria Hall (GL)	***Load Effects Assessment Program*** Moderator: Karl Friedl (USA) *United States Marine Corps Load Effects Assessment Program (MC-LEAP): An Emerging Mobility Assessment Metric* Mark Ritcher (USA) *Load Effects Assessment Program (LEAP): A Systematic Multinational Approach to Understand and Address Soldier Physical Burden* Linda Bossi (Canada) *Application of an Instrumented Obstacle Course within a Dismounted Combatant Mobility Assessment Framework: An Australian Perspective* Jace Drain (Australia) *Intra- and Inter-Individual Reproducibility of the CAN-LEAP Obstacle Course* Michel DuCharme (Canada) *Use of a Standardized Combat Readiness Course for Evaluation of Soldier Equipment Effects on Physical Performance* Leif Hasselquist (USA) *Relative Contribution of Bulk, Stiffness, & Load Weight of PPE on Soldier Performance* Monica Jones (Canada) *Load Affects Assessment Program (LEAP): Creation, Evolution, and Lessons* Alison Kelly (Canada)
1600-1700	*Harbor Ballroom (CL)*	**INVITED SPEAKER** ***Physiological Readiness and Resilience: Scientific Underpinnings for the Pillars of Military Preparedness*** Dr. William Kraemer, University of Connecticut (USA) *Introduction of Speaker* Dr. Bradley Nindl, US Army Public Health Command (USA)

PROGRAM › Wednesday, 20 August

0730-0800	*Harbor Foyer (CL)*	Registration
0730-1600	*Galleria Hall (GL)*	Exhibits
0800-0900	*Harbor Ballroom (CL)*	**INVITED SPEAKERS** ***Human Performance Optimization (HPO) Strategies: Integrating Research, Education, and Clinical Services Line of Efforts for Soldier Readiness*** Dr. Patty Deuster and COL Francis O'Connor, Uniformed Services University (USA) *Introduction of Speakers* Dr. Bruce Jones, US Army Public Health Command (USA)
		0900-0915 Break
0915-1115		**CONCURRENT SYMPOSIA**
	Lewis (CL)	***Integration of a Multidisciplinary Research Model for Human Performance Optimization and Injury Prevention in Special Operations Forces*** Chair: Timothy Sell (USA) *The Unique Injury Epidemiology of SOF Operator* Mita Lovalekar (USA) *Fatigue, Injury Risk, and the Residual Effects of Previous Injury* Timothy Sell (USA) *Nutrition, Performance and Injury* Kim Beals (USA) *Training to Match Tactical Demands and Injury Prevention Requirements* Takashi Nagai (USA)
	Carlton (CL)	***Fueling the Warfighter – An International Perspective*** Chair: Scott Montain (USA) *The United Kingdom Approach for Meeting the Energy Demands of the Warfighter* John Clarke (UK) *The Norwegian Approach for Sustaining the Warfighter* Pal Stenberg (Norway) *Meeting the Energy Needs of Warfighters in Austere Environments: The United States Perspective* Scott Montain (USA)
	Harbor Ballroom (CL)	***Novel Cooling Methodologies for the Military Training and Operational Environment*** Chair: Robert Kenefick (USA) *Ingestion of Ice Slurry on Military Work-Rest Cycles* Jason Kai Wei Lee (Singapore) *Use of Arm Immersion Cooling in the Training Environment* Robert Kenefick (USA) *The Future of Individual Soldier Micro-Climate Cooling* Samuel Cheuvront (USA)

0915-1115 *(continued)*	*Burroughs (CL)*	***Historical Aspects of Military Physical Performance*** Chair: Bruce Jones (USA) *Physical Activity, Training, Fitness and Injuries in Military and Civilian Populations: A Review* Bruce Jones (USA) *U.S. Army Research on Pharmacological Enhancement of Soldier Performance: Stimulants, Anabolic Hormones, and Blood Doping* Karl Friedl (USA) *Physical Fitness Tests: Only a Question of Work-Physiological Requirements?* Anders Sookermany (Norway) *A Historical Review of Army Physical Readiness Training and Assessment* Whitfield East (USA)
1115-1230 Lunch and Poster Session III		
1115-1230	*Galleria Hall (GL)*	**POSTER SESSION III** ***Equipment/Instrumentation*** *Load Effects Assessment Program (LEAP): Sensitivity to Operationally-Relevant Clothing and Equipment Conditions* Linda Bossi (Canada) *Using GPS and Radio Frequency Identification (RFID) Based Systems for Timing Military Endurance Performance Events* Peter Frykman (USA) *The Utility of a Tablet Controlled Wireless Timing System to Run and Manage Military Physical Performance Testing* Jay Hydren (USA) *The Utility of Using a Personal Fitness Device to Track Sleep, Activity, and Nutrition in an Infantry Battalion* Theresa Jackson (USA) *Application of a Graphene Heater to Korean Military Winter Uniforms and Its Physiological Evaluation: A Pilot Study* Young Joon Jang (Korea) *Prediction of Landing Forces During Static Line Parachuting* Tong Lee (Singapore) *Methodology for Measuring Effect of Protective Gear on Soldier Physiological Performance* K. Blake Mitchell (USA) *Portable Method for Measuring Live-Fire, Shooter-in-the-Loop Weapon Recoil Dynamics* Frank Morelli (USA) *CAF Military Task Simulations: Impact Analysis* Philip Newton (Canada) *Effects of Three Different Types of Standard Issue British Army Footwear on Vertical Ground Reaction Force in Marching Drills* Alex Rawcliffe (Scotland) *Acoustic Dosimetry in Tactical Environments to Support Auditory Damage Modeling and Hearing Protection* Christopher Smalt (USA) *Foot Type Symmetry and Change in Foot Structure from Sitting to Standing Conditions* Jinsup Song (USA) *Health Promotion and Wellness Physiologic Monitoring at Point of Injury/Care (Theater/ Deployed Settings)* David Williams (USA) *Signal Processing for Exercise Dosimetry* Brian Telfer (USA)

1115-1230 *(continued)*	*Galleria Hall (GL)*	***Testing*** *Effects of Ambient Temperature on Exercise-Induced Muscle Damage and Inflammation* Sébastien Banzet (France) *Combining Physical Tests to Determine Student Outcomes in US Air Force Pararescue Development Course* Neal Baumgartner (USA) *Comparison of Dynamic Balance Level of the Polish Special Forces Soldiers and Civilians During Survival School Training* Jerzy Bertrandt (Poland) *The Physiological Demands of Air Force Security Personnel: Controlling A Working Canine* Joanne Caldwell Odgers (Australia) *Developing a Proficiency Test for Elite Forces* Kaizhen Chen (Singapore) *Biomarker Indices of Physical Exhaustion in a Firefighter Community* Leanne Dykstra (USA) *The Danish Armed Forces' Core Test – Background and Development* Henriette Albinus Hasselstrøm (Denmark) *A Ten-Year Descriptive Study Following the Introducing of the "Physical Education and Sports System of the Brazilian Air Force"* Kin Hwang (Brazil) *The Physiological Strain Index Does Not Predict Heat Exhaustion* Igor Mekjavic (Slovenia) *Young Men's Self-Assessed Fitness Status and Recruits Physical Fitness Test Results* Leila Oja (Estonia) *Differentiation or Uniformity in Physical Fitness Testing: A Single-Track Discussion* Trond Sand (Denmark) *Footwear-Dependent Correlations Between Vertical and Standing Long Jumps* Brian Schilling (USA) *Fitness Testing in the Bundeswehr – Tracking Individual and Force Wide Baseline Fitness Using Quality Controlled BFT Data* Alexander Sievert (Germany) *Development of a Standardised Functional Performance Assessment for Dismounted Close Combat Systems* Kimberley Strickland (England) *The Rigors of "Boot Camp": Identification of Physically Demanding Tasks Within Canadian Armed Forces Basic Military Qualification Courses* Mark Buller (USA)
1230-1330	*Harbor Ballroom (CL)*	**INVITED SPEAKER** ***Protection versus Physiology: Interactions Among Physiological Regulation and Protective Equipment*** Dr. Nigel Taylor, University of Wollongong (Australia) *Introduction of Speaker* Dr. Herbert Groeller, University of Wollongong (Australia)
1330-1345 Break		

1345-1545		**THEMATIC FREE COMMUNICATIONS/POSTER**
	Burroughs (CL)	***Hormonal/Metabolic*** Moderator: Heikki Kyröläinen (Finland) *Cortisol as a Possible Predictor for Optimism and Persistence in Military Training Settings* Olaf Binsch (Netherlands) *Effects of Patrol Operation upon Hydration Status and Autonomic Modulation of Heart Rate of Brazilian Peacekeepers in Haiti* Antonio Duarte (Brazil) *Maximal Strength, Body Composition, Load Carriage Performance and Serum Hormone Concentrations During 8-Weeks of Specialized Military Training: The Effect of Added Low Volume Resistance Training* Juha Kokko (Finland) *Muscle Strength and Serum Hormone Concentrations During the 8-Week Basic Military Training Period in Non-Overreached and Overreached Finnish Conscripts* Vesa Linnamo (Finland) *Depressed Physical Performance Outlasts Hormonal Disturbances and Changes in Body Composition After a One Week of Arduous Military Exercise* Truls Raastad (Norway) *Potential Neurobiological Benefits of Exercise in Chronic Pain and PTSD* Erica Scioli-Salter (USA) *Acute Neuromuscular and Hormonal Responses to a Fatiguing Strength Loading Followed by Active or Passive Recovery* Ritva Taipale (Finland) *Physical Fitness and Hormonal Profile During a 9-Week Paratroop Training Period* Jani Vaara (Finland)
	Carlton (CL)	***Injury I*** Moderator: Helena Larson (Sweden) *Association of Functional Movement Screening with Injury Risk in Army Soldiers* Tim Bushman (USA) *Effect of Body Mass Index and Physical Fitness on Injury Risk for Soldiers During Army Basic Combat Training* Shamola Greene (USA) *Risk Factors Associated with Medial Tibial Stress Syndrome in Runners* Phil Newman (Australia) *Systematic Review of the Association of Fitness Components with Musculoskeletal Injury* Dianna Purvis (USA) *Prospective Musculoskeletal Injury Rates Among Different Categories of Soldiers* Scott Shaffer (USA) *A Novel Dual-task and Multitask Assessment Battery Guiding Return-to-Duty in Concussed Service Members* Laurel Smith (USA) *Influence of Pain and Prior Injury on Musculoskeletal Injury Occurrence: A Prospective Review of a Large Military Cohort* Deydre Teyhen (USA) *Injury Prevention in Basic Military Training: The Role of Physical Training and Modulation of Physical Demands* Thomas Wyss (Switzerland)

1345-1545 *(continued)*	*Lewis (CL)*	***Load Carriage*** Moderator: Daniel Billing (Australia) *The Impact of External Load on Tactical Combat Movements – Individual Variability and Implications for Battlefield Survivability* Daniel Billing (Australia) *An Evaluation of Equations to Estimate Energy Expenditure During Soldier Load Carriage* Angela Boynton (USA) *Passive Exoskeleton for Backpack Carriage* Chee Hoong Cheong (Singapore) *The Force Fitness Profile: Measuring Operational and Physical Fitness for Optimal Assessment and Reporting* Patrick Gagnon (Canada) *The Effects of Heavy Load Carriage During the Performance of High Intensity Military Tasks* Tunde Szivak (USA) *Estimating Peak Vertical Ground Reaction Force During Soldier Load Carriage Using Activity Monitor Acceleration* Jennifer Neugebauer (USA) *Predictive Equations to Estimate the Energy Expenditure of Walking at Different Speeds, Grades and Backpack Load Carrying* Andre Siqueira Rodrigues (Belgium) *Energy Expenditure and Training Load During Military Basic Training Period* Minna Tanskanen (Finland)
	Galleria Hall (GL)	***Functional Movement Screen*** Moderator: Keith Hauret (USA) *Relationship Between Functional Movement, Core Stability and Body Stature on Conduct after Capture Training Outcomes* Mark Carlson (Canada) *Functional Movement Changes With Deployment: The Combat Readiness Evaluation (CORE)* Sarah de la Motte (USA) *Predicting Post-Deployment Pain in US Marines* Peter Lisman (USA) *Comparison of Performance Between Rangers, Combat, Combat Service, and Combat Service Support Soldiers* Dan Rhon (USA) *A Novel Return to Duty Screening Tool for Military Clinicians* Mark Thelen (USA)
1600-1700	*Harbor Ballroom (CL)*	**INVITED SPEAKER** ***Physiological Adaptations and Military Applicability to Low-Volume, High-Intensity Interval Training in Health and Disease*** Dr. Martin Gibala, McMaster University (Canada) *Introduction of Speaker* Mr. Patrick Gagnon, Canadian Forces, Directorate of Fitness

PROGRAM › Thursday, 21 August

0730-0800	*Harbor Foyer (CL)*	Registration
0800-0900	*Harbor Ballroom (CL)*	**RESEARCH CONSENSUS**
		Defining Research Gaps and Setting Priorities Moderator: Edward Zambraski (USA)
0900-1000	*Harbor Ballroom (CL)*	**INVITED SPEAKER**
		Concurrent Strength and Aerobic Training Modes for Developing Physical Performance Dr. Keijo Häkkinen, University of Jyväskylä (Finland) *Introduction of Speaker* Dr. Heikki Kyröläinen, University of Jyväskylä (Finland)
		1000-1015 Break
1015-1215	*Carlton (CL)*	**CONCURRENT SYMPOSIA**
		Science to Practice: Transitioning Predictive Models into Working Applications for the Warfighter Chair: Beth Beidleman (USA) *Development of a Potable Water Planning Tool* Samuel Cheuvront (USA) *Preventing Heat Injuries by Predicting Human Core Temperature* Jaques Reifman (USA) *Development of the Probability of Survival Decision Aid in Cold Water* Xiaojiang Xu (USA) *Development of the Altitude Readiness Management System* Beth Beidleman (USA)
	Burroughs (CL)	***Advances in the Physiology, Biomechanics, and Modeling of Soldier Load Carriage*** Co-Chairs: Yoram Epstein (Israel) and Joseph Knapik (USA) *Load Carriage: An Integrated Management Approach* Robin Orr (Australia) *Biomechanics of Load Carriage – Historical Perspectives and Recent Insights* Joseph F. Seay (USA) *The Effects of Physical Training on Load Carriage Performance* Joseph Knapik (USA) *Physiological and Biomechanical Evaluation of a Prototype for Load Carrying System* Yuval Heled (Israel) *Strain and Stresses in the Shoulder During Load Carriage – A Computational Model* Yoram Epstein (Israel)

1015-1215 *(continued)*	*Harbor Ballroom (CL)*	***Requirements for Soldiers' Physical Performance and Training in the Nordic Countries*** Chair: Heikki Kyröläinen (Finland) *Optimal Physical Training of Soldiers During the Basic Training Period* Heikki Kyröläinen (Finland) *Requirements for Soldiers' Endurance Capacity in Prolonged Continuous Work* Mikael Mattsson (Sweden) *Development and Implementation of a New Concept for Physical Training in the Norwegian Navy Special Operations Command* Paul Andre Solberg (Norway) *Is "Micro-Training" an Efficient Training Paradigm? – A Pilot Study* Anders Kilen (Denmark)
	Lewis (CL)	***Panel Discussion: Development and Implementation of Evidence-Based Physiological and Physical Employment Standards*** Chair: Deborah Gebhardt (USA) Daniel Billing (Australia), Julie Greeves (UK), Tara Reilly (Canada), Marilyn Sharp (USA)
	1215-1330 Lunch and Poster Session IV	
1215-1330	*Galleria Hall (GL)*	**POSTER SESSION IV**
		Physical Performance Standards *Evaluation of USMC Fitness Tests as Predictors of Success on Combat Proxy Tasks* Karen Kelly (USA) *Development of a Job-Based Physical Readiness for Operations Test* Cara Lord (Australia) *Muscle Activity During Sustained Hand Held Mine Detector Use* Kane Middleton (Australia) *Correlation Between Anthropometric Variables and Body Fat Percentage in Military Young Adults of the Brazilian Air Force* Pedro Palermo (Brazil) *Gender Neutral to Gender Free: Physical Employment Standard Evolution in the Canadian Armed Forces* Tara Reilly (Canada) *The Relationship Between Performance on Physical Employment Standards and Anthropometric Characteristics of the Canadian Armed Forces* Tara Reilly (Canada) *Concept for a Pre-Deployment Assessment of Basic-Military-Fitness in the German Armed Forces* Ulrich Rohde (Germany) *Self-Reported Physical Work Demands in the Norwegian Armed Forces* Annett Victoria Stornæs (Norway) *Influence of Physical Activity Weight, Smoking and Prior Injury on Performance* Deydre Teyhen (USA)

1215-1330 *(continued)*	*Galleria Hall (GL)*	***Training/Women in Military*** *Correlation Between Lower Extremity Power and Dynamic Balance with Jump Landing Ground Forces in Basic Airborne Course Trainees* Kaizhen Chen (Singapore) *Effects of Sixteen-Week Basic Military Training of Officer Candidates (EFK1) in the Austrian Armed Forces on Their Physical and Military Performance* Robert Enne (Austria) *Effect of Physical Fitness on the Risks of Training-Related Injury for Women and Men in Army Basic Training* Stephen Rossi (USA) *Changes in Physical Demands for Deployed Female Soldiers* Tanja Roy (USA) *Developing Functionally-Adaptive and Integrated Training to Improve Fitness and Cognition for Battlefield Airmen* Adam Strang (USA) *Perceptions and Attitudes of Female Soldiers Toward Soldier's Physical Performance, Physical Fitness Tests and Physical Fitness Requirements* Jani Vaara (Finland)
1330-1430	*Harbor Ballroom (CL)*	**INVITED SPEAKER** ***Are There Ethical Limitations for Improving Physical Performance in Soldiers?*** MG Xavier Bigard, *French Anti-Doping Agency* (France) *Introduction of Speaker* LTC Mounir Chennaoui, Armed Forces Biomedical Research Institute
1430-1445 Break		
1445-1645		**THEMATIC FREE COMMUNICATIONS/POSTER**
	Burroughs (CL)	***Physical Performance Standards*** Moderator: Patrick Gagnon (Canada) *A Systematic Review and Meta-Analyses of Correlations Between Performance of Military-Relevant Tasks and Physical Fitness Tests* Veronique Hauschild (USA) *Predicting Relative and Absolute Maximal Oxygen Uptake from the 3000 Meter Run* Anders Aandstad (Norway) *US Air Force Development of Tier 2 Occupationally-Specific, Operationally-Relevant Physical Tests and Standards: Physical Demand Analysis Part 1* Neal Baumgartner (USA) *A Strategy for Developing Performance Standards in a Recruit Screening Test* John Sampson (Australia) *Performance on a Physical Employment Standard Assessment is Significantly Improved with Familiarisation* Catriona Burdon (Australia) *Developing Physical Employment Standards for Combat Controllers: A Trade with Two Specialties* Joanne Caldwell Odgers (Australia) *Epidemiological Insights from the "Activate Inactive Individuals" Survey: Differences Between Non-Athletes and Moderately Active Persons Aged 35-49 Years and 50-64 Years* Dieter Leyk (Germany) *Adapting the International Classification of Functioning (ICF-10) to Categorize Physical Demands of Canadian Armed Forces Occupations* Daniel Theoret (Canada)

1445-1645 *(continued)*	*Carlton (CL)*	***Injury II*** Moderator: Antonio Duarte (Brazil) *Self-Reported Physical Activity and Musculoskeletal Injury in Female Active Duty and National Guard/Reserve Soldiers: Preliminary Findings from the Comprehensive Soldier and Family Fitness Global Assessment Tool 2.0* Sarah de la Motte (USA) *Evaluations of Physical Training Programs in an Infantry Division* David DeGroot (USA) *Sports Injuries Among US Army Soldiers Deployed to Operations Iraq, New Dawn, and Enduring Freedom, 2001-2012* Keith Hauret (USA) *Prevalence of Low Back Disorders Among Military Pilots in the Finnish Air Force with 5 Years of Follow-Up* Tuomas Honkanen (Finland) *Comparison of Injury Incidence Between the Legacy T-10 and New T-11 Parachute System During Military Airborne Training* Joseph Knapik (USA) *Musculoskeletal Pain and Limitations in Work-Ability in Swedish Armed Forces Marines: A Population-Based Survey of Prevalence and Associated Risk Factors* Andreas Monnier (Sweden) *Incidence and Causative Factors of Lower Limb Injuries in the NZ Army* Jacques Rousseau (New Zealand)
	Lewis (CL)	***Training*** Moderator: Herbert Groeller (Australia) *How Effective is Basic Military Training in Developing the Physical Performance Attributes Necessary for Military Service?* Herbert Groeller (Australia) *The Effect of an Eight Week Military Training Program on Fine Motor and Cognitive Function* John Paul Hickey (Ireland) *Non-Mechanical Factors That Influence the Adaptation of Bone to Short-Term Military Training* Rachel Izard (England) *Effects of 12-Weeks of DFit.ca Fitness Training on the Performance of the Common Military Task Fitness Evaluation and Force Evaluation in Canadian Armed Forces (CAF) Personnel* Jacqueline Laframboise (Canada) *French Mountain Troops Basic Training: Efficiency and Tolerance in New Recruits* Alexandra Malgoyre (France) *Walking with Night Vision Goggles Increases Metabolic Demand* Lena Norrbrand (Sweden) *The Use of Ability Based Training in Police Force Recruits* Robin Orr (Australia) *Monitoring of Mental, Physical, and Organizational Determinants of Dropout in Initial Infantry Training* Bertil Veenstra (Netherlands)

1445-1645 *(continued)*	*Galleria Hall (GL)*	***Footwear/Lower Limb Injury*** Moderator: Deydre Teyhen (USA) *Trunk Posture Impacts Lower Limb Energy Absorption During Drop Landings with Body Borne Load* Tyler Brown (USA) *Lower Extremity Biomechanics and Self-Reported Foot Strike Patterns Among Runners in Traditional and Minimalist Shoes* Donald Goss (USA) *The Influence of Footwear on Vertical and Anteroposterior Ground Reaction Impulses* Steve Jamison (USA) *The Relationship Between Arch Height Type and Arch Flexibility* Rebecca Zifchock (USA)
1700-1800	*Harbor Ballroom (CL)*	**ROUNDTABLE DISCUSSION** ***Warfighter Readiness Roundtable: Aerobic and Strength Fitness and Influence on Military Physical Readiness*** Moderator: Karl Friedl (USA) *Strength Panel* Chair: William Kraemer (USA) Keijo Häkkinen (Finland), Herbert Groeller (Australia), Heikki Kyröläinen (Finland), Bradley Nindl (USA) *Aerobic Panel* Chair: Bruce Jones (USA) Joseph Knapik (USA), Antonio Duarte (Brazil), Nigel Taylor (Australia), Neal Baumgartner (USA)
1830-2200	*Harbor Ballroom (CL)*	**Closing Ceremony** *(Military Uniform Recommended)*

“There are many challenges and opportunities on the path to the goal of enhancing and sustaining high levels of physical performance for our warfighters. For the medical community, management of both risks and benefits of performance enhancing interventions must be a consideration, but the goal appears to be attainable, especially if those factors are managed at the individual level.”

Dr. John F. Glenn
Principal Assistant for Research and Technology
US Army Medical Research and Materiel Command

THEMATIC POSTER SESSION – MONDAY

Use of Dietary Supplements in Military Training and Operations

Presenters: Joseph Knapik (USA), Krista Austin (USA), Tom McLellan (Canada), Juha Hulmi (Finland), Josh Kazman (USA), Esther Dada (USA)

Dietary supplements (DSs) are commercially available products that are consumed as an addition to the usual diet. DSs include substances such as vitamins, minerals, herbs (botanicals), proteins, amino acids, and a variety of other substances. Marketing claims for some DS include improvements in overall health status, enhancement of cognitive or physical performance, increases in energy, loss of excess weight, attenuation of pain, and other favorable effects. In the United States, sales of DSs have increased from $4 billion in 1994 to $30 billion in 2011, an approximate 8-fold increase over 17 years. In this symposium, we will explore the prevalence of DS use in the military and look at associations between DSs use and physical activity. Like athletes, military personnel often have occupational tasks that require intense and prolonged periods of physical activity and service members may be more likely to use DSs that have purported ergogenic effects. Thus, we will examine the effects of caffeine on physical and cognitive performance and the effects of protein supplementation on body composition and strength. Symposium participants will gain updated knowledge of the prevalence of military DS use and the efficacy of caffeine and protein supplementation in military training and operational activities.

Chronic Exertional Compartment Syndrome in the Military

Presenters: Pieter Helmhout (Netherlands), David Roscoe (England), Andy Roberts (England), Angela Diebal (USA)

Chronic Exertional Compartment Syndrome (CECS) is a frequent cause of lower leg pain in military personnel. Prevalent military activities, such as running and marching, provoke CECS symptoms. The pathophysiology of CECS is still not fully understood. Recent research within the British Armed Forces reveals significant biomechanical differences between patients with CECS and asymptomatic controls. The role these differences may play in the development of CECS and their potential implications for training will be discussed. The diagnosis of CECS is commonly confirmed by the (static) measurement of intramuscular compartment pressure (IMCP), but controversy exists regarding the diagnostic accuracy of this current "gold standard". UK researchers provide new IMCP recommendations with superior diagnostic utility for the diagnosis of CECS. Until recently, none of the nonoperative treatment modalities for CECS (e.g., decreased level of physical activity, orthotics) yielded positive outcome. Surgical management has proven to be effective, though substantial subsets of patients report complications; not to mention the burden that post-operative rehabilitation has on military readiness. This reality provides the motivation to further investigate effective conservative management approaches. Promising results from recent studies within the US Army and the Netherlands Army, aimed at modifying running/marching technique in patients with CECS, will be discussed.

Human Factors Considerations for Wearable Systems to Enhance Soldier Performance

Presenters: Angela Boynton (USA), Karen Gregorczyk (USA), Christopher Orlowski (USA), H. Philip Crowell (USA), William Tharion (USA)

Fueled by the ability to shrink the gap between science fiction and reality, enhancement of Soldier performance through the use of wearable systems has received increasing attention over the past decade. While current work in this area represents a leap forward from past efforts in instrumenting the modern Soldier in order to enhance performance while minimizing injury risk, several human factors issues continue to plague these systems. Identification of Soldier needs, design and control constraints, and potential human-system interface issues are critical to successful implementation of future systems and warrant a more detailed exploration. Successes and shortcomings from evaluations of systems developed during previous and ongoing efforts will be presented to foster a discussion of human factors considerations related to the design and function of current and future wearable systems meant to enhance Soldier performance.

New Frontiers in Portable Data Collection of Biomechanical and Physiological Soldier Performance

Presenters: Jennifer Neugebauer (USA), Nicky Armstrong (UK), Daniel Billing (Australia), Graham Fordy (New Zealand), Philip Newton (Canada)

Biomechanical and physiological measures such as ground reaction forces, body dynamics, oxygen consumption, and muscle activity can be captured with high-resolution using laboratory-based methods. However, fully replicating Soldier activities in a laboratory environment is challenging and thus field-based measurements are essential for soldier performance assessment. Not all data collection methods are suited for use outside of the laboratory. Existing field-based technologies are based on clinical or sports populations, but they do not always translate to use in a military and/or research environment. Ideally, minimally-invasive methods for data collection could be seamlessly incorporated into operationally relevant tasks to characterize the loads and demands of Soldiers. Two such methods, accelerometer-based activity monitors and inertial measurement units (IMUs), have gained popularity for quantifying physical activity in non-military populations but to date have been underutilized with Soldier populations. Soldier activity often includes prolonged efforts, heavy load carriage, and both dynamic and steady state tasks. Accounting for this variability has yet to be fully developed with portable data collection methods. This symposium will discuss current Soldier-specific methods of portable data acquisition, both strengths and limitations, as well as future research that is needed to fully develop methods to quantify Soldier activity outside of the laboratory.

Sleep: The Ultimate Operational Enabler

Presenters: Fabien Sauvet (France), Pierrick Arnal (France), Jaques Reifman (USA), Nancy Wesensten (USA)

Sleep is a biological need required for optimal brain functioning –sleep is critical for sustaining the mental acuity required for success in military operations. Results from both laboratory and field studies show that insufficient sleep results in degraded neurobehavioral performance and mood. Soldiers who report insufficient daily sleep amounts also endorse symptoms associated with degraded behavioral health. Night operations and poor sleep environment contribute to insufficient sleep. In order to manage sleep to sustain operational performance, sleep must be accurately measured. In this symposium we discuss topics relevant to managing sleep to sustain operational readiness.

POSTER SESSION I – PERFORMANCE TRIAD

Changes in Body Composition 6-Months Post Implementation of the Performance Triad Pilot Program: A Brief Analysis

Presenter: Anne Andrews (USA)

Anne Andrews, PhD, RD1, Lauren Kropp, MPH2, Laura Vasquez, MPH2, Theresa Jackson, PhD, MPH2 1Office of The US Army Surgeon General, 2US Army Public Health Command The Performance Triad is based on the premise that small changes in sleep, activity and nutrition habits can have significant effects on military readiness, mental and physical performance and health. The Performance Triad Pilot Program was implemented in three active duty battalions within the US Army in order to determine if the initiative could be implemented and effective a at improving readiness, performance and health. The purpose of this research project was to determine the long-term effectiveness of the program on health; the objective of this analysis was to assess changes in body composition after the first 6 months in one unit. There were 441 males who volunteered to participate from that unit; 166 have completed data collection at 6 months. Body composition measures included anthropometrics, circumference measurements and body composition (body fat and muscle mass). There were no significant differences in measures of body composition over 6 months. There were small, but not significant differences in body fat mass (16.1±7.1 vs 15.5±7.5 kg, p=0.35), body fat percent (19.5±6.6 vs 18.5±6.9%, p=0.11) and muscle mass (64.7±9.3 vs 65.7±8.3 kg, p=0.18) from baseline to 6 months. These results are consistent with the a priori hypothesis for this unit. The unit was generally very fit and had low rates of overweight and/or obesity. The mean body fat at baseline was 19.5%, which is within the ideal range for males of 10-20%. We expected to see only small changes, if any, at the 6-month point since body composition changes are expected to happen slowly as knowledge, attitudes and behavior changes over time with implementation of the Performance Triad. Further analyses with the remaining two units over time will provide added information regarding the changes that may be possible after implementation of the Performance Triad program throughout the US Army.

Mobile Messaging for the Promotion of the Performance Triad

Presenter: Jeanette Little (USA)

Jeanette R Little, BS, MS, Francis McVeigh, OD, MS, MS; Holly Pavliscsak, BS, MHSA Telemedicine and Advance Technology Research Center United States Army Materiel Command Background: The United States Army conducted a research study evaluating implications of a bi-directional mobile intervention on Service Members who were rehabilitating and reintegrating into society. This presentation will focus on the mobile messages that were sent from care teams through a secure web interface to augment weekly case management care. Some of the lessons learned from this evaluation could be leveraged to assist in assessing and promoting the Performance Triad in Service Members. Methods: The mCare mobile messaging system provides the ability to send out messages directly to the patient's phone. Messages were categories into health and wellness tips, general well-being questionnaires, announcements and appointment reminders. Messages were tracked by time date stamps by sent, synched and response. Results: Appointment reminders and questionnaires were the only messages that required an acknowledged response. Over 3,000 appointment reminders were sent to 93 participants over the course of the 9 months study. The mean response time for 24 hour prior appt reminders was 51 minutes. Over 18,000 questionnaires were sent to 94 participants with a response rate of 62.4%. Additionally, health and wellness tips were sent 3 times a week and announcement messages were sent biweekly. Conclusions: Mobile messages were positively received by the experimental group throughout the course of the 9 month study. Average connection and response times indicate were appropriate responses within 24 hours. The library of content available supports utilization of mobile messaging as a mechanism to securely promote sleep, activity and nutrition and query application of those concepts. The ability to store and send out health information and collect feedback from patients between face-to-face visits supports continued contact in their "lifespace" potentially positively impacting health choices of Service Members.

Improving Performance Through Obesity Prevention: Project Fit4Duty

Presenter: Elena Spieker (USA)

Elena A. Spieker, PhD(1, 2), Douglas Maurer, DO, MPH(1), Eric Stice, PhD(3), Tracy Sbrocco, PhD(2) (1) Madigan Army Medical Center, Joint Base Lewis-McChord, Tacoma, WA (2) Uniformed Services University of the Health Sciences, Bethesda, MD (3) Oregon Research Institute, Eugene, OR In the last decade, overweight in the military has risen three-fold. Excess weight affects recruitment, promotion, and retention of service members. Consequences of "failing to make weight" not only raise concern about the impact of overnutrition on fitness, overall health, and military performance but have significant implications for national security. A primary mission of the Army is improving Soldier nutrition as part of Performance Triad. In line with Army objectives, a brief effective obesity prevention program that can be easily and inexpensively disseminated through the Patient Centered Medical Home (PCMH) could substantially reduce the prevalence of obesity in military personnel. Project Fit4Duty is a comprehensive obesity prevention program adapted for the military from Project Health, a successful civilian weight gain prevention program. Fit4Duty utilizes positive gain counseling about eating unhealthy foods and engaging in sedentary behaviors to encourage participant-driven behavior change. The Project Fit4Duty pilot study has 2 phases. As the first step in adapting the positive gain counseling program for the military, four cohorts of the Fit4Duty program were conducted in male Army Soldiers at Joint Base Lewis-McChord (JBLM). Phase 1 participants completed 6 weekly 1-hour group sessions and pre and post assessments, and were involved in the study for approximately 2 months. Soldiers in phase 1 identified specific barriers to behavior change. Key deficits included basic nutrition and cross-training education, inability to identify healthy foods on base, weight stigma, and lack of command support. Qualitative input from participants was used for program evaluation, and revision to program components for the phase 2 intervention (in progress). During phase 2, 120 participants will be randomized to Project Fit4Duty (n=60) or a Health Education (HE) comparison condition (n=60). Participants will complete height and weight measurements and self-report instruments at baseline, six weeks (post-program), and one and two year follow-ups. If successful, Project Fit4Duty would offer an economical approach for widespread obesity prevention in the U.S. Military using an established PCMH network of Family Practice physicians who report the need to address obesity prevention and the need for improved prevention programs.

Leveraging Technology to Optimize Soldier Health and Performance

Presenter: Deydre Teyhen (USA)

Deydre S. Teyhen (1), Mark D. Mellott (2) 1. Office of the Surgeon General, U.S. Army, USA, 703-681-9078, Deydre.s.teyhen.mil@mail.mil 2. Office of the Surgeon General, U.S. Army, USA, 703-681-1840, mark.d.metllott2.mil@mail.mil PUPRPOSE: The rapid growth and evolution of health-related technology capabilities is driving an established presence in the marketplace and is opening up tremendous potential to minimize and/or mitigate barriers associated with achieving optimal health, performance, and readiness. In support of the US Army Surgeon General's vision for a "System for Health" and its Performance Triad Initiative, the US Army Telemedicine and Advanced Technology Research Center led a modified Delphi process to identify and define the opportunities, gain clarity in leading practices and research gaps, and articulate the characteristics of future technology solutions to create and sustain real change in the health of individuals, the Army, and the nation. METHODS: A modified Delphi method consisting of three rounds were used to determine how to best utilize technology to promote health and readiness. The participants included researchers and clinicians from academia (n = 5) and government (n = 33). The first round identified leading clinical practices that could be enabled by technology. During the second Delphi round, participants rated leading practices, which then led to industry participants presentations (n = 16) and a moderated panel discussion among all workshop participants. Non-voting industry participants identified current practices as they applied to commercial products and implementations. A final round of voting was then completed. RESULTS: During the first round, over 500 publications were reviewed. The group identified 5 evidence-based areas in which technology could assist in creating and sustaining changes in health: (1) public health messaging, (2) changing health habits and the environmental influence on health, (3) goal setting and tracking, (4) the role of incentives in behavior change intervention, and (5) the role of peer and social networks in change. From this round, 122 evidence-based technology features and constructs were identified. The second and third step of the a Delphi method identified and prioritized 162 technology features, constructs, and best practices for physical activity monitors (n = 29), nutrition monitors (n = 35), sleep monitors (n = 24), incentives for change (n = 36), usability and interoperability (n = 25), and open data (n = 13). CONCLUSION: Leading practices, gaps, and research needs for technology-based strategies were identified and prioritized. The identified research gaps and priorities provide a research and development road map for (1) leveraging technology to minimize barriers to enhancing health and (2) facilitating evidence-based techniques to create and sustain healthy behaviors. The identified best practices provides a framework for evaluating current commercial-off-the-shelf technologies that can assist in creating and sustaining healthy behaviors.

Perceived Relationships Between Sleep, Activity, Nutrition and Mission Readiness or Combat Effectiveness Among United States Army Soldiers

Presenter: Laura Vasquez (USA)

Laura Vasquez, Theresa Jackson, Wana Jin, Jess Rawlings. United States Army Public Health Command. LTC Anne Andrews, United States Army Office of the Surgeon General Purpose: To better understand Soldiers' perceived relationships between sleep, activity and nutrition and mission readiness or combat effectiveness to better tailor messaging, communication products, and programming to Soldiers' needs for optimal effectiveness. Methods: This study is part of a larger evaluation project to evaluate the effectiveness of the Performance Triad Pilot, a U.S. Army program designed to increase readiness and resiliency by focusing on improvements in sleep, activity and nutrition (SAN). As part of baseline data collection, USAPHC scientists conducted 31 focus groups and 3 structured interviews across three sites between AUG-SEP 2013 (N=202). Qualitative sessions were stratified by rank/status (E4 and below squad members (n =74), Squad Leaders (n=64), Platoon Leaders or higher (n=54), and Medics (n=10)). These focus groups and interviews gathered information on Soldiers' SAN, including barriers, facilitators, perceptions, and needs to attain optimal SAN. During qualitative sessions, facilitators specifically asked Soldiers, "How do optimal sleep, activity or nutrition affect combat effectiveness or mission readiness?" and "Among sleep, activity or nutrition, is there one that is most important to combat effectiveness or mission readiness?" USAPHC scientists identified key themes for each behavior and aggregated results across groups from all three sites to determine if there were consistencies across sites, within groups, or overall. The team used a rapid-action analysis approach to summarize findings and generate recommendations. Results: The majority of Soldiers perceived sleep, activity and nutrition to be interrelated and equally important to their performance and combat effectiveness. When probed for the importance of each behavior on mission readiness, Soldiers commonly linked activity to combat effectiveness, particularly through functional physical training, tactical training, and injury prevention. All groups were cognizant of the effects of optimal sleep on their missions and linked sleep deprivation to safety concerns, poor decision making, increased stress, decreased morale, and decreased focus or brain function. Soldiers associated nutrition with providing energy or fuel for the mission, but of the three SAN behaviors, nutrition appeared to have the weakest link to combat effectiveness among the majority of groups. Conclusions: Future programs and initiatives should leverage Soldiers' perceptions of the relative importance or perceived relationships between SAN and combat effectiveness or mission readiness by tying them into education and messaging. Communications directed at Soldiers should highlight specific ways that a lack of optimal SAN detracts from overall mission readiness and give examples to build the perceived importance of SAN. Special emphasis should be placed on helping Soldiers make the link between their nutrition practices and mission readiness.

POSTER SESSION I – HEALTH PROMOTION/FITNESS/NUTRITION

Design and Verification of Group Food Rations During Field Training

Presenter: Aleksandra Bebnowicz (Poland)

Bebnowicz Aleksandra, Kosiuczenko Krzysztof, Jach Beata, Kler Pawel, Bertrandt Bartosz Military Research & Development Center for Food Services, Poland Training and combat activities carried out by group of soldiers of the Polish Armed Forces in garrison and in the field in various climate or terrain conditions, at different times of the day have a huge impact on physical exertion. One of the main tasks of the Military Research & Development Center for Food Services is creating varied food rations, taking into account diverse products from different groups that would meet the nutritional needs of physically active people. Group food ration PS is the newest food ration designed for Polish Armed Forces. It consists of three meals – breakfast, lunch and dinner, intended to feed a group of 10 soldiers during one day. Breakfast includes: cornflakes or oatmeal with milk and fruits, canned meat or poultry and sterilized cheese, cereal and fruit bar and beverages. Lunch consists of: soup, vegetable and meat preserve, carbohydrates products, boiled vegetables, compote and dessert. Dinner includes: sterilized main course, canned meat or poultry or fish, jam or honey and beverages. Each menu has accessories like cutlery, cup, napkin, seasonings and chewing gum. There are 14 menus of ration PS. During trials ration was heated using field heating system KPZ-100 and issued in a self-service system. Purpose: To evaluate an acceptability of new group food ration PS. Methods: All the rations components were tested by 240 untrained sensory evaluators: soldiers who participated in field training in Drawsko Pomorskie. Acceptability was evaluated using a 9-point hedonic scale. Components with mean score lower than 6 should not be included in ration. Furthermore the soldiers filled in questionnaires which consisted of questions about the variety of products and quantity of meals. Results: 127 products were evaluated, from which 98,4% got more than 6,0 points and 1,6% below 6,0. After this trial components which got less than 6 points were removed from the ration. The second part of researches showed that in the opinion of 93% of the soldiers the variety of breakfast products was sufficient, in case of lunch products 95% of representatives of the end user were satisfied and for dinner products the percentage was 96%. In the opinion of 75% of the soldiers the quantity of breakfast was sufficient, for 23% of them it was insufficient and for 2% - excessive. For lunch the results were 81%, 18% and 1% respectively. For dinner it was 83%, 16% and 1% respectively. Conclusions: Evaluation and verification enabled to remove from the ration products with a low acceptability and improve the field heating system.

Assessment of Protein-Energy and Mineral Nutritional Status of Soldiers Serving in the Armored Units of the Polish Army

Presenter: Jerzy Bertrandt (Poland)

Bertrandt J.1, Klos A.1, Lakomy R.1, Bertrandt K.1, Bertrandt B.2, Kler P.2, Bebnowicz A.2, Tomczak A.3 1Military Institute of Hygiene and Epidemiology, 4 Kozielska St., 01-163 Warsaw, Poland 2Military research and Deployment Center for Food Services, 112 Marsa St. 04-470 Warsaw, Poland 3General Staff of the Polish Armed Forces, Department of Physical Education and Sport, Warsaw, Poland Aim of the study: The aim of the study was to assess the protein-energy and mineral nutritional status of soldiers serving in the armored units of the Polish Army Methods: Total of 109 men aged 29.9 ± 5.4 years were examined. Body height and weight were measured and using caliper with constant pressure 10g/mm2, the thickness of four selected skinfolds were measured. The degree of bone mineralization were analyzed by densitometry method on the non-dominant forearm hand . The study was conducted by DEXA, using a EXA 3000 apparatus. Results of measurements of height and weight were the basis for calculating the body mass index BMI, and the values obtained have allowed the respondents classified according to the classification Ferro- Luzzi, groups of normal weight (BMI ≥ 18.5 ≤ 24.9 kg/m2), overweight (BMI ≥ 25.5 kg/m2), and obese (BMI ≥ 30.0 kg/m2). Values of skinfolds thickness formed the basis of the calculation percentage of body fat. Results: Average height and weight of the respondents amounted to 177.7 ± 5.7 cm and 86.0 ± 11.1 kg. Arm circumference of the patients was 34.6 ± 3.3 cm. The thicknesses of skinfolds at biceps, triceps, subscapular and the iliac crest was, 2.81 ± 0.54 mm, 3.18 ± 0.63 mm, 13.38 ± 6.33 mm and 27.01 ± 8.3 mm respectively . On the basis of the BMI values there was shown that 64.2 % of the subjects were overweight and 14.7% of respondents found obesity . The average body fat of the subjects was 20.5 ± 4.0 % and was higher than the generally accepted standards. Proper bone calcification was found in 88.6 % of patients. Among examined soldiers, changes characteristic of osteopenia showed in 9.6 % and of osteoporosis in 1.8 %. Conclusions: 1. The soldiers' protein-energy and mineral nutritional status disorders of varying severity are the result of unbalanced diet. 2. Among the soldiers of the Polish Army armored units it is advisable to conduct training on rational nutrition and nutritional prevention of metabolic diseases of civilization.

Generalized Ligamentous Laxity May Be a Predisposing Factor for Musculoskeletal Injuries

Presenter: Noreffendy Bin Ali (Singapore)

Hamid Rahmatullah bin Abd Razak, MBBS, MRCS (Glasg) Noreffendy Bin Ali, MBBS, MSpMed Howe Tet Sen, MBBS, FRCS (Orth) Background: Generalized ligamentous laxity is a common finding of clinical importance in the management of musculoskeletal conditions. This is common in young patients and is generally associated with an increased incidence of musculoskeletal injury. Hypermobility has been implicated in ankle sprains, anterior cruciate ligament injury, shoulder instability, and osteoarthritis of the hand. Purpose: The aim of this study is to determine if generalized ligamentous laxity may be a predisposing factor for musculoskeletal injuries in young males. We hypothesized that generalized ligamentous laxity would be more common in individuals with musculoskeletal injuries compared with controls. Materials and Methods: This prospective case-control study examined generalized ligamentous laxity in 100 consecutive individuals aged 18 to 25 who reported with musculoskeletal injuries to a primary healthcare centre in the military. The Beighton score was used to measure joint laxity, which was determined to be present by overall scores equal to or exceeding 4. The control group comprised 100 age- and gender-matched individuals without any musculoskeletal injuries or complaints. Results: Generalized ligamentous laxity was present in 12% of the cases compared with 4% of controls (P=0.043). Individuals who presented with musculoskeletal injuries were 3.35 times more likely to have generalized ligamentous laxity as compared to controls. Conclusion: Generalized ligamentous laxity was more common in individuals who presented with a musculoskeletal injury. Hence, it may be a predisposing factor for musculoskeletal injuries. Keywords: generalized ligamentous laxity; military; musculoskeletal injury.

Follow-Up Assessment of Warrior Fitness Training Program Graduates – How Did They Differ from Direct-Entry Recruits and How Are They Doing Now?

Presenter: Jennifer Born (Canada)

Jennifer E.C. Lee (1&2), Jennifer Born(2), Michael Spivock(3) & Paige Mattie(3) (1) Personnel and Family Support Research, Director General Military Personnel Research and Analysis (2) Directorate of Force Health Protection (3) Human Performance, Director General Morale and Welfare Services, Department of National Defence (Canada). Purpose: Global trends of increased obesity and poorer lifestyle present a barrier to military recruiting. Consequently, the Canadian Armed Forces (CAF) implemented the Warrior Fitness Training (WFT) program in 2006 to help prepare applicants who do not initially meet the minimal physical fitness standard for direct-entry into basic military training. The aims of this study were to i) compare the initial health and lifestyle attributes of WFT participants with those of direct-entry recruits and ii) assess their health and lifestyle over time. Methods: An analysis of available data sources was conducted to compare the initial health and lifestyle attributes of WFT participants (N = 1160) with those of direct-entry recruits. In 2011, follow-up surveys were administered to these WFT participants to examine changes in their health and lifestyle up to five years after graduating from the program. Results: Compared to direct-entry recruits, WFT participants reported significantly higher BMI, lower physical activity, and poorer eating habits. Follow-up health and lifestyle data were available for only 140 WFT participants. Results revealed that physical activity and BMI significantly increased among these WFT participants at follow-up. Conclusions: As expected, WFT participants initially demonstrated less favourable health and lifestyle characteristics than direct-entry recruits. While their levels of physical activity increased over time, so did their BMI. However, these results should be interpreted with caution. Several methodological issues must be acknowledged, which limit the generalizability of findings. Future research will explore trends in health and lifestyle to identify factors that predict success in the CAF.

A User-Friendly Mobile App for Predicting Potable Water Needs: The Soldier Water Estimation Tool (SWET)

Presenter: Nisha Charkoudian (USA)

N Charkoudian, EM Caruso, SN Cheuvront, RW Kenefick, AJ Lapadula, AJ Swiston, and T Patel. US Army Research Institute of Environmental Medicine (USARIEM), Natick, MA and MIT-Lincoln Laboratory, Lexington MA. Background: Potable water is essential to maintain health and sustain military operations, but carrying and transporting water is a major logistical burden. Accurate water planning tools are needed to minimize this burden while sustaining hydration. To calculate water needs, knowledge of sweat losses is critical, particularly for active populations and those experiencing heat stress. Methods: USARIEM has developed and validated a sweat prediction equation based on metabolic demands, clothing biophysical parameters, and a range of environmental settings, including solar and high terrestrial conditions (Gonzalez et al. J Appl Physiol 144: 436-443, 2013). However, use of the equation has been limited to experts. The goal of this project was to translate the prediction equation into a user-friendly Smartphone application (Soldier Water Estimation Tool, SWET) that provides an estimated potable water requirement from five simple inputs with minimal loss of prediction accuracy based upon a detailed multi-parametric sensitivity analysis. Results: USARIEM's updated sweat prediction equation was translated from its previous format (a Microsoft Excel® spreadsheet) to an easy-to-use mobile application (on the Android platform) with 5 user inputs. Users select from multiple choice inputs for activity level, clothing, and cloud cover, and manually enter exact values for temperature and relative humidity. The app updates in real time and reports fluid requirement in liters/hour. Total potable water needs can be estimated based on activity, duration, and number of personnel. Conclusion: This decision aid will support a wide range of military users to include mission planners for combat and humanitarian missions, medical personnel, and unit leaders. The SWET app could be incorporated into medical planning tools. Future versions of the SWET software could run on a wide variety of platforms including personal computers, and websites. Additionally, the SWET app has commercial potential in the sport performance and wilderness medicine communities. Research supported by USAMRMC. Author views not official US Army or DoD policy.

Implementing a New Physical Fitness Evaluation in the Canadian Armed Forces: The Force Program in Numbers

Presenter: Patrick Gagnon (Canada)

P.Gagnon, MSc. B.Stockbrugger, MSc, D.Couturier, BSc. Canadian Forces Morale and Welfare Services. Directorate of Fitness. Human Performance Research and Development. Background: The Canadian Armed Forces (CAF) recently implemented the FORCE Evaluation (Fitness for Operational Requirements of CAF Employment), a field expedient fitness test designed predict the physical capabilities of completing common military tasks. The test is to be administered annually and the minimum standards on the test components are age and gender free, therefore the same for all CAF members. Since 1 April 2013, all CAF personnel had to attempt the new FORCE evaluation to familiarize themselves with the new test and adjust their training if necessary to achieve the standard when the test officially replaces the former CF EXPRES evaluation on 1 April 2014. Purpose: The purpose of this study was to analyse the test results from this transition year in order to report any potential adverse impacts to the chain of command as well as provide leadership with an overall appreciation of the outcome of the implementation process. Methods: Every CAF member was administered the test at their local base/wing and the results of their FORCE evaluation were captured on a scannable form, subsequently sent to the DFIT Human Performance research team for analysis. Forms were scanned into a database, cleaned and then analysed by service (Navy, Army, Air Force), gender, age groups and rank. Results: To date, the database contains 25,614 test results. This represents only a portion of the number of tests administered from 1 April 2013 and 31 March 2014 (N: 65,000+). The overall pass rate on the FORCE evaluation for the entire sample is 95.7%. When separated by service, the Royal Canadian Navy is at 95.9% (N: 2834), the Canadian Army is at 97.5% (N: 8506) and the Royal Canadian Air Force is at 97.3% (N: 4258). In terms of gender, men show failure rates of 3.2% (N:21492) whereas women show a failure rate of 9.7% (N: 3268). There are no significant differences between officers and non-commissioned members. Conclusions: From this initial year of implementation of the FORCE evaluation, we can confirm that the test does not pose adverse impacts to any sub-groups with our military population. Although women have slightly lower pass rates than men, the delta is well within legally acceptable ranges (Constable & Palmer, 2000). We do see some declines in the pass rates as personnel get older which suggests that in the future, aging CAF personnel will have to adapt their training programs and potentially invest more time and effort in order to maintain their operational readiness and be retained in the CAF. Overall the CAF leadership is satisfied with those initial numbers and the expectation is that the number of failures will decrease as CAF personnel become more accustomed to the test and prepare more adequately.

Recovery of Trunk Extension and Flexion Strength One Year After Spinal Fusion Surgery

Presenter: Arja Häkkinen (Finland)

Spine surgery may be considered when conservative treatment is not effective in reducing pain or improving quality of life in certain spinal disorders. Lumbar spine fusion (LSF, stabilization of the painful segments) aims to restore load balance along the spinal column. In addition to the spinal column, LSF affects ligaments and paraspinal muscles. Several studies have shown muscle atrophy leading to fatty infiltration of the muscles, especially in the multifidus after LSF. The aim of the present study was to analyze trunk muscle function preoperatively and 1-year postoperatively in LSF patients. A total of 195, [66% females, mean (SD), age 61(12) years and BMI 28.4(4.4)] patients undergoing LSF at Tampere University or Jyväskylä Central hospital participated in the study. Indications for surgery were degenerative or isthmic spondylolisthesis, spinal stenosis, disc herniation, degeneration postoperative conditions, or scoliosis. Median (IQR) duration of preoperative back pain was 31(18,66) months. Flexion and extension strength of the trunk was measured preoperatively and 12 months after surgery using a strain-gauge dynamometer. Pain was assessed by visual analog scale (VAS, 0-100mm). Average preoperative trunk extension and flexion strength levels were 205(144)N and 295(172)N, respectively. One year after the surgery, mean (95% CI) trunk extension strength increased by 53(37-70)N ($p<0.001$) and flexion strength by 69(53-85)N ($p<0.001$). Preoperative extension/flexion strength ratio was 0.7(0.38) and did not change during follow-up. Average(SD) pain intensity during trunk extension decreased from 55(29)mm to 14(25)mm and during flexion from 41(29) to 11(21)mm between preoperative and 1-year postoperative measurements. There was no correlation between strength measurements and back pain at any time point. There was a moderate correlation between preoperative trunk muscle strength levels and their changes during the 12 month follow-up [extension r=-0.42 (95%CI, -0.55 to -0.29) and flexion r=0.41 (-0.54 to -0.28)]. Although spinal fusion may be effective in reduction of pain in several spinal disorders, low trunk extension and flexion strength levels remain one year postoperatively. In addition, the muscular deficit of the trunk predominates on extensors indicating an imbalance between trunk flexors and extensors. The trunk extension/ flexion strength ratio is reported to be between 1.1-1.3 in healthy population, is considerably below that in present LSF-patients (Häkkinen et al. 2003, Takemasa et al. 1995, Yahia et al. 2011). Specific information about trunk muscle strength is important in planning and evaluating treatment. There is need for proper progressive strength training protocols to normalize back function and restore functional and working capacity to prevent further back pain episodes.

Häkkinen A et al. Spine 2003,28;1068-73.
Takemasa et al. Spine 1995; 20:2522-30.
Yahia et al. Joint, Bone, Spine 2011;78:291-7.

Changes in Markers of Bone Turnover and Sclerostin During Short-Term Military Training

Presenter: Rachel Izard (England)

Izard, RM1., Greeves, JP1., Fraser, WD2. 1 HQ Army Recruiting and Training Division, Upavon, Wiltshire, UK. 2 Norwich Medical School, University of East Anglia, UK. INTRODUCTION: Increased mineralisation and periosteal expansion of the tibia have been shown following short-term military training and suggest changes in bone turnover, favouring bone formation (1). Sclerostin, which has anti-anabolic effects and is inhibited by mechanical loading, has recently been identified as a key regulatory marker in mechanotransduction of bone. AIM: To examine the effects of 10 weeks arduous short-term military training on markers of bone turnover and sclerostin. Methods: Eighty two male recruits (mean ± 1SD, age 21 ± 3 y, height 1.78 ± 0.07 m and body mass 75.1 ± 8.6 kg) undertaking initial Infantry training (Catterick, UK) volunteered to take part. Early morning blood samples (0500 – 0545h) were collected at Baseline (week 1), Mid (week 5) and End (week 10) of training following an overnight fast. Samples were analysed for markers of bone formation (P1NP and OC) and resorption (CTX), sclerostin, vitamin D status (total 25(OH)D - only measured at Baseline and End) and regulatory markers of calcium metabolism (intact PTH, albumin adjusted Ca and PO_4). Repeated measured ANOVA (SPSS v19.0) were used to assess changes in bone markers over time. Statistical significance was set a-priori at $P<0.05$. RESULTS: P1NP increased significantly from Baseline (112.5 ± 67.6 µg/L) to Mid (126.3 ± 69.2 µg/L) returning to baseline values at End (111.2 ± 62.3 µg/L) of training. OC decreased significantly from Baseline (50.2 ± 28.3 ng/mL) at Mid (43.9 ± 22.2 ng/mL, $P<0.001$) and End (40.0 ± 20.5 ng/mL, $P<0.001$) of training. CTX decreased significantly from Baseline (1.08 ± 0.49 ng/mL) to Mid (0.90 ± 0.49 ng/mL) returning to baseline values at End (1.03 ± 0.45 ng/mL) of training. Sclerostin decreased significantly from Baseline (42.45 ± 16.9 pmol/L) at Mid (37.1 ± 13.4 pmol/L) returning to baseline values at End (40.1 ± 13.1 pmol/L) of training. 25(OH)D decreased from Baseline (72.1 ± 21.3 nmol/L) to End (41.8 ± 15.6 nmol/L) and increases in Ca and PO_4 were reported during training, iPTH remained unchanged. CONCLUSIONS: Changes in biochemical markers of bone turnover and sclerostin were shown to favour bone formation, evident early in training. These findings underpin the anabolic response of the tibia to military training. Suppression of sclerostin with mechanical loading appears to be an important mechanism stimulating bone formation. 1. Izard et al (2014) Changes in Tibial Density and Geometry in Infantry Recruits Following Initial Military Training. ICSPP, Boston.

The Impact of Sleep Quality on Physical Fitness and General Health Functioning

Presenter: Josh Kazman (USA)

Preetha Abraham, Daniel Suarez, Josh Kazman, Stacey Zeno, Patricia Deuster Uniformed Services University of the Health Sciences, Bethesda, MD 20814 Objectives: Sleep plays an important role in resting both brain and body. The current study examined the relationship between self-reported sleep quality and overall health functioning and physical fitness. Methods: Health was assessed by using anthropometric measures (blood pressure, percent body fat, waist circumference, fasting glucose, and body weight), maximal aerobic capacity (VO_2max), and self-reported general health functioning (RAND-36). Adults (n=38) between 18 and 42 years of age (mean: 27.2±0.86) completed the Pittsburgh Sleep Quality Index (PSQI), a 19-item scale with 7 subscales and a global score to quantify self-reported sleep quality. Based on the global score, participants were divided into three groups: Good (n=19), Poor (n=11) and Extremely Poor (n=4) sleepers. Analyses were controlled for age, gender and education. Results: Overall mean PSQI score was 5.4±0.6. Sleep quality was significantly and negatively related to measures of self-reported general health, including Energy/Fatigue ($r= -0.60$, $p\leq0.001$), Physical Functioning ($r= -0.68$, $p\leq0.00$), Social Functioning ($r= -0.45$, $p\leq0.01$) and overall General Health ($r=-0.43$, $p\leq0.05$). Also, sleep quality was negatively related to maximal aerobic capacity($r=-0.34$, $p=0.06$). In addition, although only 4 participants were in the extremely poor sleep category, they scored significantly lower on energy, physical, social and overall general health levels than good and poor sleepers ($p\leq0.05$). Conclusion: Extremely poor sleepers, despite a small sample size, reported significantly more symptoms of fatigue, poor physical and social functioning than good and poor sleepers. Targeted educational interventions and resources to improve sleep quality and increase aerobic capacity, may be useful for overall health functioning.

Retrospective Evaluation of Health Reports of the Disqualified Recruits for Military Service Between 2008-2010 in Turkish Armed Forces

Presenter: Necmettin Kocak (Turkey)

Necmettin Kocak, Turkish Coast Guard Command, Ankara, Turkey, Turker Turker Turkish Armed Forces Health Command, Ankara, Turkey,.Hakan Istanbulluoglu, Turkish General Staff, Ankara, Turkey, Ibrahim Ayd□n, Surgeon General Office of Ministry of Defence, Ankara, Turkey C Selim Kilic Gulhane Military Medical Academy, Department of Epidemiology, Ankara,Turkey Mahir Gulec, Gülhane Military Medical Academy, Department of Public Health, Ankara,Turkey Bilal Bakir, Gülhane Military Medical Academy, Department of Public Health, Ankara, Turkey In Turkey, military service is compulsory for all Turkish males at age 20. To qualify for military service, a prospective candidate must meet the minimum fitness requirements. For this reason every service candidates should undergo a pre-service health examination. However, many candidates can be disqualified after being recruited by the health boards of military hospitals. Purpose: This study aims to detect the rates of disqualified recruits due to the diseases of orthopedics and musculoskeletal system for military service between 2008 and 2010 in Turkish Armed Forces. Methods: This study has been conducted between December 2010 and May 2012. Individual Health reports archived by Ministry of defense of 40717 recruits were reviewed retrospectively Results: In this study, the data of the 3915 recruits given unfitness report for military service from “Musculoskeletal Diseases Clinic” has been analyzed. The majority of the reports has belonged to the recruits who were 20 years old. The prevalence of top and bottom extremity squeal of fracture and the handicap of movement were detected as 0.37, 0.29 per thousand in 2008, 0.50, 0.45 per thousand in 2009 and 1.55, 0.53 per thousand in 2010 respectively. CONCLUSION: In our study, it has been detected that top and bottom extremity squeal of fracture and the handicap of movement are at high levels and the prevalence of this is getting increased as the time passes.

Effect of Sport Consumption and Dependence on Stress Management in French Soldiers Deployed Six Months in Afghanistan

Presenter: Alexandra Malgoyre (France)

Malgoyre A1., Demont G2., Sanchez H1., Trousselard M1. 1 Institut de Recherche Biomédicale des Armées, BP 73, 91223 Bretigny sur Orge, France. 2 Antenne Médicale des Armées, Quartier Galliéni, 25800 Valdahon. E-mail : alexandra.malgoyre@irba.fr CONTEXT AND OBJECTIVES: Sport activities can be considered either in terms of sport consumption (hours of sport per week) or sport dependence characterizing a behavioural addiction (BA). During military operations soldiers are used to dealing with stress. Whereas sport consumption is considered as an interesting way to handle stress during military deployment, we hypothesised that exercise dependence could be deleterious for stress management. We studied the effects of alteration in sport consumption and dependence on soldiers stress resistance in the context of a six months deployment in Afghanistan. EQUIPMENT AND METHODS: In an anonymous prospective cohort study (397 soldiers) we studied with questionnaires, Extra Regimental Sport consumption (ERS) and sport dependence before, during, and six months after deployment (131 soldiers). Subjects were dispatched into 4 levels of ERS consumption:0h, 0h30-3h30,4h-6h30, 7h or more and into 3 groups of sport dependence: Non Dependent Asymptomatic (NDA), Non Dependent Symptomatic (NDS), Sport Dependent (SD). We evaluated anxiety, depression diseases (Hamilton scales) and psychological state (Cohen's perceived stress and Profil of Mood Scale (POMS). Plasmatic Brain Derived Neurotrophic Factor (BDNF), considered as a good marker of central nervous system plasticity, was also measured. RESULTS: Before deployment, ERS consumption concerned 65% of soldiers. 42% of soldiers have a BA with SD (4%) and NDS (38%). Interestingly, BA was not statistically related to higher ERS consumption. Level of perceived stress, anxiety and depression diseases was higher when a BAis detected. In soldiers without a BA, results showed that perceived stress and state of "mood of tension/anxiety" were higher in subjects without ERS. Neither ERS consumption, nor BA altered BDNF concentration. During deployment, ERS consumption and the percentage of BA observed were not different from before, but the distribution in ERS levels or sport dependence groups were modified. Thus, 64% of soldiers with a BA were not identified as addicted before the deployment. After deployment, both higher BDNF concentration and anxiety disease score were observed in soldiers developing a BA in comparison with who did not develop an addiction. Soldiers who reduced their ERS consumption, suffered from depression compared to soldiers without ERS alteration. Conversely, soldiers who increased their ERS consumption exhibited lower anxiety and depression scores. DISCUSSION:BA seems to present: (1) a relation with high "anxiety" (perceived stress, state of tension, or even anxiety disease, (2) a lability in chronic stress environment. However, BA could be considered as an efficient strategy referred to the high level of BDNF after the mission. A follow-up is ongoing 18 months after the deployment to confirm this assumption. Increasing voluntary sport could be protective whereas decreasing in ERS after a military operation should be interpreted as a warning for both medical staff.

Telehealth Coaching to Promote Bone Health and Nutrition in Deployed Soldiers

Presenter: Mary McCarthy (USA)

M. McCarthy, PhD, RN, MAJ (USA Retired), S. Ramme, MS, RD, and L. Frank, PhD, RD Madigan Army Medical Center, Tacoma, WA Young service members are returning from war with significant physical injuries, as well as "wear and tear" from long work hours, heavy body armor, and alterations in diet and exercise behaviors. Previous findings have demonstrated that deployment conditions contribute to a decrease in physical activity but adequate dietary intake of calcium, vitamin D, and other nutrients appears to sustain bone mineral density. Telehealth coaching has been used with some success to engage Soldiers deployed to remote environments to maintain healthy behaviors. This is the second in a series of studies examining the impact of deployment on bone health and nutrition. Purpose: The purpose of this study was to determine if telehealth coaching throughout a deployment is superior to one-time nutrition and fitness education to support nutritious food intake, bone-building physical activity, and bone health assessed before and after deployment. Methods: This prospective, longitudinal, cluster-randomized trial enrolled 234 Soldiers at baseline; 155 returned for post-deployment measures; 85 in the telehealth group (TG) and 70 in the control group (CG), yielding a 34% attrition rate. All Soldiers received a nutrition and bone health class prior to deployment. The TG received on-demand/periodic health-related messages via Army Milbook or an Outlook mail platform throughout the deployment. Outcomes included anthropometrics, frequency and intensity of work, sport, and leisure activities using BHPAQ, dietary intake, bone mineral density (BMD), and bone turnover markers. We used the MICE package for R v.3.0.1 for all analyses. Results: Baseline 25(OH)D revealed a high rate of insufficiency (61%, level < 30 ng/mL) and moderate level of deficiency (17%, level < 20 ng/mL) overall. Soldiers significantly improved 25(OH)D levels with CG achieving a normal level; mean 27.7 to 34.9 ng/mL and the TG raised levels from 21.6 to 26.0 ng/mL. Post-deployment osteocalcin was significantly higher in the TG (28.3 + 1.1 vs 22.0 + 0.99 ng/mL; p = 0.01) and the change in sport activities was positive for the TG but negative for the CG (0.29 + 0.11 vs -0.17 + .09; p = .01). Calcium intake and BMD remained stable for both groups. Weight and body mass index were unchanged but body fat was significantly higher in the TG (3.9% vs -.52%; p=.003). Internet transmission of materials and Soldier accessibility to them were challenges that limited intervention dose. Conclusions: The telehealth approach to Soldier engagement and education while deployed in remote environments was affected by internet capabilities and mission requirements. Improving vitamin D status and remaining active while deployed appears to sustain healthy bone density. Soldiers in the TG did report increased sport activity and there was evidence for greater bone turnover which may confirm the positive effects of health coaching. Early and aggressive educational outreach efforts using readily accessible and reliable technologies can help promote healthy behaviors and prevent chronic musculoskeletal disability in young Soldiers.

Pregnancy Postpartum Physical Training's Effect on Health, Wellbeing, and Performance

Presenter: Jess Rawlings (USA)

Jess Rawlings, MS Theresa Jackson, PhD Jacqueline Watkins, MPH Lisa Young, MS Institution: U.S. Army Public Health Command BACKGROUND The U.S. Army requires pregnant female Soldiers return to regular unit physical training and body composition standards within 180 days of delivery. The mandated Pregnancy Postpartum Physical Training (P3T) Program, consisting of physical training and education components, is designed to assist female Soldiers in meeting this requirement. METHODS The US Army Public Health Command (USAPHC) conducted a P3T program evaluation among pregnant and postpartum Soldiers to determine the program's impact on their health, readiness, and performance. The evaluation utilized a post-test only design with online questionnaires to assess the experiences of Soldiers nearing the end of their pregnancies and postpartum periods who had participated in P3T. Outcomes of interest included perceived program benefits and the extent to which participants found the program helpful or unhelpful in meeting Army physical fitness standards, Army Body Composition Program (ABCP) standards, and job responsibilities. The study also included tests of differential program effectiveness as a function of pregnant or postpartum status and whether or not the program the respondent attended adhered to a minimum of 75% of its exercise, education, and safety standards. RESULTS A total of 170 pregnant Soldiers and 297 postpartum Soldiers from four installations completed electronic surveys from February 2013-January 2014. The most commonly reported P3T program benefits included gaining helpful pregnancy and parenting knowledge (43%), feeling more able to meet the challenges of motherhood (39%), and gaining confidence in the ability to be a parent and Soldier (37%). Approximately three-fourths of participants agreed or strongly agreed that P3T helped them continue to perform their job duties, meet the physical and mental responsibilities of their job, and maintain the stamina required for their job. Postpartum Soldiers reported higher levels of agreement that P3T helped them in each of these areas ($p<.001$) and were also more likely than pregnant Soldiers to report that P3T helped them meet APFT standards (37% vs. 19%, $p<.001$) and ABCP requirements (37% vs. 15%, $p<.001$). Pregnant Soldiers were more likely than postpartum Soldiers to report that P3T helped them decide to stay in the Army (32% vs. 23%, $p<.05$). Fewer than half of participants indicated the program in which they participated met education, exercise, and/or safety standards. Respondents who participated in programs adhering to standards reported higher levels of favorable experiences and outcomes ($p<.05$) than respondents who participated in programs that did not meet standards. CONCLUSIONS P3T program participants report several perceived benefits of participation. Postpartum Soldiers are more likely to perceive the program as beneficial in meeting job responsibilities and fitness/weight requirements, but pregnant Soldiers are more likely to report the program assisted in their decision to stay in the Army. Given the relationship between implementation standards and perceived benefits, every effort should be made to ensure the program adheres to its implementation model in order to maximize P3T's impact on health and performance.

Improving the Health and Wellness of the Army Family: Army Wellness Center Clients' Progress Towards Their Health and Wellness Goals

Presenter: Luis Omar Rivera (USA)

L. Omar Rivera, PhD, Moira Shaw Rivera, PhD, Todd Hoover, MA United States Army Public Health Command, Health Promotion and Wellness The US Army Public Health Command developed and implemented a standardized wellness education model known as the Army Wellness Center (AWC). Currently, nineteen AWCs provide integrated primary prevention programs and services that promote, enhance, and sustain healthy lifestyles to improve the overall well-being of Army community members. AWCs provide a standardized suite of six core primary prevention programs to address the key areas necessary to promote overall health and wellness, to include health assessment review (HAR), physical fitness, healthy nutrition, stress management, tobacco education, and general wellness education. Health educators guide client participation in these programs by helping them set and work towards their health and wellness goals. Evaluators identified a cohort of clients who completed an initial HAR between October 2013 and December 2013 ($N = 5,709$) and prospectively examined the extent to which clients saw goal-related health improvements through February 2014. This examination focused on clients who set a goal to lose weight, improve diet and nutrition, or reduce stress. Physiological measurements were assessed each time clients visited an AWC and self-reported health behaviors were assessed each time clients completed an HAR. Preliminary analyses compared initial assessments with most recent follow-up assessments. The 570 clients who set a goal to lose weight, and had BMI assessed at least twice with at least 30 days between assessments, saw an average decrease in BMI between initial ($M = 31.01$, $SD = 4.74$) and most recent assessment ($M = 30.56$, $SD = 4.62$), $t(569) = 7.18$, $p < 0.01$. The 508 clients who set a goal to lose weight, and had body fat assessed at least twice with at least 30 days between assessments, saw an average decrease in body fat percentage between initial ($M = 34.12$, $SD = 8.14$) and most recent assessment ($M = 33.76$, $SD = 8.18$), $t(507) = 2.56$, $p < 0.05$. The 200 clients who set a goal to improve diet and nutrition, and had nutritional habits assessed at least twice, reported an increase in the number of fruits or vegetables consumed per day, the frequency of high fiber food consumption, and the frequency of low fat food consumption (all $ps < 0.05$) and a decrease in the frequency of high sugar dessert consumption, high fat dessert consumption, and high sodium food consumption (all $ps < 0.05$). Finally, the 150 clients who set a goal to reduce stress, and completed the Perceived Stress Scale (Cohen, 1983) at least twice, reported a decrease in perceived stress from initial ($M = 16.81$, $SD = 7.94$) to most recent assessment ($M = 14.61$, $SD = 7.03$), $S(149) = 1912$, $p < 0.001$). These results provide preliminary evidence that AWC clients experience positive goal-related health improvements over time and suggest the need to continue with rigorous evaluation efforts.

Differences in the Cardiovascular Autonomic Function Between Fighter Pilots and Sergeants of Brazilian Air Force

Presenter: Grace Sá (Brazil)

Grace B. de Sá, Antonio F. Ribeiro, Thiago R. Gonçalves, Pedro P. S. Soares. Air Force Sports Commission, Brazilian Air Force, Rio de Janeiro. Federal Fluminense University, Niterói. RJ, Brasil. The cardiovascular autonomic modulation is crucial for fighter pilots to avoid aircraft accidents, since they suffer exposure to high G acceleration during combat maneuvers. Physical fitness may be an intervening factor in cardiovascular control. The healthiest and most VO2max subjects tend to have higher Heart Rate Variability (HRV), which can be detected by the sympathetic and vagal activities changes. The objective of this study is to compare the HRV between fighter pilots and sergeants in the supine and orthostatic positions. The first group (G1) consisted of 13 sergeants with administrative functions (age=31±5 years; VO2máx=42±2 ml/kgxmin-1; BMI=25.5±2.6 kg/m2); and the second (G2) was composed by 8 fighter pilots (age=30±2 years, VO2máx=62±13 ml/kgxmin-1; BMI=24.3±1.5 kg/m2) . All of them were considered fit for work after health inspection and signed a consent term. The HR was recorded for 15min in the supine position (baseline), followed by 45min in the active orthostatic position (ort45) and 15min at the supine position again (post-ort). The Polar RS800 was used to record RR intervals. The bands of high and low frequencies, in absolute and normalized form, and sympathovagal balance (HF, LF, HFn, LFn and LF/HF) were analyzed by the Fourier Transform in Matlab 5.0, and the differences (Δ) were calculated between ort45 x baseline, and post-ort x baseline, for all variables. T-Test unpaired (=0.05) was applied to analyze the differences between G1xG2, using the SPSS17.0. When comparing the groups between moments, it appears that G2 had a greater Δ in LF between ort45 x baseline that G1 (G2LF=905.14 x G1LF=416.67). It indicated that G2 had more expressive increase in sympathetic activity (LF) during orthostatism, so a higher HRV. In relation of post-ort and ort45 variation, it was found that LF increased in G1 (Δ=206.1) and had a withdrawal in G2 (Δ=-108.9), suggesting that this group presented a better sympathetic return while assumed the supine position again. Furthermore, significant differences (p≤0.05) were found for all variables between ort45 x baseline in G2 (ΔRR=-237.92, ΔLF=905.14, ΔHF=-529.55, ΔLFn=32.62, ΔHFn=-35.4, ΔLF/HF=6.92). G1 has differed in RR, LFn, HFn and LF/HF when remained in orthostatic position (Δ = -185.39, 20.81, -22.54 and 5.23, respectively). The fall of G2 HFn in post-ort, below baseline values (G2ΔHFn=-8.28 x G1ΔHFn=0.73), demonstrated a marked vagal retake. G2 demonstrated a higher HRV than G1, group which has a lower VO2max. Fighter pilots tend to have higher HRV compared to sergeants, possibly because they have better cardiorespiratory fitness and greater adaptation to the effects of gravity on the cardiovascular autonomic system. The knowledge about cardiovascular control of pilots and the influence of fitness on this modulation are extremely important to promote better training strategies, once new aircraft have technologies that require the pilot to withstand loads up to 14Gz.

The Struggle for Balance and Quality of Life as a Warfighter in Norwegian Special Forces – A 18 Months Longitudinal Study

Presenter: Magnhild Skare (Norway)

Skare, M. & Solberg, P. A. Norwegian School of Sport Sciences/ Defence Institute Background: The physical and psychological demands of a Special Operation Force (SOF) operator are extremely high. To maintain a high level as a warfighter it is essential to address the factors influencing their possibilities to stay healthy over a long career. This include a high level of physical fitness, avoiding injuries and being able to balance the requirements in life, to reach for the highest possible quality of life. To design an optimal exercise concept for a SOF operator it is necessary to understand the full range of their activities and daily demands. The «Human Performance Program" (HPP) includes a holistic approach to physical fitness for SEAL operators. The Norwegian HPP (2012-2013) had a similar purpose for the Norwegian SOF operators. One goal was to examine the psychological variables that may influence the operator's quality of life. Methods: A longitudinal study was conducted among the operators in the Norwegian Navy Special Operations Command. Measurements were performed at baseline and every 6 months over 18 months. Several variables attempting to tap the operator's circumstances in life (work-home cross pressure, awareness, sleep quality, physical complaints: headache, nausea, etc. and burnout: lack of ability to recover after physical activity) was measured together with variables reflecting their general quality of life (vitality, life satisfaction and subjective health). All analyses were conducted in SPSS (18.0). Relations between variables were examined with Pearson's r and multiple regression analyses. Results: At baseline strong and moderate relations between all variables was found. Work-home cross pressure was particularly strongly related to the operators vitality (-.52), life satisfaction (- .54) and subjective health (-.39). There was a moderate relationship between feelings of burnout and vitality and subjective health (.39 and -.42, respectively). Eighteen months later, baseline work-home cross pressure was still strongly related to life satisfaction (- 0.57) and vitality (- .51). Further, high baseline levels of burnout indicated lower vitality (0.46), life satisfaction (0.42) and subjective health (- .65) at 18 months. Multiple regression analyses indicated that all baseline variables explained 62 % of the variance in vitality, and 50 % of their life satisfaction and subjective health at 18 months. Sleep quality was the strongest predictor for vitality (B = .49), work-home cross pressure for life satisfaction (B = -.46) and burnout for subjective health (B = -.81). Discussion and Conclusion: The results suggest that sleep quality, feelings of high work-home cross pressure and burnout strongly influence the SOF operators overall perception of quality of life. Operators with few work-home conflicts and well-developed recovery routines consider their overall well-being and health better. The findings emphasize the importance of taking into account the personal burden for the operators. To ensure that the SOF-operators stay both physical and psychological healthy over time, it is important that the leadership consider these aspects of a warfighters life.

Development of an Incentive Program to Encourage Fitness Over and Above the Minimal Operational Standard

Presenter: Michael Spivock (Canada)

Development of an Incentive Program to Encourage Fitness over and above the Minimal Operational Standard. Michael Spivock, PhD, Paige Mattie, MHK, Barry Stockbrugger, MSc Canadian Forces Morale and Welfare Services. Directorate of Fitness. Human Performance Research and Development. Corresponding author: michael.spivock@forces.gc.ca Background: The Canadian Armed Forces (CAF) recently implemented the FORCE Evaluation (Fitness for Operational Requirements of CAF Employment), a field expedient fitness test designed to predict the physical requirements of completing common military tasks. Given that attaining this minimal physical fitness standard may not represent a challenge to some personnel, a fitness incentive program was requested by the chain of command to recognize and reward fitness over and above the minimal standard. Purpose: The purpose of this study was to develop age- and gender-specific point scales for each test item within the FORCE Evaluation as well as to determine a meaningful and attainable reward structure. Methods: Firstly, an exhaustive literature review was conducted, examining (1) peer-reviewed documentation in the area of motivation and rewards, (2) successful corporate employee programs aimed and health and fitness and (3) how other military organisations recognize and reward fitness levels above operational standards. Secondly, based on the performance of approximately 25 000 CAF personnel, age and gender norms were established for each element of the FORCE Evaluation. Finally, recommendations stemming from this review were validated with CAF personnel during their annual FORCE Evaluation as well as at a series of meetings across the country. Results: Based on literature reviewed, it was concluded that, in order to be effective, a fitness-based incentive program should incorporate meaningful incentives, outline specific program requirements, involve leadership and include a sound reporting or tracking system (Moore 2003). With this idea, the resulting incentive program structure is based on gender and 4 age categories. The results on the 4 elements of the FORCE Evaluation are converted to a point scale from which normative scores are derived, where the median score corresponds to the bronze level, and silver, gold and platinum correspond to a score which is 1, 2 and 3 standard deviations above this median respectively. Nearly 12000 personnel were polled during their fitness test and indicated that their preferences for rewards would be merit board point towards promotions, paid time off, recognition on the uniform and material rewards (t-shirts, gym bags…). A growing line of research in the group motivation literature indicates that rewarding groups can have a significant effect in motivating behavior, particularly in the lowest performers (Weber & Hertel, 2007). The meetings revealed that the idea of group rewards resonated with CAF personnel as well, particularly in that group recognition could encourage unit commanders to provide time for physical training during the work day. Conclusions: Though the initial mandate of this project was to examine individual-level rewards, the chain of command was presented with the group rewards option and directed the research team to pursue this avenue as well. An integrated model of group and individual rewards will therefore be presented.

Military Field Labs in the Royal Netherlands Army: A Promising Concept

Presenter: Taco Visser (Netherlands)

Taco Visser, MSc, Anton M.B. Koteris Royal Netherlands Army / Training Medicine and Training Physiology Introduction Defense organizations worldwide structure and organize the process of training and educating their service members' health, physical fitness, and combat readiness in different ways. The Royal Netherlands Army (RNLA), comprising nearly 20.000 employees, has a long tradition in using a separate military sports organization (300 employees) to physically and mentally educate and train RNLA soldiers and cadre (NCO & CO). The Dutch defense organization has a longstanding contract with TNO (Netherlands Organization for Applied Sciences) to research and innovate on issues such as equipment, technology, cyber, clothing, ammunition, future warfare, gaming and e-learning, and the human factor. In the sports medicine center of excellence of the RNLA, Training Medicine and Training Physiology ('TGTF'), sports physicians and exercise physiologists together work on improving health, physical fitness and combat readiness (11). Despite of these (centralized) organizational structures, there is an urgent need to actually translate knowledge and expertise derived from applied research on topics related to physical fitness and combat readiness, to be used for the benefit of our operational brigades. This gap can be filled by a concept that has succesfully been used in the RNLA for some years now: the Military Field Lab (MFL). Brigade Military Field Lab In the MFL concept, embedded specialists ('front office') work in close relation to operational brigades to constantly improve health and physical/mental readiness of individuals and units. The MFL is guided (given direction) and backed up by its 'back office' TGTF. The first MFL started in 2006 at the Netherlands Air Mobile Brigade. In 2009, the Netherlands Special Forces incorporated a MFL and, last year, the 13th Motorized Brigade started a MFL. Our intention is to have a MFL operational at both the 43th Mechanized Brigade and the Operational Support Command by the end of this year. Each embedded MFL specialist, a so-called Military Field Lab Manager, is incorporated in the medical cell of the brigade. Issues that are addressed by the MFLs include: military physical training & education programs, job-related physical performance testing and assessment, injury prevention, and health promotion. MFL activities and current projects Core activities of the MFL are: (1) unit-wise longitudinal monitoring of health and fitness parameters using standard testing protocols, (2) advising cadre on the physical readiness of their unit, and (3) implementing (innovative) tools to support units in improving health, physical fitness and combat readiness of their soldiers. Military Field Lab Managers play a key role in forming strong multidisciplinary teams within the brigade (e.g., commanders, medical personnel, psychologists, sports instructors) to reach these goals. Current projects include: monitoring of infantry/special forces basic training; development of job-related physical performance testing (i.e., the FIGHT, comparable to the test of the USArmy Baseline Physical Readiness Requirements Study); implementing innovative training doctrines (strength & conditioning, speed & agility); unit-specific training & education programs concerning topics related to acclimatization (heat, jungle, cold).

Deployment Stress, Its Impact on Swedish Peacekeeping Soldiers in Northern Afghanistan

Presenter: Niclas Wisen (Sweden)

Niclas E. Wisen, Swedish Armed Forces/ Karolinska Institute. Giorgio Grossi. The Stress research insitutie Deployment stress is many times associated with trauma, however many deployed soldiers in peacekeeping missions are to a larger extent exposed to other deployment stressors and its wear and tear in a cumulative matter. In this longitudinal study we follow a group of soldiers (n=39) during the three phases of deployment (training, deployment and follow up). We have chosen three areas of dependent variables based on clinical experience of common complaints after deployment. We look upon sleep, neuropsychological tests and bio-markers of stress. Since the aim is to assess deployment stress we have a control group (n=19) of soldiers performing guard duty in Sweden. Method: Sleep is assessed using a wrist-worn device Motionwatch 8 that logs sleeping patterns over extensive periods. Data contains basic measures on the quantity of sleep but also measures on the quality of sleep. Sleep is also measured using self-assessment forms. Bio-markers related to stress are analyzed. Salivary cortisol and DHEAS are analyzed in the first round. Serum is then frozen for further analysis. Neuropsychological tests concerns memory function (working and episodic memory), ability to concentrate and problem-solving. Complementary to the above test some self-assessment forms concerning coping, perceived stress, irritability, alcohol and boredom are given. Both groups (deployed and control) are measured at baseline. The deployed group were assessed with some (not the whole battery of test) during deployment. Upon homecoming (late may 2014) the whole battery will be performed again and in September the follow up measure will be conducted. Results: So far we mainly have cross section data on baseline level for the two groups. We have some data collected during deployment and parts of the measures from the sleep monitors. Discussion: This is an ongoing study with an explorative approach. We want to se whether any of the measures are affected over deployment and if so if status returns to baseline once the deployment stressors are absent. Concerned with the mental health of our soldiers we continuously try to provide preventive measures. Working with psychological fitness is a relevant field in accomplishing success in that. In order to develop strategies or models for working we must fill in the gaps in out knowledge. No one disputes the role of sleep and effects of sleep deprivation on performance both physical and psychological. But can we see a connection between sleep, circadian-rhythm and levels of stress hormones? If so what are the impact on resilience and ability to recover after periods of intensified stress. The list of dots that needs to be connected is definitely long and in this study we make an effort to address at least some of the dots.

Health and Fitness Promotion for Desk Warriors: Do We Have the Right Tools?

Presenter: Alexander Witzki (Germany)

Health and fitness promotion for desk warriors: Do we have the right tools? Alexander Witzki (1), Ulrich Rohde (1), Nadine Hartmann (1), Matthias Krapick (1), Philipp Preuß (2), Alexander Sievert (2), Dieter Leyk (1,2) Institution: (1) Central Institute of the Bundeswehr Medical Service Koblenz - Department Military Ergonomics and Exercise Physiology (2) German Sport University Cologne - Department of Physiology and Anatomy Physical fitness is a prerequisite in military settings. The growing number of sedentary work requirements adversely affects the actual physical activity of many soldiers. This effect reflects the trend in today's industrialized societies. Counteracting this development will require health prevention measures on a large scale. Purpose: A one year pilot study was conducted to study effects of health and fitness promotion instruments and participation rates. Methods: 905 soldiers of an administrative unit were offered to participate in a fitness and health promotion program during duty hours. It consisted of: health and fitness check-ups, a broad range of exercise opportunities for beginners as well as experienced athletes, monthly lectures by training and nutritional experts, an intranet forum, nutritional information, and special meals. The program was initiated and strongly supported by the commanding officers who participated [1]. Results: The majority of the participants (82%) reported a high degree of satisfaction with the overall program. Positive effects were reported on health and performance related behavioral parameters as well as on physical and job performance. 94% of the participants indicated their interest in future health and fitness promotion programs. However, less than half of the unit staff (44%) participated in the program. Only 18% participated in the evaluation at the end of the pilot study. Conclusions: The health and fitness promotion program was well received and very successful based on the data reported by participants. However, only a part of potential participants could be reached. An even smaller portion of participants still participated in the final survey or the fitness and health check-up at the end of the one year period. Thus, offering health and promotion programs in almost ideal settings (i.e. on duty) is not self-sufficient [2]. Additional and more effective tools are required on both personal and institutional levels. [1] Witzki A, Rohde U, Rüther T, Klein G, Hofmann, M, Franke, E, Leyk, D: Erkenntnisse aus der Gesundheits- und Fitness-Initiative an einer großen Dienststelle für die künftige Präventionsarbeit in der Bundeswehr. [Findings from the health and fitness campaign at a large personnel office for the future prevention work in the Bundeswehr] Wehrmedizinische Monatsschrift 2013; 57: 171–6. [2] Leyk D, Rohde U, Hartmann ND, Preuß PA, Sievert A, Witzki A: Results of a workplace health campaign—what can be achieved? Dtsch Arztebl Int 2014;111 (in print) DOI: 10.3238/arztebl.2014.0xxx

CONCURRENT SYMPOSIA – TUESDAY

Physical Performance, Musculoskeletal Injuries and Women in the Military: State of the Science and Recommendations for the Way Ahead

Physiological and Medical Aspects That Put Women Soldiers at Increased Risk for Overuse Injuries

Presenter: Yoram Epstein (Israel)

Anthropometric and physiological factors place female soldiers at a disadvantage relative to male soldiers in most aspects of physical performance. Average aerobic and anaerobic fitness levels are lower in women than in men. Thus, women have a lower overall work capacity and must exert themselves more than men to achieve the same output. The lower weight and fat-free mass and the higher body fat of women are associated with lower muscle strength and endurance, placing them at disadvantage compared with men in carrying out military tasks such as lifting and carrying weights, or marching with a load. Working at a higher percentage of their maximal capacity to achieve the same performance levels as men, women tire earlier. Their smaller size, different bone geometry, and lower bone density also predispose women to a higher incidence of stress fractures. The purpose of this presentation is to review with a critical eye the literature on gender related physiological and anatomical differences that put female soldiers at increased risk of overuse injuries. Although some "close combat roles" will still be an exception, mainly because of the extreme physical demands that are beyond the physiological adaptability capacities of females, integration of women into military combat professions is feasible in many cases, which will be discussed in view of the Israeli experience.

Risk Factors for Musculoskeletal Injuries in Deployed Female Soldiers

Presenter: Tanja Roy (USA)

Background- Up to 70% of surveyed deployed service members suffer a musculoskeletal injury (MSI) during deployment. Each year MSIs result in millions of lost duty days and thousands of medical discharges resulting in billions of dollars in disability costs. Approximately 15% of the U.S. Army is made up of women and no studies have identified risk factors for MSI while deployed despite the fact that female soldiers have higher incidence rates of MSI than male soldiers. The purpose of this prospective cohort study was to investigate occupational, physical, and psychosocial risk factors for musculoskeletal injury in female soldiers. Methods- Female participants were recruited from three BCTs deploying during 2012. They underwent performance testing and completed surveys prior to deployment. Surveys measured demographics, coping, sleep, and job stress. Upon completion of the deployment, soldiers again filled out surveys to include an additional survey on occupational demands and MSI. All MSIs either impaired the Soldier's ability to perform occupational tasks or physical training. Results-Of the 160 women, 57 (35.6%) suffered 78 MSI. In univariate analysis the following significantly increased relative risk (RR) of injury: wearing an average load greater than 10% percent of body weight (RR=2.00) or greater than 29 lbs (RR=2.50), wearing the average load more than 1 hour (RR=2.44), wearing a heaviest load worn more than 15% of body weight (RR=5.83) or more than 48 lbs (RR=1.56), wearing a back pack (RR=1.82), wearing body armor more than an hour (RR=1.62), lifting objects with an average weight of over 50 lbs (RR=1.96), lifting the average object 1-2 times (RR=1.73), carrying the average object more than 25 ft (RR=2.01), and Y balance composite score less than 95.23 (RR=1.71). Rank; age; body mass index; height; weight; months deployed; history of deployment; type of body armor; time spent sitting, walking, or standing; distance walked per day, time wearing the heaviest load, days per week spent lifting objects, coping ability, sleep quality, job stress, fitness level, loaded step test, and Illinois Agility test did not affect RR. In multivariate analysis (logistic regression) heaviest load as a percent of body weight (Odds Ratio [OR]=1.04), time wearing the heaviest load (OR=1.15), number of family members (OR=0.59), and pre-deployment Brief Cope score (OR=0.97) all predicted MSI and had significant ORs. Average number of times an object was lifted and average distance objects were carried were both part of the best model to predict MSI but did not have significant ORs. Conclusions- Wearing heavier loads for longer durations, decreased coping ability prior to deployment, and more family members all contributed significantly to predicting MSI in deployed female Soldiers.

Sex-Specific Applicant Physical Selection Standards May Be Appropriate

Presenter: Jace Drain (Australia)

Purpose: A study was undertaken to investigate physical performance adaptations in male and female recruits through a 12-week basic military recruit training course. By understanding performance improvements in recruits during basic recruit training, in particular differences between sexes, military organisations can make more informed decisions regarding applicant physical selection standards. Methods: A total of 132 recruits were followed through the 12-week basic recruit training course at the Australian Army recruit training centre. Physical performance was assessed at weeks 1, 8 and 12. At each time point participants were subjected to a battery of tests that included:

• Generic fitness tests; push-ups, sit-ups, multi-stage shuttle test.

• Military-related tests; box lift and place, jerry can carry, 3.2-km loaded run.

All participants also undertook the Australian Army baseline physical employment standards (PES) assessments at week 8, which included a forced march, fire and movement simulation, lift and carryassessment and box lift and place. The PES assessments reflect the minimum level of physical capability required of all Army personnel and are based on the performance of essential military duties. Performance measures were recorded for the generic and military-related tests whilst PES assessment results were pass/fail. Results: Males (n=125) improved ($p<0.05$) performance on all generic and military-related tests from weeks 1-8 of basic recruit training. From weeks 8-12 males only showed improvement ($p<0.05$) in box, lift and place performance. Females (n=7) improved ($p<0.05$) performance in the multi-stage shuttle test from weeks 1-8, and continued to improve ($p<0.05$) through to week 12. All males passed the PES assessments at week 8, as did all females with the exception of the box, lift and place where only two females (out of seven) passed. The magnitude of improvements in box, lift and place performance from weeks 1-8 were 3.3 kg (2.3-4.4 kg, 95% confidence intervals) and 2.5 kg (-0.2-5.2 kg, 95% confidence intervals) for males and females respectively. Conclusions: The results showed that males responded positively to the training stimulus provided during the first eight weeks of basic recruit training. Females however, generally failed to respond to the physical conditioning over this time. Of particular concern are box, lift and place performance improvements and subsequent failure rates amongst females given the occupational relevance of this task. When the magnitude of box, lift and place performance improvements are considered (lower 95% confidence intervals for males and females are 2.3 and -0.2 kg respectively)with reference to incumbent PES assessments, sex-specific applicant physical selection standards, at least for muscular strength, may be appropriate. The results also suggest than an increased emphasis on whole-body muscular strength is required to improve (female) performance in the box, lift and place, and in turn performance in military-related manual handling tasks.

Performance Differences on Combat Proxy Tasks in U.S. Marines: Are Females Ready for the Fight?

Presenter: Karen Kelly (USA)

Objective: Military career advancement depends crucially on serving in combat roles. For decades women have been restricted from certain Military Occupational Specialties (MOSs), such as infantry, though there has been a gradual push to open up closed occupations to women. Those supporting the restriction typically cite, among other reasons, the physical demands of combat. Thus, the purpose of this study was to evaluate performance on combat proxy tasks in both female and male Marines. Methods: Data were collected from 3 different sites within the USMC Training and Education Command. All participants (409 males [M], 379 females [F]) were active-duty Marines who were recently tested on the Physical Fitness Test (PFT) and Combat Fitness Test (CFT). Participants were asked to execute a total of 6 combat proxy events: pull-ups, deadlifts, clean and presses, 120-mm tank loading drill, 155-mm artillery round carry, and negotiating a 7-ft wall while wearing a fighting load (~30 lb). Results: Successful completion of proxy tests is as follows: pull-ups (M: 15.59, F: 3.57 mean score); deadlift of 135 lb (M: 100%, F: 97.1%), clean and press of 115 lb (M: 80%, F: 8.7%), 120-mm round loading (M: 99.8%, F: 81.5%), 155-mm round carry (M: 99.8%, F: 71.4%), 7-ft wall (M: 98.8%, F: 78.6%). Deconstructing the clean and press revealed the following: 74% of females could successfully press 70 lb, and there was a liner relationship in decline as the weight increased. Additionally, females— who were able to perform 1 pull-up—performed better than females who could not do a pull-up but who achieved a 70-second flexed arm hang. That is, for females who could perform 1 pull-up, there was a trend for better performance (compared with females who could complete a 70-second flexed arm hang but could do no pull-ups) on the CFT component tasks and the combat-related tasks. Finally, of the good performers (N = 620), there were 66% males and 34% females. Of the best performers (N = 351), there were 92% males, and 8% females. Conclusions: The primary limiting factor for females, in terms of reduced success on proxy tasks, is upper body strength. However, it is important to note that this study did not include any training, and thus it is not known if success would have been higher given proper time to strength train for the given tasks. Despite this, there were some females (~8%) who could successfully complete the majority of the proxy tasks, and thus are physically capable of meeting the demands of closed combat occupations.

Physical Training Strategies for Performance Optimization in Women in Combat-Centric Occupations

Presenter: Bradley Nindl (USA)

The rescinding of the 1994 Ban on women serving in units that "co-locate" with direct combat forces will have far-reaching implications on the health and performance of women serving in the military. As women have lower physical capacity (i.e. muscle cross sectional area, lung capacity, cardiac output, maximal strength) than men, implementation of optimal physical training programs designed to improve women's physical capacity will be critical to ensuring this policy will be successful. For example, Published work has indicated that women training for 3 alternating days a week for 6 months in periodized heavy resistance training (RM loads in the range of 8-5 reps) can significantly improve military occupational task performance such as load carriage and repetitive lifting. This session will overview how physical training can augment women's military task performance and provide specific recommendations for program design and implementation.

Minimal Footwear: A Return to the Basics Chair: Irene Davis (USA)

Presenters: Irene Davis (USA), Sarah Trager Ridge (USA), Neil Fleming (USA)

Humans have been walking and running barefoot for most of their evolutionary history. However, evidence of minimal footwear, in the form of sagebrush bark sandals, date back to over 10,000 years ago. These shoes were simply comprised of a flat foot bed with straps to hold them on their feet. We have been running in shoes that simply protect the bottom of our feet until the last 5 decades where running shoes become increasingly cushioned and supportive. However, there has been a movement back towards barefoot/minimal footwear running. Many of the military groups, in particular special operations, have embraced this footwear for their training. This has led to concerns regarding whether less cushioning and support will lead to increased injury risk. Therefore, the purpose of this symposium is to review the state of knowledge regarding minimal footwear running. We will begin with a presentation on current evidence comparing mechanics between minimal footwear to both barefoot and traditional shoes. We will then discuss injuries associated with minimal footwear that have been reported in the literature to date. Finally, we will close with a presentation of sound transition programs aimed at reducing injury risk.

AltitudeOmics to Advance Warfigher Performance at High Altitude Chair: Robert Roach (USA)

Presenters: Robert Roach (USA), Andrew Subudhi (USA), Rosie Twomey (UK), Andrew Lovering (USA)

The AltitudeOmcis study was the first ever in humans to combine study at high altitude of the physiology (breathing, blood flowing, exercising etc.) responses with the first study of the cellular and molecular machinery that controls those processes. We focused on acclimatization because once a warfighter has a solid base of acclimatization they are resistant to high altitude sickness and have much better exercise capacity. No current drug can give those benefits together, and no drug can improve exercise capacity the way acclimatization can. There is then a distinct possibility that discovering these same pathways in young healthy people could be used for ANYONE suffering from low oxygen levels. The impact could be direct for any patient with heart and lung diseases where oxygen levels are limited, even if they live in New York City or any other sea level location. If acclimatization could be triggered with a drug, then those patients could gain exercise capacity and suffer less from their diseases. This session will cover the combined physiology and omics studies for acclimatization to high altitude and provide new insights into protecting and improving warfighter performance at high altitudes.

Senior Leader Physical Performance in Joint Professional and International Military Education Setting

Presenters: Thomas Williams (USA), Anders Sookermany (Norway), Jean Pierre Irribarra (Chile), Cristian Vial Maceratta (Chile)

Most of the militaries around the world provide senior leader development and education programs to prepare their senior leaders for service as the strategic level. This symposium briefly reviews the development and dramatic expansion of the U.S. Army War College's (USAWC) program that was linked to the Joint Professional Military Education over its 30 years. Presentations will highlight how the Norwegian's and Chilean's military education models were influenced by this USAWC program (to include envisioning a change for Chilean society via the Chilean's military increased focus on health and fitness. Today, the USAWC focuses on enhancing the performance and leader development of senior leaders, to include over 77 students from over 70 countries, world-wide. Presentations will also include various techniques focused on Performance Movement Analysis for the USAWC Senior leaders.

POSTER SESSION II – THERMOREGULATION/BASIC RESEARCH

Circulating MicroRNAs as Biomarkers of Muscle Injuries

Presenter: Sébastien Banzet (France)

SIRACUSA Julien, BOURDON Stéphanie, SOURDRILLE Antoine, KOULMANN Nathalie, BANZET Sébastien Institut de Recherche Biomédicale des Armées, BP 73, 91223 Brétigny/Orge, France. Exercise-induced muscle damage (EIMD) and muscle injuries are common outcomes in military training and operations. MicroRNAs (miRNA) are short non-coding RNAs involved in post-transcriptional regulation of gene expression. Many miRNAs are ubiquitously expressed, but some others are tissue-specific. MiRNAs can be measured in various biological fluids including plasma and it has been proposed that they could be useful biomarkers of tissue injuries. We previously found that muscle-specific miRNAs increase in plasma of human subjects in response to EIMD. Purpose: To investigate circulating miRNAs in rats subjected either to traumatic (crush) or toxic (notexin) muscle injuries to find new candidate biomarkers. Methods: Adult rats were anesthetized and left soleus muscle degeneration was induced either by notexin injection isolated from snake venom (Notechis scutatus, Latoxan, France) directly into the belly of the muscle surgically exposed, or by mechanical crush. They were sacrificed 6h, 12h, 24h or 48h later (n=8 per group) and were compared to sham operated and control rats. Plasma was sampled and miRNA profiling was performed on pooled samples with PCR arrays. Thereafter, candidate miRNAs were measured in individual samples. Results : 752 miRNAs were measured in pools and 58 were selected based on their abundance in plasma, tissue specificity and differential expression in response to muscle injuries. Muscle-specific miRNAs (miR-1, 133a, 133b and 206) significantly increased 6 and/or 12h after injury. Non muscle-specific miRNAs are under investigation. Conclusion: Circulating miRNAs are promising early markers of muscle injuries and could be an interesting alternative to classical plasma markers

A Partitioned Approach to Reducing Thermoregulatory Strain Whilst Wearing Fully-Encapsulating Chemical Protective Equipment and Exercising in Desert-Like Conditions

Presenter: Christie Garson (UK)

Military personnel exercising in desert conditions wearing chemical personal protective equipment (PPE) have an increased risk of heat illness. Some chemical PPE (e.g. gloves, respirator and overboots) are made from moisture vapour impermeable (MVIP) materials, which increase insulation and impede evaporation from that body area, increasing the thermal burden. The aim was to quantify the thermal burden imposed by each MVIP item. The study was a five-condition, repeated measures design with male volunteers (18-27 years) who exercised lightly (average V $\dot{V}O_2$: 13.6 mL.kg-1.min-1), interspersed with 20-minute rest periods, in a hot, dry environment (40.5 °C, 20 % relative humidity) for a maximum of 170 minutes. Conditions varied in which MVIP items were worn. In Control (CON) condition all items were worn (respirator, gloves, body armour liner and overboots), subsequent conditions involved the removal of one item (NG: gloves, NOB: overboots, NR: respirator and NBAL: body armour liner), with the weight of that item being substituted. One-way and two-way ANOVA results from the final 60-minute work period and 20-minute rest period are expressed as the mean [SEM], a value of $p < 0.05$ was considered significant for all results presented. V $\dot{V}O_2$ was the same between conditions. The rate of rise of rectal temperature (Tre) during the final work period in NG was reduced by 0.36°C.hr-1 compared to CON and 0.28°C.hr-1 compared to NOB. Rates of rise were used to predict the time for Tre to reach 40°C which was extended by 13.3% in NG compared to CON. During the final rest period, the rate of change of mean body temperature was lowest in both NG (-0.44±0.15) and NBAL (-0.25±0.14) compared to both CON (0.08±0.1) and NOB (0.12±0.10). The physiological strain index (PSI) was lowest for NR (5.14±0.18) compared to CON (5.68±0.16) during the final work period, however during the final rest period PSI was lowest in NR (5.88±0.26) compared to all conditions except NG (6.14±0.25). CON elicited the highest rating of perceived exertion (12.62±0.68) in the final work period compared to all conditions except NBAL (12.15±0.63). NBAL and NOB were perceived to be drier than CON in the final work period. NBAL was also perceived to be cooler in both the final work and rest periods compared to CON. NG was rated more comfortable than CON in the final work period whilst in the final rest period, all conditions were rated more comfortable than CON except for NR. In conclusion, if MVIP gloves could be made completely permeable, there would be a considerable heat strain advantage (-13.3%). The impact of partially permeable gloves is to be assessed. Interestingly, NBAL was perceived to be drier and cooler compared to CON, a finding that was not strongly supported by physiological data whereas the physiological benefits of NR were not strongly supported by perceptual data.

The Effect of Ambient Humidity on Performance During Simulated Desert Partrols

Presenter: Mikael Gronkvist (Sweden)

Mikael Grönkvist(4), Ursa Ciuha(2,3), Ola Eiken(4) and Igor B. Mekjavic(1) (1) Department of Automation, Biocybernetics and Robotics, Jozef Stefan Institute; (2) International Postgraduate School Jozef Stefan, Ljubljana, Slovenia; (3) Biomed d.o.o., Ljubljana, Slovenia; (4) Environmental Physiology, Royal Institute of Technology, Stockholm, Sweden. Introduction: Daytime in the summer, ambient relative humidity (RH) in a desert may be ≤10%. Predominantly for technical reasons, however, laboratory simulations of desert climate are typically undertaken at RH >20%. The present study evaluated the effect of 10% vis-à-vis 20% RH on heat dissipation during simulated desert patrol missions. Methods: Ten healthy heat-unacclimatised male subjects participated in two 130-min trials, during which they walked on a treadmill at a speed of 3.2 km/h, with an incident wind at the same velocity, i.e. simulating zero wind conditions. Each trial commenced with a 10-min baseline at 25°C and 40% RH; thereafter the subject transferred to a climatic chamber and started the simulated desert patrol mission of two sorties, comprising two 50-min walks interspersed by a 20-min rest period. The trial was conducted twice; in both conditions the subject wore the same full protective equipment (FP), including body armour and the ambient temperature was maintained at 45°C. In one condition the ambient relative humidity was 20% (FP20), and in the other 10% (FP10). The order of the two trials was randomised. Results: The trials had to be discontinued due to heat exhaustion (nausea, headache, dizziness, paresthesia in arms) for 5 subjects in the FP20 and for 2 in the FP10 condition. Rectal temperature, average skin temperature and heart rate rose at substantially higher rates in the FP20 than in the FP10 condition. Data from the 5 subjects that completed both trials showed that the FP20 condition induced higher end-point rectal temperature (Δ=0.36°C) and heart rate (Δ=14 bpm) than did the FP10 condition. Conclusion: The results emphasise the significant effect of a 10% unit difference in relative humidity on physical performance in hot conditions. This should be considered when evaluating personal garments and/or human performance in simulated desert conditions.

NF-κB Transactivation Regulates MCP-1 Gene and Protein Expression in C2C12 Myotube Cultures after Acute Skeletal Muscle Injury

Presenter: Kevin O'Fallon (USA)

NF-κB transactivation regulates MCP-1 gene and protein expression in C2C12 myotube cultures after acute skeletal muscle injury Kevin S. O'Fallon1,2, Ling Xin1, Lawrence M. Schwartz2, Monica J. Hubal3 Department of Kinesiology1, Department of Biology2, University of Massachusetts, Amherst, MA, Children's National Medical Center, Washington DC3 Nuclear factor kappa-beta (NF-κB) and monocyte chemoattractant protein-1 (MCP-1) have been shown to help regulate the inflammatory response to skeletal muscle injury. However, it is currently unclear whether the early post-injury changes in NF-kB transactivation status and MCP-1 gene and protein expression originate from skeletal muscle cells (satellite cells and myotubes) or if they are derived from immune cells resident within the injured muscle tissue. Understanding the source and kinetics of NF-kB transactivation and MCP-1 expression from injured muscle tissue will provide new insight into the skeletal muscle regeneration program and potentially lead to development of therapeutic strategies to accelerate muscle recovery. The purpose of this study was to define the roles and interplay of NF-κB and MCP-1 in muscle regeneration and inflammatory signaling in skeletal muscle cells following acute injury. To test the hypothesis that changes in NF-kB transactivation status and MCP-1 mRNA and protein expression occur in muscle cells, we used an in vitro scratch-injury model in C2C12 myotube cultures. Changes in NF-κB nuclear transactivation, MCP-1 mRNA and protein expression, satellite cell proliferation, and morphological changes in regenerating myotube cultures were assessed at baseline (BSLN) -72 hours (h) post-injury by way of ELISA and 5-bromo-2'-deoxyuridine (BrdU) incorporation assays. NF-κB transactivation was significantly ($p<0.01$) downregulated by 30±1.4% at 6h and 44±1.1% at 12h post-injury, relative to uninjured controls. MCP-1 mRNA and intracellular protein expression were significantly ($p<0.05$) upregulated by 1.9±0.1 fold at 1-3h and by 96±24% at 1-6h, respectively, leading to significant ($p<0.004$) increases in MCP-1 protein secretion from muscle cells at 12h (56±12%) and 24h (35±15%), relative to uninjured controls. Pharmacological blockade of NF-κB transactivation with an inhibitor of IκBα degradation, administered 1h pre-injury, transiently reduced NF-κB activation by 70±35% ($p<0.01$) from BSLN-3h, leading to significant ($p<0.05$) downregulation of satellite cell proliferation by 21±16% at 19h and 10±4% at 72h, relative to untreated controls. NF-κB activation moderately correlated ($R2=0.48$, $p<0.05$) with MCP-1 secretion from injured muscle cultures, and blockade of NF-κB transactivation reduced MCP-1 secretion by 2.9±0.04-fold at 12h and 1.2±0.01-fold at 24h, relative to untreated controls, and moderately correlated ($R2=0.55$, $p<0.05$) with NF-κB transactivation. These data support recent in vivo findings to demonstrate that NF-κB and MCP-1 signaling are critical regulators of inflammatory and regenerative responses following muscle injury. Moreover, this work provides the first kinetic profile of the early (<24h) molecular responses of NF-κB and MCP-1 in muscle cells after acute injury, and introduces novel evidence that NF-κB regulates MCP-1 gene expression and protein secretion from muscle cells, indicating an indispensible role of NF-κB signaling in muscle regeneration and inflammatory signaling in vitro. Funding Source: DoD Combat Feeding Research & Engineering Program

The Effect of Nutrition on Core Temperature

Presenter: Hilde Teien (Norway)

The effect of nutrition on core temperature Hilde K. Teien, Per-Kristian Opstad, Norwegian Defence Research Establishment (FFI) Purpose: To investigate the effect of continuous military operations on soldier's core temperature and alterations in the set-point, and to evaluate the effect of additional nutrition (6000 kcal/on day 6). Methods: 18 cadets from the Norwegian Military Academy who participated in a 7 days ranger training course were included; some were withdrawn because of medical causalities. 6 cadets in the experiment group (EG) (BMI: 24.6 ± 1.5 kg/m2) who got 6000 kcal on day 6 were compared with the control group (CG) of 4 cadets (BMI: 24.0 ± 0.7 kg/m2) who got the standard diet containing 750 kcal/day. Heart rate, core and skin temperature were recorded as well as changes in trijodothyronine (T_3), tyroxin (T_4) and thyroid-stimulating hormone (TSH) concentrations in serum. Body composition was investigated before and immediately after the course (Inbody 720). Statistical analysis was performed with repeated-measure MANOVA and pared and related samples t-tests in SPSS. Results: Extra nutrition prevented the decrease in rectal temperature ($p = 0.029$) with a difference of 0.4 °C, EG (37.2-37.6 °C) and CG (36.7-37.1 °C), compared to the CG. The skin temperature was not affected. In contrast the foot temperature increased for both groups, EG 6.2 ± 2.1 °C ($p = 0.00001$) and CG 4.2 ± 1.2 °C ($p = 0.005$), compared with the control experiment. The effect of nutrition was observed for T_3 ($p = 0.008$). Also the EG had a fall in T_3 on day 7 ($p = 0,049$) compared with the control experiment. No differences between the groups were observed for T_4 and TSH. A reduction was found for both groups regarding bodyweight ($p = 9x10\text{-}8$) and fat mas ($p = 2x10\text{-}6$), where the EG had the lowest average weight loss ($p = 0.041$), EG 4.5 kg (6.7-4.2 kg) and CG 5.4 kg (6.0-3.0 kg). Heart rate was not affected due to extra nutrition ($p = 0.956$) or stress ($p = 0.867$). Conclusion: Multiple stressors affect both the core and the skin temperature with a reduced core-temperature combined with an increase in skin temperature. This may be due to reduced set-point, or also to changes in the level of signal molecules and receptors on target cells giving an increase in the blood circulation to the skin and the following loss of heat. Nutrition may contribute to the difference in core temperature between the two groups, but the impact of physical activity can't be excluded. Alterations in the thyroid function may also have led to the reduced core temperature. The loss of fat mass may contribute to increased heat loss, by reduced isolation, but can't explain any reduced set-point. The observations in this study suggest that the cadets are more vulnerable to hypothermia but more protected against frostbite injuries.

Impact of Intense Exercise and Sleep Deprivation on Blood Metabolic Parameters and Heat Shock Protein Expression Following Lethal Heat Exposure in Rats

Presenter: Yong Chiat Wong (Singapore)

Yong-Chiat Wong1, Kian-Chye Ng1, Jian Wu1, David Chiok-Yuen Fun1, Mui-Hong Tan1, Lydia Yu-Li Law1, Fabian Chin-Leong Lim2, Jia Lu1,2,3, Jason Kai-Wei Lee1,2,3 1Defence Medical & Environmental Research Institute, DSO National Laboratories, Singapore 2Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore 3Yong Loo Lin School of Medicine, National University of Singapore, Singapore PURPOSE Soldiers are exposed to the combination of physical exertion and sleep deprivation during training and operation, and may therefore be more susceptible to heat stroke in warm environment. This project examined the impact of intense exercise and sleep deprivation on survival duration and the associated blood metabolic parameters and heat shock protein (HSP) expression following lethal heat exposure in sedated rats. METHODS Ninety 11-week old male Wistar rats were randomly assigned to intense training (IT), intense training and sleep deprived (IT+SD) and control groups. The IT group was exposed to daily intense exercise, while the IT+SD group was exposed to daily intense exercise and sleep deprivation for 5 days. Animals in the control group were kept in the cage under normal condition during this phase. All animals were sedated and underwent either non-heat (NH) or heat (HT) treatments on the 6th day. Passive heat stress was induced to the HT rats to elicit a core temperature (Tc) of 42oC while core temperature of the NH rats was maintained at 37°C. The survival duration was measured and the blood was sampled at specific time points throughout the period of NH and HT exposure. The animals were sacrificed and brain samples were collected for immunohistochemical analysis. RESULTS The IT+SD rats survived longest (36.6 ± 4.8 min), followed by the IT rats (21.1 ± 3.2 min) and then the control rates under lethal heat exposure (13.2 ± 2.6 min; p<0 05). At Tc 42oC, the preconditioned rats showed significantly higher blood pO2 and lower lactate compared to the control rats (pO2: C ± 8.1 mmHg, IT=82.4 ± 9.4 mmHg, IT+SD=84.2 ± 13.6 mmHg (p<0 05); lactate: C ± 0.5 mmol/L, IT=0.9 ± 0.5 mmol/L, IT+SD=2.0 ± 0.3 mmol/L (p<0 05)). After the Tc was maintained at 42oC for 15 minutes, the preconditioned rats showed higher blood pH compared to the control rats (pH: C ± 0.04, IT=7.34 ± 0.09, IT+SD=7.35 ± 0.04 (p<0.05)). Immunohistochemistry demonstrated elevated HSP27 staining in the brain cerebellum, cortex, hippocampus and thalamus of the NH and HT preconditioned rats. CONCLUSIONS Intense training and sleep deprivation have an independent and accumulative conditioning effect in delaying the onset of heat stroke. The longer survival duration following five days of IT and IT+SD preconditioning might have been due to an increased buffering capacity to heat-induced metabolic acidosis and cytoprotective effects at various parts of the central nervous system.

Thermal Sensation as an Alternate Indicator of Thermal Strain During Exercise

Presenter: Miyo Yokota (USA)

Miyo Yokota, Robert Kenefick, Bruce Cadarette, Leslie Levine, Larry Berglund U.S. Army Research Institute of Environmental Medicine (USARIEM), Natick, MA, USA INTRODUCTION Core temperature (Tc), skin temperature (Tsk) and heart rate (HR) are common physiological measures of thermal strain that can be collected in real time during physical exercise. However, there may be situations (e.g., excessive motion artifact, malfunctions of physiological monitoring systems) during which these measures may be difficult to assess. The thermal sensation (TS) scale, a nine point scale with verbal anchors where 0 = unbearably cold, 4 = comfortable, and 8 = unbearably hot, may be a useful alternative indicator of thermal strain when physiological measures are not available. The purpose of this study was to quantify soldiers' TS in relationship to physiological measures during work in various operational and environmental conditions. MATERIALS AND METHODS Physiological measures (i.e., HR, Tc, Tsk) and self-reported TS were compiled from four laboratory studies (52 heat acclimated or unacclimated US male soldiers; 22 ± 4 yrs; 26.0 ± 2.9 BMI; 15 ± 4% fat). Environmental conditions ranged from 10 to 45ºC, and 20 to 50% RH; exercise consisted of continuous or intermittent walking and cycle ergometry (380-450W) in various clothing ensembles including T-shirt/shorts, Army Combat Uniform (ACU) with/ without body armor (BA), or full chemical-biological protective ensembles. Data were collected every 10-20 min. The relationships between TS, and physiological measures and mean body temperatures (MBT); Burton's MBT = 0.65*Tc + 0.35*Tsk and Gagge's MBT = (1-□)*Tc + □*Tsk, where □ = 0.042 + 0.75/(6.3+50*(Tc-36.8) were evaluated. RESULTS A range of TS were reported when Soldiers wearing T-shirts/shorts exercised in 10 ºC conditions (TS ≤ 1, very cold) or when Soldiers wearing ACU + BA walked in 45 ºC, 20% RH (TS ≥ 7,very hot), or wore T-shirt/shorts and walked in 40 ºC,20% RH (TS ≥ 7, very hot). Work-rest cycles reduced TS (6, hot) even when Soldiers were fully encapsulated in 32 ºC, 20% RH. Overall, TS was highly correlated with Tsk ($r^2 = 0.67$, $p < 0.05$), Burton's MBT ($r^2 = 0.72$ $p < 0.05$), and the difference between Tc and Tsk (ΔTc-Tsk, $r^2 = 0.61$, $p < 0.05$). When Tsk > 35.7ºC or ΔTc-Tsk ≤ 2.0ºC, TS was rated as hot (≥ 6) and TS was rated as cold (≤ 2) when Tsk < 28.7 and ΔTc-Tsk ≥ 10.4ºC . DISCUSSION This study confirmed that soldiers' feeling hot or cold during work/exercises agrees well with high or low Tsk and Burton's MBT. High weighted Tsk in Burton's MBT was a better predictor than Gagge's MBT. In addition, very hot or cold sensations are associated with ΔTc-Tsk. These findings suggest that when physiological measures are not available, TS can be a useful indicator of thermal strain especially in extreme operational environments. Disclaimer: Authors' views are not official views of US Army/Department of Defense

POSTER SESSION II – LOAD CARRIAGE/INJURY

Biomechanical Effects of Small Shifts in Load Distribution

Presenter: Angela Boynton (USA)

Angela C. Boynton, PhD U.S. Army Research Laboratory Human Research & Engineering Directorate Aberdeen Proving Ground, MD PURPOSE: Dismounted Soldier loads often exceed 45 kg, with a portion of that load hand-carried as weapon weight. While the effects of military load carriage on biomechanics and physical task performance have been studied extensively, less focus has been placed on understanding the effects of how load is distributed, particularly to the hands. Biomechanical changes associated with load carriage can impact Soldier mobility and lethality; therefore, it is important to understand how load distribution impacts those variables. In a previous study, significant increases in metabolic cost, stride frequency, and hip and back muscle activity, along with changes in trunk and pelvis dynamics, occurred when an 8% body mass load was hand-carried rather than evenly distributed on the trunk. However, the impact of hand-carrying a small load in addition to a large trunk-borne load, as would be encountered in military operations, remains unknown. Therefore, the purpose of this study was to evaluate the effects of shifting a small portion of carried load from a rucksack to the hands. METHODS: Twelve subjects with military load carriage experience walked on an instrumented treadmill at a self-selected pace for 7-minutes while carrying a 34 kg load (1) located entirely in a rucksack, or (2) distributed between the rucksack and a dummy M4 (2.7 kg) carried in both hands. Ground reaction force, lower extremity muscle activity, and trunk and leg kinematics were collected during the final minute of walking for each condition. A repeated measures analysis of variance was used to identify statistical differences between load distribution conditions for each variable of interest. RESULTS: Walking speed, step length, step width and step rate were comparable between the two conditions. Distributing part of the carried load to the hands resulted in significant increases in peak propulsive force (5%, $p=0.03$) and peak tibialis anterior activity (15%, $p=0.04$). Although not statistically significant, vertical loading rate ($p=0.15$) and peak ankle plantarflexion angle ($p=0.10$) also tended to be higher when part of the load was hand-carried. The remaining peak ground reaction forces, leg muscle activity, joint angles and trunk dynamics variables were unaffected by the small change in load distribution. CONCLUSION: Shifting a small portion (~8%) of a heavy load to the hands elicited changes in gait dynamics and muscular activity. However, this small shift did not result in the differences in cadence and trunk dynamics observed in the previous load distribution study where the entire load was moved from the trunk to the hands. These results indicate that the magnitude and direction of biomechanical changes may depend on the relative percentage of total load distributed to the hands. Further research is needed to determine the effect of varying the proportion of load carried in the hands relative to the total load. The impact of observed biomechanical changes on Soldier task performance, particularly over prolonged durations of load carriage, should also be investigated.

Quantifying Offloading Capabilities of a Load Distribution System

Presenter: Marina Carboni (USA)

Marina Carboni, K. Blake Mitchell, Karen N. Gregorczyk Natick Soldier Research, Development, & Engineering Center Recently, Load Distribution Systems (LDS) have been developed to redistribute Soldier-borne load from the shoulder region to the pelvis. The impacts of redistributing the load (from shoulders to pelvis) on dismounted Soldier comfort and physical performance have not yet been determined. Prior to assessing the effects of load redistribution, it must be shown that redistributing the load is achievable and measureable. PURPOSE: To identify distinct, quantifiable levels of offloading while standing still, wearing an LDS and a typical dismounted Soldier's fighting load configuration (30.3 kg). METHODS: The Novel Pliance-x32 pressure system was used to measure the distributed pressure across the right and left shoulders and pelvis, using four individual sensor pads. Each sensor pad contained 256 sensor elements with pressure measured at each element (1.8225cm2). For each shoulder and pelvis sensor, the areas of measure were categorized into six regions based on anatomical locations (chest, top of shoulder, scapula, anterior superior iliac spine, posterior superior iliac spine, iliac crest). Seven active duty male, infantry (11B) Soldiers (178±6.6cm, 79.5±11.7 kg, 20.3±2 years) were outfitted with the sensors, fighting load, and LDS (Dynamic Weight Distribution (DWD) by Source Vagabond Systems Ltd). The DWD included a waist belt secured at the hips with an adjustable spine-bar that attached to the torso-borne load via a rigid sheath element. The spine-bar was able to slide up and down within the sheath element with the ability to lock in place, allowing the load to be lifted off the shoulders and transferred to the pelvis via the spine and waist belt. The Soldiers were asked to remain still in a standing posture while pressure data was collected for up to 10 seconds. Various degrees of offloading were assessed in order to identify three levels of offloading (high, medium, low amounts). In addition, an assessment of measurement repeatability between subjects for the DWD disengaged condition (spine-bar height unadjusted) was performed. RESULTS: Based on mean pressure measured at the top of the shoulders, three distinct levels of offloading (24±4%, 53±10%, 79±15%, $p<.05$) were achieved while standing still. If fit of the DWD was optimal based on hip belt size and spine-bar length, then the average maximum offloading achievable increased from 79±15% to 88±9% ($p<.05$). For the three levels of offloading achieved, the pressure on the hips significantly increased compared to the fighting load with no DWD ($p<.05$). Assessment of the measurement repeatability (DWD disengaged) showed no significant differences between subjects ($p<.05$). CONCLUSIONS: Using the mean pressure collected on the shoulders and hips, three distinct levels of offloading with the DWD system were identified; although, it was found that the levels of achievable offloading are highly dependent on an optimal fit of the DWD system components (hip belt and spine-bar). Methodology from this work will be used in a follow-on study that will measure the impact of redistributing the load on comfort and physical performance.

Greater Loading in Warfighters Exhibits Slower Target Identification and Reduced Segmental Coordinative Coupling During a Dynamic Marksmanship Task

Presenter: Scott Ducharme (USA)

Greater loading in warfighters exhibits slower target identification and reduced segmental coordinative coupling during a dynamic marksmanship task Motor Control Laboratory, Department of Kinesiology, University of Massachusetts Amherst Embedded Performance Optimization, Holliston MA Ducharme, S.W., Palmer, C.J., Rosado, L., Busa, M., Lim, J., Simon, D., Amado, A., & Van Emmerik, R.E.A. Load on warfighters such as armor and pack may impact marksmanship performance and the ability to identify and assess visual information from the environment. Warfighters must concurrently process this information while dexterously coordinating whole-body dynamic actions in the face of these task-relevant loads. The purpose of this study was to evaluate how various load configurations impact target identification response times, as well as the coordinative coupling between the head and trunk during a dynamic marksmanship task. Military-trained marksmen ($n = 10$) stepped off a platform onto abutting force plates, and shot twice at a left target, then twice at a right target, or vice versa. Shot direction order was indicated by a randomized Landolt C optotype prompt centrally located between targets. The time course to identify the optotype direction, referred to as time-to-discriminate, was defined as the time from landing on the platform to the moment the head began moving towards the first target. Participants experienced seven different load-varying configurations, including no load. Strength of coordination between the head and trunk during gross movement from the first target to the second was examined through cross-correlation analysis of the axial vector velocity profiles. Maximal cross-correlation values represent the greatest degree of coupling between two time-varying signals, whereby lower values indicate a decoupling between the two signals. Coordination variability between head and trunk segmental motion was examined using vector coding analysis, and provided a measure of kurtosis within movement trials. Lower kurtosis values indicate a higher amount of coordination variability. Analysis of head-trunk maximal correlations revealed an overall main effect of load ($p = .007$). The lowest correlation coefficient was observed in the heaviest load condition. Additionally, kurtosis analysis of the vector coding profiles revealed the highest coordination variability (lowest kurtosis) for the heaviest load condition. Finally, time-to-discriminate analysis displayed an overall main effect of load ($p = .017$), in which the heaviest load condition yielded the longest time-to-discriminate. These findings indicate large load magnitudes led to greater segmental decoupling, as well as greater variability of coordination between the head and trunk. Furthermore, increased load led to a greater time requirement for object identification and, therefore, slower decision-making. A greater amount of decoupling ultimately demands reassembly of segment coupling, which entails an additional time component. These outcomes provide evidence that heavily loading the trunk and head affects coordinative dynamics, and negatively impacts response-time task performance during a marksmanship task.

Running Gait Re-Training in a Soldier Following Femoral Neck Stress Fracture: A Case Study

Presenter: Donald Goss (USA)

Donald Goss, Francis Bisagni, Molly James, Stuart Campbell, Christopher Rabago, Kelly Rodriguez Background and Purpose: Average vertical ground reaction force loading rates (AVLR) > 70 BW/s have been associated with stress fractures and other lower extremity overuse injuries. The purpose of this case study was to demonstrate that a Soldier with a history of femoral neck stress fractures can be trained to reduce AVLR while running. Case Description: An 18 year old female complained of left hip pain during her fourth week in basic combat training (BCT). Bone scan revealed focal uptake at the right intercondylar femur consistent with trabecular stress fracture. Follow up bone scans and hip MRIs were conducted eight weeks later while in advanced individual training (AIT) revealing grade 2 stress fractures of the compressive aspects of bilateral femoral necks. Soldier began a gradual progressive physical therapy program. Approximately 10 months after her initial complaints, the Soldier returned to running over ground without pain. After one month of running over ground, her physical therapists became concerned by her loud audible initial foot contacts that are typically associated with greater AVLR. The Soldier was invited to run 12 trials at her self-selected speed over embedded force plates sampling kinetic data at 1200 Hz in a laboratory setting. Trials were combined to calculate AVLR for each lower extremity. AVLR was defined as the slope of the vertical ground reaction force curve 20-80% of the time to impact peak or 3-12% of the stance time in the absence of an impact peak. Foot strike pattern was classified by observational gait analysis. Step rate was calculated using the formulae step period = step length/velocity and step rate= 1/step period. Initially, the Soldier demonstrated a rearfoot strike pattern with a step rate of 172.5 steps/min and AVLRs of 60.9 +/- 5.1 BW/s left and 74.7 +/- 10.1 BW/s right. Due to concern over her potentially injurious right-sided AVLR of 75 BW/s, the rehabiliation team initiated a gait re-training program. Interventions: The Soldier participated in 8 weeks of body weight supported running three times per week on an Alter-G treadmill progressing from 50-100% BW. Step rate manipulation was matched to a metronome at 180 beats/min and the Soldier was instructed to avoid using a rearfoot strike pattern. Outcomes: At the completion of the Alter G and metronome training, the Soldier was running pain free over ground approximately one year after the initial complaint of pain during BCT. In a follow-up over ground lab data collection session the Soldier demonstrated a non-rearfoot strike pattern at this time with a step rate of 175.8 steps/min and AVLRs of 30.3 +/- 2.3 BW/s left and 34.4 +/- 4.9 BW/s right. Discussion: This Soldier with a history of femoral neck stress fracture demonstrated the ability to reduce AVLR in an effort to prevent future injury. One limitation of this case study is that we did not standardize running speed across trials.

Incidence and Impact of Injuries from Sports, Exercise–Related Activity Among Active Duty Military Personnel

Presenter: Keith Hauret (USA)

Stephen Rossi, MPH; Keith Hauret, MSPH, MPT, and Dr. Bruce Jones, MD, MPH Army Institute of Public Health, Aberdeen Proving Ground, MD 03/28/2014 The 10-week Army basic training (BT) course includes a high volume of weight-bearing activity that increases risk for training-related injuries. These injuries limit the ability to train and increase risk for attrition. The relative risk for women compared to men during BT has ranged from 1.6 to 2.7 times higher for women. Purpose: This study evaluated the association of gender and training-related injury when controlling for physical fitness with a large database. Methods: Demographics, training-related injuries, and performance data on the first 2-mile run test (1st week of BT) were linked and analyzed for 156,114 men and 27,132 women. The 2-mile run time was used as an indicator of physical fitness. Quintiles of 2-mile run time (Q_1 [fastest] –> Q_5 [slowest]) were developed for women and men, combined. Relative risk (RR; w:m) and 95% confidence intervals (CI) were used to compare injury risk of women compared men. Results: Overall, 39.8% of women and 19.5% of men had a training-related injury. The crude RR (w:m) for injury was 2.05 (CI: 2.0-2.1). The overall adjusted Maental-Haenszel RR (w:m) injury when controlling for run time was 1.5 (CI: 1.4-1.5). For men, the percent injured increased in a step-wise manner from Q_1 (14.2%) to Q_5 (30.3%). For women, the graph of percent injured by quintile was a J-shaped curve as the percentage of injured women decreased from Q_1 (33.5) to Q_3 (28.7%), then increased in Q_4 (33.0%) and Q_5 (44.2%). The RR (w:m) of injury was highest for Q_1 (RR: 2.36; CI: 2.1-2.7) and decreased for each successively slower quintile of run time (Q_5 RR: 1.46; CI: 1.4-1.5). Conclusion: This large population study confirmed the findings from previous, but smaller, studies that showed that when men and women with similar run times are compared, the risk for a training-related injury becomes more similar (Crude RR: 2.05; CI: 2.0-2.1 compared to adjust RR: 1.5; CI: 1.4-1.5) for women compared to men.

Changes in Tibial Density and Geometry in Infantry Recruits Following Initial Military Training

Presenter: Rachel Izard (England)

Izard, RM1. Greeves, JP1. Negus, CH2. Sale, C3. Fraser, WD4. 1 HQ Army Recruiting and Training Division, Upavon, UK. 2 L-3 ATI, San Diego, CA, USA 3 Biomedical, Life and Health Sciences Research Centre, Nottingham Trent University, UK. 4 Norwich Medical School, University of East Anglia, UK. INTRODUCTION: Arduous basic military training is associated with increased risk of tibial stress fracture injury, indicating high loading rates at the tibia. High loading rates are also known to provide a potent oesteogenic stimulus. AIM: To monitor changes in tibial bone mass and geometry after 10 weeks of initial military training in male Infantry recruits. METHODS: Ninety recruits (mean ± 1SD, age 21 ± 3 y, height 1.78 ± 0.06 m and body mass 73.95 ± 9.76 kg) undertaking initial Infantry training (Catterick, UK) volunteered to take part. pQCT scans (XCT2000L, Stratec Pforzheim, Germany) were obtained before (Baseline) and after (End) 10 weeks of training. Scans were performed at the 4% (trabecular bone), 38% and 66% (cortical bone) of the tibial length measured from the distal end plate of the tibia. BAMPack software (L-3 Jaycor, San Diego, CA) was used to calculate whole and regional (600 sectors) bone parameters using previously described methods (Evans et al. 2008. MSSE, 40, 11S). Parameters included trabecular density (TbDn), cortical density (CtDn), cortical area (CtAr) and cortical thickness (CtTh). Biomechanical strength indices were also recorded and included the bone strength index (BSI), cross sectional moment of inertia about the anterior – posterior (iAP) and medial – lateral (iML) axes, and the polar moment of inertia (i). Wilcoxon-signed rank tests (SPSS v19.0) were used to analyse data. Statistical significance was set a-priori at $P<0.05$. RESULTS: Significant increases were observed in bone mineralisation (TbDn and CtDn) at all sites and bone geometry (CtAr and CtTh) and bone strength (i and BSI) at the 38 and 66% sites (Table 1). Changes were predominantly observed in the anterior, medial-anterior and anterior-posterior sectors. CONCLUSIONS: Increased mineralisation at the distal tibia and increased cortical area of the tibial shaft reflect the high bending and compressive forces experienced during military training. It is unclear whether the osteogenic benefits of military training are experienced by recruits who sustain stress fracture injuries.

POSTER SESSION II – HORMONAL/METABOLIC/COGNITION

Influence of the Experimental Environment on Physical and Cognitive Performance of Soldiers

Presenter: H. Philip Crowell (USA)

H. Philip Crowell, Ph.D. Kathy L. Kehring Rhoda M. Wilson U.S. Army Research Laboratory Human Research and Engineering Directorate Aberdeen Proving Ground, MD 21005 Purpose As concepts for new communication, navigation, and situational awareness systems are developed for dismounted Soldiers, the interaction of the Soldier with this equipment needs to be evaluated. These evaluations can take place in a variety of experimental environments. Different environments are needed to balance the control that researchers have over the variables in the study with the realism of the task that the subjects are performing. However, before these systems are evaluated in any experimental environment, it is important to understand how the environment influences a Soldier's physical and cognitive performance. The purpose of this study was to evaluate the influence of the experimental environment on physical and cognitive performance of dismounted Soldiers. Methods In this study, different experimental environments were examined: real world environments, virtual representations of the real world environments in the Immersive Environment Simulator (IES), and a laboratory environment. The real world environments included the Ground Vehicle Experimentation Course (GVEC) and a group of warehouses at Aberdeen Proving Ground, MD. The IES consisted of the Omni-Directional Treadmill Upgrade surrounded by a four large screens on which virtual representations of the real world environments were displayed. The laboratory environment consisted of a treadmill in a large room. There was no display system associated with this treadmill. Twelve Soldiers participated in this study. The physical task in this study was walking and the cognitive task was auditory monitoring. First, the Soldiers walked on the treadmill and around the GVEC (real world and IES) at 1.43, 1.56, and 1.70 m/s (3.2, 3.5, 3.8 mph) while oxygen uptake was measured. Then they performed a self-paced navigation around the warehouses in the real world and the IES; oxygen uptake and completion time were measured. Later, the Soldiers performed the auditory monitoring task while walking and in a control condition. Results At 1.56 m/s, oxygen uptake was significantly higher in the laboratory environment than the real world environment. At 1.56 and 1.70 m/s, oxygen uptake in the IES environment was significantly higher than the real world environment. When Soldiers navigated around the warehouses, oxygen uptake was the same for the real world and IES environments; however, completion time was significantly longer in the IES environment. For the auditory monitoring task, the Soldiers were significantly less accurate in the IES environment than the laboratory environment. Conclusions The experimental environment affected oxygen uptake when speed was controlled. However, when the walking task was self-paced, the physical effort required in the real world and IES environments was the same, but the speed was slower in the IES. For the auditory monitoring task, response accuracy was affected by the experimental environment. Soldiers were less accurate in the IES environment than in the laboratory environment. The results of this study can be used to design studies to examine Soldier-equipment interactions.

Gut Microbiome Metabolism of Dietary Polyphenols of In Vitro Studies

Presenter: Kenneth Racicot (USA)

Humans are now recognized as “superorganisms” due to their close symbiotic association with microbiota whose genomes are 104 larger than the host. An intimate relationship between human and microbiota affects drug metabolism, toxicity, and efficacy of the host and contributes to disease etiology. Composition and diversity of intestinal microbes are subject to dietary, environmental, genetic, and physiological factors. While diets and nutrients are well appreciated for their role in disease development and prevention, they can also affect health via microbiota. Dietary flavonoids have poor absorption in the small intestine. Proanthocyanidins (PAC) are oligomeric and polymeric flavan-3-ols that as parent compound, or phase II metabolites, have a reciprocal relationship with gut microbiota. Although the relationship requires full elucidation, current evidence suggests PACs are not only subject to bacterial metabolism to form smaller phenolics, but they also perpetuate changes in microbiota. This reciprocity may in turn mediate some aspects of local gut and overall systemic health. Bacterial polyphenol metabolites have been show to down-regulate inflammatory responses through NF-κB pathways both in vivo and in vitro more effective than the parent compound. The mechanisms for the immune modulation include inhibiting NF-κB activation through diminishing MAP kinase activation, decreasing reactive oxygen species production and inhibiting prostaglandin E2 production. There is evidence to suggest that some polyphenols may bind directly to host cellular toll-like receptor, nucleotide-binding and/or oligomerization domains to initiate innate immune responses. The lower molecular weight phenolic metabolites may also exhibit receptor-mediated or passive translocation and influence inflammatory pathways intracellularly. In conjunction with the Warfighter Directorate (WD), the Combat Feeding Directorate (CFD) has been developing in vitro models to study the mechanisms of polyphenol metabolism in the human large intestine. A DAS-gip™ multi-chamber, automated, parallel anaerobic bioreactor has been established by the WD. The reactors are inoculated with human fecal material, polyphenols added, and growth kinetics monitored via protein content and pH. Changes in short chain fatty acid (SCFA) production are analyzed using GC-FID, bacterial community identification using 16S RNA pyrosequencing, and PAC metabolites analyzed using GC-MS. Increasing the PAC content in the fecal fermentation causes a dose response bacterial growth-promoting effect. Here we will present PAC dosage data to include bacterial community profiling, SCFA production, and PAC metabolite identification and content. Caco-2 human colorectal adenocarcinoma colon cells grown in a Transwell™ format serve as a model of the epithelial cell barrier lining of the intestinal tract. Presented will be the influence of Caco-2 differentiation and polyphenol metabolites on inflammatory and immune responses, and the effect of fecal water toxicity on cell viability. An established in vitro model of the large intestine allows for current and future fundamental research to evaluate the effect of dietary (natural product versus supplement) or pharmacological inputs (antibiotic or NSAID) on growth kinetics and changes in gut bacterial composition.

Neuromuscular Performance and Hormonal Profile in a Two-Week Military Training Period in Garrison and Field Conditions

Presenter: Mika Salonen (Finland)

Salonen M1, Huovinen J2, Vaara J1,2, Piirainen J2 and Kyröläinen H1,2 1Department of Leadership and Military Pedagogy, National Defense University, Helsinki, Finland 2Department of Biology of Physical Activity, University of Jyväskylä, Finland Military training loads may differ between garrison and field conditions. Therefore, this study aimed to investigate the training load of conscripts during both garrison and field service and to evaluate recovery during 3 days after training. Methods: 20 young (20±1 yrs.), fit (12 min running test: 2980±267 m) conscripts participated in the study, which consisted of 4 days of garrison training (days 1-4) and 7 days of military field training (days 5-12) followed by a 3 day recovery period (days 13-15). Body composition and serum hormone concentrations [testosterone (TES), cortisol (COR), sex-hormone binding globulin (SHBG)] were assessed at day 1 (D1), day 5 (D5), day 8 (D8), day 12 (D12) and day 15 (D15). Maximal isometric force and EMG of the knee extensors and arm flexors were measured in 10 participants at D5, D12 and D15. Results: Body mass decreased ($p<0.001$) at D8 and D12 compared to D1 (D1: 76.0±7.1; D8: 74.1±6.7; D12: 73.1±6.4) and fat mass at D5, D8 and D12 compared to D1 ($p<0.001$). During military field training, maximum force of the arm flexors increased at D12 and D15 compared to D5 ($p<0.05$) (D5: 343±51; D12: 354±52; D15: 351±50 N), while no changes ($p=0.063$) in the respective force of the knee extensors were observed. EMG of the biceps brachii muscle increased between D5 and D12 ($p<0.001$) (D5: 567±230; D12: 647±330 µVs), while EMG of the rectus femoris muscle decreased ($p<0.05$) between D5 and D12 (D5: 169±55, D12: 161±45 µVs). Rate of force development (RFD) of the knee extensors decreased ($p<0.05$) at D12 and D15 compared to D5 (D5: 383±130, D12: 321±120, D15: 328±120 N/s) but no respective changes occurred in the elbow flexors. RFD did not fully recover to baseline levels during the 3 day recovery period. TES decreased ($p<0.05$-0.001) throughout the training period but recovered during the recovery period (D1: 18.2±3.9, D5: 16.2±4.0, D8: 10.2±3.6, D12: 7.0±4.1, D15: 19.9±5.3 nmol/l), while SHBG increased by 24% from D1 to D12. COR decreased ($p<0.05$) between D8 and D12 (D8: 583 ± 146 nmol/l; D12: 388 ± 109 nmol/l). Discussion: The present findings demonstrate that changes in maximal force production differ between the arm flexors and knee extensors. The respective changes in EMG values suggest that after training, the conscripts were able to recruit more motor units and/or their firing frequency increased in the arm flexors. The decreasing trend in the knee extensors together with a reduction in the respective EMG values suggest, however, a fatiguing phenomenon due to strenuous military training, short sleeping hours and energy deficit. This is confirmed by the drastic changes in serum hormone responses. In conclusion, although the conscripts were overloaded during the training period, three days were enough to recover neuromuscular performance and serum hormone concentrations.

Vascular Response to 1 Week Sleep Restriction. A Metabolic Response

Presenter: Fabien Sauvet (France)

Fabien SAUVET (1,2), Clément BOUGARD (1,2), Pierrick ARNAL(1,2,3), Garance DISPERSYN (1,2), Catherine DROGOU (1,2), Pascal VAN BEERS (1,2), Mathias GUILLARD (1,2), Cyprien BOURRIHLON (1,2), Arnaud RABAT (1,2), Damien LEGER (2, 4), Mounir CHENNAOUI1,2 1. Armed Forces Biomedical Research Institute (IRBA), Brétigny-sur-Orge, France 2. VIFASOM team (EA U 07), Descartes University, Hôtel Dieu, Paris 3. Saint Etienne University, France 4. Centre du sommeil et de la vigilance, Hotel Dieu, Paris ABSTRACT Study objectives: Sleep loss is suspected to induce endothelial dysfunction, a key factor in cardiovascular risk. We examined whether one week sleep restriction (SR) involves to endothelial dysfunction and liked with inflammatory and endocrinal response. Design: 12 healthy men (29.5 ± 4.8 yr) followed during baseline (B, 8 hours of sleep), 1 (SR1) and 7 (SR6) days of sleep restriction (4 h sleep : 23:00 – 4:00) and after 1 (R1) and 12 (R12) recovery sleep nigts (8h sleep/day). Interventions: changes in cutaneous vascular conductance (CVC) induced by local application of methacholine (MCh), cathodal current (CIV) and heat (44°C) at 10:00 and 16:00. Finger CVC and skin temperature (Tfi) were also studied during local cold exposure (5°C, 20 min) and passive recovery (22°C min). Measurements and results: compared with B1, MCh and Heat CVC changes were decreased in SR6 (10:00 and 16:00) and R1 (at 10:00). No effect of SR was observed in Tfi and CVC during immersion whereas values were lesser during recovery in SR6 (10:00 and 16:00) and R1 (at 10:00). These changes were associated with an increase of weight (0.8 Kg at SR6), insuline, IGF-1, free IGF-1 and MCP-1 plasma levels (at 10:00) and lower ACTH plasma level. From SR2 to R13, TNF-alpha and IL-1beta blood mRNA levels were higher than in B1 at 10:00. Compared to B1, cortisol salivary levels were lower at 07:00 from SR2 to R13 and higher at 21:00 from SR2 to SR6. No effect of SR on heart rate, blood pressure, cathecholamines levels, body temperature (Tco), mean skin temperature, IL-6, TNF-□, and Il-8 plasma levels were observed. Conclusion: These results demonstrate that SR induces a reduction in endothelial-dependant vasodilatation and local tolerance to cold. This endothelial dysfunction is independent of blood pressure and sympathetic activity but associated with a cortisol, inflammation and glucose metabolism responses.

Sound-Related Emotions and Self-Management Methods During Emergencies

Presenter: Jukka Seppänen (Finland)

Jukka Seppänen, Army Academy, Finnish Defence Forces, Finland PURPOSE: The role of emotions, provoked e.g. by unfamiliar sounds during emergencies, was studied by analyzing narratives written by maritime and aviation professionals who were asked to describe what kind of sounds they have heard in vessels and aircrafts in real situations and how those sounds have affected their emotions. They were also asked what kind of self-management methods they have used to maintain mental performance. In addition to that, participants of the Helicopter Underwater Escape Training course in Meriturva were interviewed to find out what kind of emotions and thoughts they underwent and what kind of methods they used to maintain performance when escaping from a sunken and inverted helicopter-simulator. METHODS: The narrative content of eight responses, received in an internet inquiry, was analyzed using the five-step Awareness Wheel model (sensory observations, feelings, thoughts, wants, actions). In total, 22 independent storie-wheels were found: Four of the wheels included all steps while others consisted of from two to four steps. All eleven interviews by professional aviators and paramedics were analyzed using SHELL-model, which is widely used as an accident analysis tool but can also be used as a framework to clarify human performance needs, capabilities and limitations and to help organizations to improve training. RESULTS: The respondents described the auditory observations and feelings they provoke as familiar, harmless, sudden, disturbing, question provoking, worrisome, mind oppressing, startling, frightening and dangerous. The respondents used self-management methods such as using common sense, keeping calm, isolating feelings from conscious thinking, relying on experience when estimating seriousness, keeping a poker face (all these found in thoughts and wants) and assembling, using manuals, acting as a good example and according to the protocol (in actions). All the interviewees mentioned many personal qualities (Livewear, human in the focus) needed in the exercise: physical fitness, breath-holding ability, concentration, calmness, analytical thinking, positive releasing, foreseeing, using mental images and thumb rules. Some noxious things, thoughts and feelings like disorientation, loosing situational awareness, uncomfortability, stress, fear, panic, need to hurry-up, urge to breathe or rush to the surface, were also mentioned. The most important relationship between SHELL-components was Software-Liveware-interface. Procedural information given during the training was seen as crucial to control the unfamiliar situation and repetitions to correct timing and overstudying. Also the Hardware-Liveware-interface, like using scuba-masks in the pool or the lack of drysuits when flying inland, and Environment-Liveware-interface, like water in the nose/mount/pharynx or coldness and darkness in real situations, were pondered. The Liveware-Liveware-interface was the weakest relationship: Under underwater conditions and time pressure it's hard to observe what others are doing. CONCLUSION: Sounds have an essential role in correct understanding of emergency situations, but they can also have a negative effect when provoking fear or other unwanted emotions. Psychological self-management methods used by professionals were found to be rich. Because of the answers concentrated in the Liveware (focus), emergency and escape training could be improved including solution-based mental methods in the education.

Using Oculomotoric Parameters to Determine Task Demands in Ideal Type Military Tasks

Presenter: Alexander Sievert (Germany)

Sievert, Alexander(1), Gorges, Willi(2), Witzki, Alexander(2), Leyk, Dieter(2,1) Institution: (1) German Sport University Cologne - Department of Physiology and Anatomy (2) Central Institute of the Bundeswehr Medical Service Koblenz - Department IV Military Ergonomics and Exercise Physiology Objective and reliable information about specific cognitive demands in ecologically valid tasks is largely unavailable. This is of concern for many information processing tasks introduced into the military by the modern integrated battlefield. However, such data are necessary to define adequate levels of performance and the identification of critical changes. Eye movements are tightly related to visual information uptake and the focus of attention. This direct link to cognition exists also for non-visual tasks. Thus, oculomotoric measures present an ideal approach for the assessment of cognitive demands in the workplace. Purpose: To obtain an initial insight into differences in cognitive demands of military workplaces, two ideal type workplace simulations were designed and subsequently analyzed using eye movement derived metrics. Methods: The simulations [1] were ideal type, multi monitor workplaces designed to represent (a) the low complexity, vigilance oriented spectrum of military tasks (Simulation of Low Complexity Workplaces -SILCO) and (b) high complexity workplaces with multiple concurrent tasks and temporal constraints (Simulation of High Complexity Workplaces - SIHCO). Eye movements were recorded during 30 minute bouts of simulated work in SILCO and SIHCO workplaces using a infrared based remote eye tracking system. Initial data analyses were done for main monitor data only to focus on primary task performance. Analyzed oculomotor parameters were fixations, saccades, and blinks. Results: 54 and 57 male soldiers were tested for the SIHCO / SILCO workplaces respectively. Number of saccades did not differ (0.5%) while average saccade durations in SILCO were 48% lower, average saccade speed and distance were 25% and 28% higher respectively. Saccade frequency was 40% higher in SIHCO. Also, number of fixations was 30% lower and average fixation duration was 25% shorter. Fixation frequency did not differ significantly. Total number of lid closures was 72% lower in SILCO while average lid closure time did not differ (0.3%). Conclusions: Oculomotor parameters showed marked differences between simulations and conclusive patterns varying with visual and cognitive complexity. Differences in saccade based parameters can be interpreted to primarily reflect visual complexity, however longer saccade durations and reduced saccade speed may also hint at increased cognitive workload in SIHCO. Mean fixation durations and blink rates also correspond to differing cognitive demands. The combined synopsis of multiple oculomotoric measures can be used to determine task specific patterns of visual and cognitive demands in two ideal type military workplaces. [1] A more detailed description of the two simulations is presented by Witzki et al: Simulating ideal type workplaces to determine military specific cognitive demands

The Relationship of Intolerance of Uncertainty and Ambiguity to the Preservation of Working Memory Capacity

Presenter: Jason Spitaletta (USA)

Maj Jason A. Spitaletta, USMCR and Marc M. Sebrechts, PhD (The Catholic University of America) Purpose Uncertainty is a fundamental characteristic of warfare (Boyd, 1976) and thus combat decision-making, the principal human factor in warfare, (Krulak, 1999) is based on incomplete, inaccurate, and/or contradictory information (HQMC, 1997). Working memory capacity (WMC) is a key to such decision-making, and depletion of that capacity has been found in a military cohort undergoing predeployment training (Jha et al., 2010; Stanley & Jha, 2009). However, the specific roles of uncertainty and/or ambiguity and their relationship to WMC under ambiguity has not yet been investigated. Previous research found that while IU was not significantly correlated with WMC, it was related to preserving WMC when processing ambiguous stimuli (Spitaletta, 2012). The purpose of these studies was to examine the relationship between intolerance of uncertainty and intolerance of ambiguity and the preservation of working memory capacity (WMC), as well as the longitudinal stability of that relationship. Methods Experiment 1 involved active duty US Army soldiers assigned to the 10th Mountain Division in Fort Drum, NY. Participants completed an initial (T1) set of self-report assessments and cognitive tests including personality (BFI), ambiguity tolerance (MAT-50), the intolerance of uncertainty scale (IUS), the Operation Span (OSpan and a variant of the OSpan that uses ambiguous stimuli along with traditional (normal) letters (OSpan-A). Participants were then reassessed eight-weeks later (T2). Experiment 2 involved a cohort of undergraduate students at Catholic University (CUA), following the same procedures, but with a follow-up ranging from four to six weeks. Results For the military cohort, neuroticism was a better predictor of working memory capacity preservation than either intolerance of ambiguity (IA) or uncertainty (IU); those with higher neuroticism scores showed greater decline in OSpan from T1 to T2. IA was a reliable predictor of WMC preservation in the undergraduate cohort; those more tolerant of ambiguity showed a smaller decline in OSpan from T1 to T2. IA was a reliable predictor of preservation of ambiguous stimuli recall from T1 to T2 in the undergraduate cohort with those more tolerant of ambiguity showing less decline in OSpan score from T1 to T2. Recall for ambiguous stimuli at T1 was related to change in normal stimuli recall at T1 for the military cohort; individuals with higher recall for ambiguous stimuli showed smaller differences in normal stimuli recall between the OSpan and OSpan-A. Conclusions The introduction of ambiguous stimuli to the OSpan (OSpan-A) was designed to place an increased demand on working memory and this was supported by our findings. Additionally, we hypothesized that there would be a differential effect on performance based on intolerance of uncertainty and ambiguity, with more intolerant individuals showing a greater decrease in performance. The results, while encouraging, require additional replication with a larger military cohort to more accurately assess the role of IA and IU in WMC preservation as well as the predictive validity of the OSpan-A.

Simulating Ideal Type Workplaces to Determine Military Specific Cognitive Demands

Presenter: Alexander Witzki (Germany)

Alexander Witzki(1), Alexander Sievert(2), Willi Gorges(1), Dieter Leyk(1,2) (1) Central Institute of the Bundeswehr Medical Service Koblenz - Department IV Military Ergonomics and Exercise Physiology (2) German Sport University Cologne - Department of Physiology and Anatomy
The integrated battlefield has introduced new and frequently high cognitive demands into all echelons of today's military. Tasks range from video surveillance and maintenance of situational reports to drone operation and command and control. Sustained cognitive performance is essential and lapses or gradual shifts may entail dire consequences. To date, task specific, evidence based definitions of adequate levels of performance are mostly unavailable due to the sheer number and range of tasks. A "job by job" approach to obtain task specific data on demands is not feasible. However, polarization of tasks according to their complexity from low (high focus on vigilance) to high (multiple tasks and temporal constrains) combined with idealized workplaces could prove a viable option to gain important task related insights. Purpose: To that end, two ideal type workplace simulations (SILCO = low complexity, SIHCO = high complexity) were developed and tested for cognitive demands. Methods: Both simulations were implemented in an enhanced version of an existing test environment (KaSimiR), featuring centralized data collection under customizable, controlled conditions. Workplace layout, selection and implementation of sub-tasks were based on on-site analyses, subject matter expert interviews, and literature reviews on workplace design / demands. Subtasks were selected to (1) represent multimodal profiles of demand, (2) closely mirror military tasks, and (3) reflect a wide range of actual jobs. Successful implementation of workplace designs with regards to differing mental demands was validated on the basis of subjective ratings (NASA-Task-Load-Index and scaled ratings of mental demands and task difficulty) after 30 minutes of simulated work. Results: In a between subject design 90 subjects rated the simulations as lifelike, credible, military specific and –relevant. NASA-Task-Load-Index measures showed significantly higher ratings in the high complex simulation (SIHCO) for mental demands, temporal demands, and effort. SIHCO was also consistently rated higher in overall demands and task difficulty. Conclusions: Results show that the design, implementation and integration of the ideal type workplace simulations were successful. Both simulations represent the intended demand situations, feature appropriate profiles of complexity and difficulties, and show high face validity. SIHCO and SILCO can serve as a solid foundation for a multitude of research scenarios to determine influences on cognitive demands and performance in military settings. The successful integration into the KaSimiR test environment enables further, in depth analysis options: Physiological parameters i.e. heart-rate and/ or oculomotor parameters as well as subjective measures can be added and synchronized to simulation specific performance data. This allows for a multi-method assessment of human cognitive performance. In a next step, a more detailed analysis of recorded eye-movement data will reveal further insights into workplace and task demands [1]. [1] Preliminary results are presented by Sievert et al: Using oculomotoric parameters to determine task demands in ideal type military tasks.

THEMATIC FREE COMMUNICATIONS/POSTERS – INJURY, PERFORMANCE AND ASSESSMENTS

Comparison of Abdominal Fat and Cardiorespiratory Fitness in US Air Force Personnel

Presenter: Neal Baumgartner (USA)

Neal Baumgartner, Matthew F. Gruse, Jessica A. Neff, Alaina D. Dooley, Kimberly N. Hale INSTITUTIONS: USAF Fitness Testing and Standards Unit, and AETC Studies and Analysis Squadron, Randolph Air Force Base, TX. INTRODUCTION: The US Air Force (AF) is the only military service to employ abdominal circumference (AC) as the official measurement methodology for the body composition component of physical fitness. Therefore, the AF can compare abdominal fat to cardiorespiratory endurance (official measure 1.5 mile run) in large population samples which is of import since research data clearly show that cardiorespiratory fitness mitigates elevated health risk associated with increases in abdominal fat independent of body mass or total adiposity. PURPOSE: We retrospectively reviewed the relationship between abdominal fat (AC measurement) and cardiorespiratory endurance (1.5 mile run time) in cohorts of AF males and females. METHODS: Official fitness assessment data collected in 2013 on a cohort of AF males (n = 85,203) and data collected from 2010 - 2013 on a cohort of AF females (n = 65,259) were pulled from the AF Fitness Management System Database and analyzed. AC was taken horizontally at the superior border of the iliac crest - midaxillary line landmark on a standing subject at the end of a normal expiration. Maximal oxygen consumption was estimated from 1.5 mile run time, test conducted after the AC measurement. Data were analyzed using JMP 10.0. RESULTS: Bivariate, cross-sectional analysis showed a significant and consistent relationship between AC and run time ($r = .42$, $p < .0001$ for all males), i.e., run time increased as AC increased across a full range of measures. Individuals with moderate AC risk (males: 35.5 inches - 39 inches, females: 32.0 inches - 35.5 inches) showed a significant but lesser relationship between AC and run time ($r = .21$, $p < .0001$ for males and $r = .18$, $p < .0001$ for females). More specifically, for moderate risk AC values, run time increased on average 16 seconds per inch increase in AC for males and 19 seconds per inch increase in AC for females. CONCLUSIONS: For large cohorts of AF males and females a significant correlation exists between AC and 1.5 mile run time; as abdominal fat increases, cardiorespiratory fitness declines. This has important implications for military personnel fitness and health, fitness policy, and fitness training programs.

Factors Associated with Male Obesity: A Case-Control Study of Young Adult Males

Presenter: Noreffendy Bin Ali (Singapore)

Haiyuan Shi, MB.BS (Singapore) Bo Jiang, B.Soc.Sc (Singapore); M.Soc.Sc (Singapore) Joshua Dao Wei Sim, B.Sc (Australia) Zhi Zhen Chum, B.Eng Noreffendy Bin Ali, MB.BS (Singapore); M.Sc (UK) Mun Heng Toh, B.A; B.Soc.Sc; M.Soc.Sc; PhD, Econ (Singapore) Purpose: A case-control study among Singapore Armed Forces' newly enlisted Servicemen was conducted to examine factors associated with male obesity. Materials and Methods: 459 individuals from the Obese Basic Military Training (BMT) program were selected as "cases" (average age 19.5, BMI 30.4) and another 340 individuals were selected from the Normal BMT program as "controls" (average age 19.3, BMI 21.4). Information such as family background, socioeconomic factors and lifestyle practices were captured using facilitator-led questionnaires. Results: Several variables were significantly associated with obesity after adjustments for possible confounders. These include childhood obesity (OR=2.06), less than an hour of exercise per day (OR=2.97), Indian ethnicity (OR=2.22), specific education backgrounds (especially that of ITE - OR=2.75), father's employment at non-managerial/professional jobs (OR=1.52), mother's employment at managerial/professional jobs (OR=2.02), regular smoking (OR=1.73) and alcohol consumption (OR=2.26), six hours or less of sleep (OR=3.73), obesity among family members (OR=1.86 for mother; OR=2.98 for siblings), parental history of diabetes mellitus (OR=2.22 for father; OR=2.70 for mother), consumption of low-fat milk (OR=1.46) and eating at inexpensive local food stalls (OR=1.82). Conclusion: Our study found that a number of factors, ranging from personal and family backgrounds to lifestyle choices, were significantly associated with obesity among male youths.

A Systematic Review on the Association Between Performance of Military Tasks and Injuries in Military Populations

Presenter: Elizabeth Clearfield (USA)

Elizabeth Clearfield, Keith G. Hauret, Bruce H. Jones Injury Prevention Program, United States Army Institute of Public Health Background: The Baseline Physical Readiness Requirements Study is an investigation of physically demanding performance tasks that all Soldiers are expected to perform, with a goal of recommending a battery of fitness tests associated with the ability to perform these tasks. Purpose: Injury is a major problem in the Army; in order to understand the potential injury risks of implementing a new fitness test it is important to determine the relationship between performance of common military tasks and injury. We hypothesized that the more physically demanding a task, the higher the risk of injury. This was a systematic review of the literature on military populations that examined the relationship between performance of work-related tasks and musculoskeletal injury. Methods: Systematic literature searches were conducted using electronic databases and hand searches of grey literature, non-published works, and references in identified studies. Included studies investigated musculoskeletal injuries associated with performance of occupational tasks in military populations. Tasks of interest were grouped by similarity of movements (kneeling/crouching), complementary motions (pushing/pulling) or because they are often performed in sequence (lifting/carrying). Studies were given a quality score based on pre-set criteria. Results: A total of nine studies were identified: five on lifting/carrying tasks, one examining pushing/pulling and kneeling tasks, and three which did not examine tasks but grouped participants by physical demands in military occupational specialties (MOSs). For lifting tasks, lifting on three days per week compared to "never" had the highest risk ratio in two studies. Other risk factors identified were lifting to chest height (compared to lower heights) and lifting heavier weights (>36.4kg compared to 9.1-22.7kg). In one study, female Soldiers performing pushing/pulling tasks had greater odds of knee-related disability than female Soldiers who did not do pushing/pulling tasks (<130lbs, odds ratio [OR]=1.05 and ≥130lbs, OR=1.11; 95% confidence intervals not provided). In the same study, there were also slightly higher odds of knee-related disability in women who performed kneeling tasks while shoveling/lifting and filing (OR=1.03 and OR=1.16, respectively). In studies examining the physical demand ratings of MOSs, Soldiers in MOSs with moderate and heavy physical job demands had slightly higher odds of musculoskeletal injury hospitalization (OR=1.09, 95% CI=1.00-1.18 and OR=1.07, 95% CI=0.99-1.16, respectively) compared to Soldiers in MOSs in light physical demand MOSs. Another study showed no association between physical demand MOSs and time to an injury-related disability for male Soldiers. Conclusion: There is a sparsity of high quality studies on the association between injury and military-relevant performance tasks. Interpretation of risk factors is limited because the studies did not use standardized definitions for tasks, intensity, or frequency of task performance, and most did not specify types of injury. Multiple factors related to lifting tasks were found to increase the injury risk, including the amount of weight being lifted, frequency of lifting, and height to which the object is lifted.

How Important is Initial Employment Training in the Development of Physical Performance?

Presenter: Herbert Groeller (Australia)

Herbert Groeller1, Denise M. Linnane2, Simon D. Burley1, Peter Orchard1, John A. Sampson1, Greg L.Castairs2, Daniel C. Billing2 and Jace R. Drain2 . 1 Centre for Human and Applied Physiology, School of Medicine, University of Wollongong, Australia. 2Land Division, Defence Science and Technology Organisation, Australia Initial employment specific training for many soldiers is the final preparatory step prior to posting to their operational units. As a consequence, employment specific training regimen has a critical role to ensure the physical preparedness of soldiers to meet the occupational demands of their specialised roles. However, there is limited evidence on the influence of this training in developing the physical attributes necessary for military duty. Given the impact of basic military training upon recruit physical performance is well described, this investigation determined the relative contribution of initial employment category training for developing physical capability in soldiers. Fifty one soldiers (45M, 6F) were assessed at four time points; commencement of training (Wk1), mid-way (Wk8) and at the conclusion (Wk12) of basic military training, and upon completion of the initial employment category regimen (Wk18-27). At each time point, tasks relevant to military duties; lifting strength (1RM box lift), local muscle endurance (jerry can carry) and cardiovascular endurance (3.2 km-22 kg load carriage) or, pre-existing generic assessments of military fitness; estimated maximal oxygen consumption (20 m shuttle run), upper-body (2-min push-ups) and trunk (2-min sit-ups) endurance were assessed. In addition a sub-sample of recruits (n = 12) were selected and assessed for upper-body strength (1RM bench press), leg power (vertical jump), 30-sec high-intensity work capacity (cycle ergometer) and peak oxygen consumption (treadmill). Herein, data for Wk12 and Wk18-27 are reported as mean ± 95% confidence intervals, statistical significance set at P<0.05. A significant decline in cardiovascular endurance (Wk12, 1109 ±37; Wk18-27, 1161 ±51 s), local muscle endurance (Wk12, 753 ±72.2; Wk18-27, 683 ±77.8 m) and upper-body strength (Wk12, 83.3 ±16.0; Wk18-27, 73.2 ±16.6 kg) was observed during the initial employment training phase. Furthermore, no significant change between Wk12 and Wk18-27 of training was detected in lift strength, leg power, 30-sec high intensity work capacity, trunk endurance, estimated and peak oxygen consumption. In contrast, upper-body endurance (Wk12, 46.7 ±2.7; Wk18-27, 57.5 ±3.1) performance significantly increased. Despite up to 15 weeks of additional employment specific military training, soldiers did not make further physical performance gains in strength, power, endurance or function prior to posting to their units. Given this decline in physical preparedness, our results clearly show that the preceding 12-week basic military training regimen is a critical period for physical adaptation to occur. Furthermore, the findings of this investigation strongly support further examination of the physical training stimulus used during the initial employment category regimen.

The Relationship Between Stretcher Carry Performance and Decline in Physical Capacity Assessments

Presenter: Kane Middleton (Australia)

Benjamin Beck*, Greg L. Carstairs*, Joanne N. Caldwell*-, Tim L.A. Doyle* and Kane J. Middleton*- *Land Division, Defence Science and Technology Organisation, Melbourne, Australia -Centre for Human and Applied Physiology, University of Wollongong, Australia Corresponding author: benjamin.beck2@dsto.defence.gov.au Purpose: Carrying a casualty on a stretcher is a critical task for military personnel. Muscular strength and endurance are important physical capacities in the execution of this task, however the extent to which they contribute to carry performance is not well understood. Thus, the aim of this study was to investigate the association between three physical capacity tests (using pre and post measures) and maximal stretcher carry distance. Methods: 53 male and 17 female soldiers conducted a four-person 90.4 kg stretcher carry. Participants completed the task to a cadence, where they performed the carry over 25 m in 20 s, rested for 5 s and repeated until volitional fatigue. Prior to (pre-test) and immediately following (post-test) the stretcher carry, participants completed one of three tests of physical capacity: isometric hand grip recorded over 15 s, back/leg isometric strength and vertical jump. Values for grip endurance represent the mean of the 15 s test for the right hand. Anthropometric measures were: stature, body mass and estimated forearm bone-plus-muscle cross-sectional area. Participant scores for carry distance were segregated into terciles and are reported as lower (low performers) and upper (high performers). A mixed design ANOVA was conducted to compare pre and post-test measures of low and high performers (between-groups) and pre and post-test measures within each group (within-subjects). Independent sample t-tests were used to compare anthropometric measures between terciles. Significance was set at an alpha level of 0.05. Results: Body mass ($t(67) = -2.969$, $p<0.05$), stature ($t(67) = -4.452$, $p<0.001$) and forearm bone-plus-muscle cross-sectional area ($t(64) = -6.635$, $p<0.001$) were significantly greater in high performers when compared with low performers. Post carry measures declined significantly relative to pre carry measures for the physical capacity tests of grip endurance ($F(1,21) = 11.617$, $p<0.05$) and back/leg isometric strength ($F(1,23) = 48.576$, $p<0.001$), while increasing significantly for leg power ($F(1,13) = 5.951$, $p<0.05$). The main effect between low and high performers was significant for leg power ($F(1,13) = 9.219$, $p<0.05$) and back/leg isometric strength ($F(1,23) = 13.493$, $p<0.05$), indicating that high performers had greater capacity in these areas. The interaction was not significant, indicating the change in pre and post carry measures does not depend on tercile. Conclusions: The results of this study indicate that greater body mass, stature, forearm bone-plus-muscle cross-sectional area, leg power and back/leg isometric strength were associated with increased stretcher carry distance. Regardless of carry distance, there were similar absolute changes in post carry measures. This indicates that increased muscular strength and endurance capacity will enable improved stretcher carry performance, but does not impact upon decrement post a stretcher carry. The outcomes of this study can be used to inform soldier physical conditioning to improve stretcher carry performance.

Lumbar Loads in Standing and Seated Postures During Common Military Lifting Tasks

Presenter: Kane Middleton (Australia)

Kane J. Middleton*-, Greg L. Carstairs- and Daniel J. Ham- *Centre for Human and Applied Physiology, University of Wollongong, Wollongong, Australia -Defence Science and Technology Organisation, Melbourne, Australia Many military occupations involve lifting while having to adopt potentially compromising postures. Many lifting tasks inside land vehicles, rotary/fixed wing aircraft and naval vessels are performed in confined spaces while adopting a seated posture. Purpose: To compare lumbar loading during a common military lifting task in standing and seated postures. Methods: Five male soldiers (age 21.0 ± 2.8 years; height 178.6 ± 5.1 cm; mass 85.5 ± 4.1 kg) performed a 40 kg box lift to 1.5 m (standing) and 1.08 m (seated). From measures of segment kinematics and kinetic hand loads, lumbar compression and shear forces were estimated. These data were analysed using paired t-tests. Significance was set at an alpha level of 0.05. Results: Although no difference in compression force between postures was found, a significantly higher anterior shear force was found in the standing lift. Interestingly, the coefficients of variation of the standing lift were larger than that of the seated lift (Table 1). In addition, trunk flexion angle (Standing: 64.8 ± 16.31°, Seated: 52.4 ± 1.82°) and moment arm (Standing: 0.5 ± 0.06 m, Seated: 0.4 ± 0.01 m) were significantly higher in the standing lift. Table 1 Lumbar force and associated kinematic and force coefficients of variation for the standing and seated lift postures. Values are means (±sd) where applicable. *Significantly different to standing lift Standing Seated Force (N) Compression 5566.2 (627.83) 5584.0 (15.98) Shear 519.4 (104.37) 224.2 (9.36)* Coefficient of Variation (%) Compression Force 11 3 Shear Force 20 4 Trunk Flexion 25 3 Moment Arm 12 2 Conclusions: An increasingly stooped posture and large moment arm contribute to the significantly higher anterior shear forces observed during the standing lift when compared with the seated lift. Thus, the adoption of a more upright lifting posture where the external mass is held close to the body may lead to a significant reduction in shear force compared with lifting postures associated with increased trunk flexion. The larger coefficients of variation in the standing lift suggest that each participant adopted quite a different posture at the initiation of the lift. This postural variation is commensurate with recommendations that lifters should be educated to find their individually appropriate lifting posture and pattern of movement. The low variability in the seated lift suggests that participants used fewer degrees of freedom with respect to the number of joints used in the seated posture, possibly not allowing them to adopt a posture that is appropriate for each individual. When compared with a standing lift and for an equivalent moment arm, the compression force experienced during seated lifting tasks may be higher, placing personnel at a greater risk of back pain/injury. This has clear implications for task design/guidelines when in confined spaces and a seated posture must be adopted.

Thermal Impact of US Army Body Armor Protection Levels (BAPL)

Presenter: Adam Potter (USA)

Thermal impact of US Army body armor protection levels (BAPL) Adam W. Potter, Anthony J. Karis, and Julio A. Gonzalez U.S. Army Research Institute of Environmental Medicine, Natick, MA USA 01760 Introduction: Dismounted military are often engaged in high intensity and dangerous work activities while deployed in harsh environments. In order to defend against the elements, enemies, and environment, soldiers wear protective clothing and individual equipment (CIE), to include ballistic protection in the form of hard (e.g., ceramic plates) and soft (e.g., Kevlar®) armor materials. The present study quantified the biophysical characteristics of various US Army body armor protection levels (BAPL), and used mathematical models to predict the thermal impact on soldiers. The US Army BAPL levels range from 0 (no armor) to 5+ where full soft armor, and front, back, and side plates are worn. Methods: Each BAPL was tested on a sweating thermal manikin in a controlled climate chamber to determine total thermal insulation (clo), vapor permeability (im), and evaporative potential (im/clo). Each configuration was tested to ASTM standards F1291-10 and F2370-10 to determine stationary (0.4 m/s-1 wind speed (ws)) values and then tested at wind speeds 1.2 and 2.0 m/s-1 to establish a modeling curve. The measured values were then used to mathematically predict maximal work times at different work intensities (150W, 250W, and 425W) under desert (48.89°C, 20% RH, 1 m/s-1 ws), jungle (35°C, 75% RH, 1 m/s-1 ws), and temperate (35°C, 50% RH, 1 m/s-1 ws) environments, each in no sun and full sun conditions. Results: Compared to no armor (BAPL0), thermal resistance (clo) increased evaporative potential (im/clo) decreased with increases in body armor protection level (BAPL1: 3.0%, BAPL2: 3.2%, BAPL3: 3.3%, BAPL4: 3.4%, BAPL5: 3.6%, BAPL5+: 4.0%). Predicted maximal work times, in no sun conditions, indicated that in desert, jungle, and temperate conditions at 150W, and temperate conditions at 250W, individuals could work for 300+ min for all BAPL; jungle conditions at 250W, the maximal work ranged from 300+ min at BAPL0 to 120 min at BAPL5+; desert conditions at 250W, maximal work times ranged from 139 min at BAPL0 to 83 min at BAPL5+; while at 425W predicted maximal work times ranged from 42 - 50 min, regardless of BAPL. In full sun conditions, predicted maximal work times in temperate conditions 150W were 300+ min for each configuration; jungle conditions at 150W, maximal work times ranged from 300+ min to 162 min; desert conditions at 150W maximal work times ranged from 184 min to 110 min; temperate conditions at 250W, maximal work time ranged from 148 min to 89 min; while in jungle and desert 250W and all conditions at 425W maximal work ranged from 36 - 73 min. Conclusion: Biophysical assessments and predictive modeling show a quantifiable relationship exists between increased protection, increased thermal burden, and decreased work capacity.

Physical Impairment Effects on Marksmanship, Grenade Throwing and Weapon Loading

Presenter: Jennifer Swoboda (USA)

Jennifer C. Swoboda William H. Harper Frank Morelli Patrick W. Wiley U.S. Army Research Laboratory Human Research and Engineering Directorate Aberdeen Proving Ground, MD 21005 ABSTRACT Purpose We conducted two studies to examine the simulated effects of physical impairment on various mission-related tasks, specifically marksmanship, grenade throwing and weapon loading. The purpose of the first study was to characterize live-fire shooting performance during varied conditions of simulated hand and vision impairment. The purpose of the second study was to quantify the effect a simulated impaired hand or arm (dominant and non-dominant) had on an individual's ability to throw a grenade and load a weapon. We conducted the studies to provide data for Verification & Validation (V&V) for the Army Research Laboratory's Operational Requirement-based Casualty Assessment (ORCA) model for task-based impairment in support of the Joint Trauma Analysis and Prevention of Injury in Combat (JTAPIC) program. This research will determine thresholds at which tasks are unable to be accomplished due to physical impairment. Methods In the first study we conducted shooting for both reflexive and aimed firing positions at distances from 10 to 300 meters. We evaluated shooting accuracy (hit percentage and radial error) and response time. In the second study, the grenade task examined distance and accuracy while throwing a grenade from the kneeling, standing and laying supine postures. We also measured time to perform the individual sub-tasks involved in throwing a grenade. The weapon loading task examined time of changing a magazine on an already loaded weapon, as well as loading an unloaded weapon. Results The shooting task revealed significant differences (p=0.000) in target engagement time due to impairment condition. The grenade task throwing distance data revealed that from each of the throwing postures -- standing, kneeling and laying supine -- a significant main effect for physical impairment condition (p=0.000, difference of up to 46 inches). There were no significant main effects or interactions of physical impairment condition relative to mean accuracy in any of the throwing conditions. Also, main effects for physical impairment were found for the time to complete the individual sub-tasks in throwing the grenade, i.e., pull grenade from pouch, pull pin, and throw grenade. In both weapon loading tasks, a main effect of physical impairment was revealed ($p < 0.05$). Results showed that for the grenade throwing and weapon loading tasks, impairment of either the dominant arm or dominant hand it took significantly longer to perform the various subtasks. Conclusions Study results will be used to validate elemental capabilities used in the ORCA model to predict ability to perform a task. Lessons learned from these studies may be applicable to a training environment. Study participants employed different methods of completing the tasks when impaired. Research into these work around strategies, may help determine the most effective way of performing these tasks during impairment. Further practice and training using these methods may result in tactics and techniques that could be employed if impairment occurred during combat.

THEMATIC FREE COMMUNICATIONS/POSTERS – HEALTH/FITNESS

The Impact of Dermal Calcium Loss and Deployment on Soldier Bone Health

Presenter: Mary McCarthy (USA)

A. Carlson, MS, RD, 1LT, SP and M. McCarthy, PhD, RN, MAJ (USA Retired) Madigan Army Medical Center, Tacoma, WA Since 2001, over two million U.S. military members have deployed to Iraq or Afghanistan. Sixty-eight percent of current Army enlisted Soldiers are between 17 and 29 years of age; an age that coincides with the period of peak bone mass. The variability in mission requirements during deployments may limit routine exercise regimens and dietary intake. Previous studies suggest that load bearing physical activity may positively impact bone health; however, when combined with poor nutrition and nutrient losses from environmental factors it may negatively impact bone mineral density (BMD). Purpose: There were three aims: 1) Determine the feasibility of quantifying sweat calcium loss during desert physical training, 2) Explore the significance of calcium loss to contributors of decreased BMD, and 3) Describe the influence of self-reported exercise and diet on bone health over the course of a 12-month deployment. Methods: We used a prospective, descriptive, longitudinal design and enrolled deploying Soldiers up to 30 years of age in a combat arms and a combat support unit. Sample was 156 Soldiers; 52 completed the sweat collection, and 104 deployed for an average of 12 months. Sweat collection via patch method occurred during scheduled desert training prior to deployment. Biomarkers of bone turnover, BMD, anthropometric measures, and activity and diet from questionnaires, were obtained pre-deployment and within 60 days of return. Tests of change and bivariate correlations were used to analyze descriptive data; t-tests for independent and paired samples were used where appropriate. Results: Dermal and urinary calcium losses were above normal for 10%, and 17% of the group, respectively, when measured during desert training pre-deployment. A decrease in weight, BMI, body fat, and waist circumference occurred in both units. Physical activity levels declined in each unit type; two sports activities of moderate intensity and frequency were significantly correlated with increased heel BMD ($r = .47$, $p = .01$) in Group 2 (combat arms). Group 1 (combat support) diet did not have an impact on BMD, yet BMD was significantly greater upon return, $p = <.001$. For Group 2, intake from calories, carbohydrates, fats, and protein were significantly correlated with heel BMD following deployment. Vitamin D levels improved from an insufficient level to the lower limit of normal upon return. Conclusions: The early theory that heavy sweating and load carrying would lead to lower BMD with related musculoskeletal injuries following deployment was not supported by our results. However, with attrition at 50% it is possible that those who were injured did not return and report such complaints. The lower levels of physical activity reported present risks for decreased endurance and physical performance upon return to a garrison environment leading to musculoskeletal injuries, stress fractures in particular. Brigade health care professionals are in an influential position to educate Soldiers about wellness to include diet, physical activity, and bone health.

The Influence of Strength and Power During the Performance of High Intensity Military Tasks Under Heavy Load Carriage

Presenter: Tunde Szivak (USA)

William J. Kraemer, Jesse Maladouangdock,Shawn D. Flanagan, Brett A. Comstock, David R. Hooper, David P, Looney, Tunde K.Szivak Human Performance Laboratory, Department of Kinesiology, University of Connecticut, Storrs, CT 06269, USA A significant amount of research has examined the physiological determinants of heavy load carriage while performing medium to long distance road marching (3.2km - 20 km). However, there is limited research examining the factors important for heavy load carriage in short duration, high intensity combat relevant tasks, which is more relevant to the modern battlefield. Thus, the purpose of this investigation was to examine the relationships of strength and power to during a performance of high intensity military tasks under heavy load carriage. Eighteen trained men (mean ± SD: age: 21 ± 2 years; height: 172 ± 6 cm; weight: 80 ± 13 kg) volunteered for the study and were timed during the performance of a high intensity combat relevant course under two randomized experimental conditions; unloaded and loaded. 1 RM strength was measured in the squat and bench press and power determined on a force plate using a counter-movement vertical jump. During the unloaded trial subjects wore a combat uniform with boots weighing ~ 3.2 kg and during the loaded trial in addition to the combat uniform and boots, subjects wore interceptor body armor (6.94 kg-9.10 kg) and a MOLLE rucksack weighing ~ 30 kg. The combat relevant course performed consisted of 3 consecutive tasks, which began from the prone position, leading into a 30m sprint, followed by a 27 m zig-zag run, ending with a 10 m casualty drag weight ~79.4 kg and was repeated 3 times with 5 min rest between cycles. As strength and power increased performance time decreased. Significant ($P \leq 0.05$) Pearson correlations reflected this pattern negative correlations between squat strength (r=-0.63, -0.62), vertical jump power (r=-0.67, -0.67) and bench press strength (r=-0.60, -0.62) with performance times even in the unloaded and hypothesized loaded conditions, respectively. This study supports that such tasks are in part influenced by strength and power capabilities in men and supports the importance of strength and power training to optimize in high intensity military activities under any unloaded and loaded conditions.

Physical Fitness of Young Soldiers: Number of Risk Factors Reduces Endurance, Agility and Strength Performances

Presenter: Dieter Leyk (Germany)

Dieter Leyk(1,2), Ulrich Rohde(1), Alexander Sievert(2), Alexander Witzki(1), Thomas Ruether(2) Institution: (1) Central Institute of the Bundeswehr Medical Service Koblenz - Department IV Military Ergonomics and Exercise Physiology (2) German Sport University Cologne - Department of Physiology and Anatomy Soldiers must be healthy, deployable and able to work successfully under pressure. They have been considered relatively immune to the sedentary lifestyle epidemic as regular physical exercise and training are supposed to be fundamental parts of the military service. However, it is proven that increased sedentary work, unhealthy dietary habits as well as physically passive leisure activities have caused considerable increase of soldiers who experience medical conditions. Even worse, it has become abundantly clear that the adoption of unhealthy or inactive lifestyle habits occurs increasingly earlier in life. Purpose: Aim of this cross-sectional study was to determine physical fitness of male soldiers aged 18-25. We investigated the association between performance and the presence or frequency of the risk factors overweight, smoking, and lack of exercise. Methods: 4,950 volunteers performed the Basic-Fitness-Test consisting of the three elements endurance (1000m-run), agility (10m-shuttle-sprint) and strength (flexed-arm-hang). Anthropometric measurements and anonymized questionnaire data were used to determine presence and frequency of the health risk factors overweight, smoking, and lack of exercise. Results: The number of persons without one of these risk factors decreased from some 50% (18-year-olds) below 20% for 25-year-old males. Volunteers without risk factors finished the 1000m-run in 235±32s, the agility test in 42.1±3.8s and the flexed arm hang in 60.1±19.8s. Physical performance in all dimensions tested (endurance, speed/agility, strength) notably deteriorated with the presence of a risk factor and markedly for multiple incidences of risk factors ($p<0.001$). Mean performances of soldiers with the 3 risk factors were 300±50s (1000m-run), 46.9±4.3s (10m-shuttle-sprint) and 27.1±16.4s (flexed-arm-hang). Conclusions: Sedentary lifestyles of young soldiers considerably impair their physical fitness. Incidence of even a single risk factor is associated with considerable losses in performance. To avoid further negative effects, Armed Forces must intensify their efforts to maintain health and performance of their soldiers. Literatur: 1. Leyk et al: Physical Fitness, Weight, Smoking, and Exercise Patterns in Young Adults. Dtsch Arztebl Int(44):737–45, 2012 2. Leyk D, Sievert A: Influence of training on performance and health in middle age. Herz 37: 493-496, 2012 3. Leyk et al: Importance of sports during youth and Exercise barriers in 20-29 year old male non-athletes differently motivated for regular physical activities. J Strength Cond Res 26, S15-S22, 2012 4. Sievert et al: Physical fitness assessment in the German Forces: Basis-Fitness-Test and Compact-Moving-Trail as integrated concept for training and mission preparation. 8th European Sport Medicine Congress of EFSMA, Strasbourg, 2013 5. Leyk and Helmhout: Chapter 1 – Epidemic of Sedentary Lifestyle: Evolution and Implications. Final Report NATO Task Group HFM-178, 2012

Physical Fitness Levels and Outcomes on the Canadian Special Operations Regiment Assessment Centre

Presenter: Conor MacDonald (Canada)

C.MacDonald, S.Jaenen, M.Carlson & A.Fuite Canadian Forces Morale and Welfare Services; Directorate of Fitness; Human Performance Research and Development Introduction: The Canadian Special Operations Regiment (CSOR) is a high-readiness, agile and robust Special Forces (SF) unit within the Canadian Special Operations Forces Command. The CSOR selection and training processes are arduous in order to produce highly flexible and adaptive SF Operators. Specifically, the Assessment Centre (AC) phase of selection places candidates under rigorous physical and mental stress. As a result, many candidates fail to complete the AC. In 2009, physiological profiling of candidates was completed prior to commencement of the AC. The results were used in the development of a Pre-Selection Physical Fitness Training Program (PFTP) designed to help candidates physically prepare for the AC. Physiological profiling was repeated in 2013 to: (i) determine if fitness levels of AC candidates had improved from 2009 to 2013; and (ii) compare the fitness levels of candidates based on their outcomes on the 2013 AC. Methods: Participants in this study were male Canadian Armed Forces members (n=103) who had applied for service with CSOR and were invited to attend the 2013 AC. All participants were pre-screened and provided written informed consent. A maximal fitness test battery was completed over 2.5 days prior to the AC and 24 hours of physical recovery was provided before commencement of the AC. The test battery included a treadmill Graded Exercise Test, Yo-Yo Intermittent Recovery Test (YYIRT) Level 1, continuous pull-ups, flexor core endurance, standard load squats and combined hand grip. Results: Participants on the 2013 AC had a mean VO2peak of 56.0±4.9 ml·kg-1·min-1 (n=63), which was significantly higher than participants in 2009 who had a mean VO2peak of 54.2±4.0 ml·kg-1·min-1 (n=66) (p=0.016). No significant differences existed between groups for any other independent variables. Participant outcomes on the 2013 AC were divided into three groups: (i) those who successfully completed (COM) the AC (n=59); (ii) those who did not complete (DNC) the AC (n=37); and (iii) those who were removed from the AC (n=7) for medical reasons. Physiological data of the COM and DNC groups were compared. Participants in the COM group covered a mean distance of 1,736±369 m on the YYIRT (n=45), which was significantly greater than participants in the DNC group who covered a mean distance of 1,546±296 m (n=36) (p=0.014). No significant differences existed between groups for any other independent variables. Conclusion: Participants in 2013 were found to have a significantly higher aerobic capacity than those of 2009. This improvement may partially be attributed to the release and dissemination of the PFTP in 2010. Furthermore, as indicated by the YYIRT results, participants who COM the AC had a greater capacity to execute and recover from repeated bouts of high-intensity exercise than those who DNC. The findings of this study will be taken into consideration when re-evaluating the Pre-Selection PFTP to ensure that candidates continue to arrive at the CSOR AC physically prepared

Iron Status and Initial Military Training in the US Army and Israeli Defense Forces

Presenter: James McClung (USA)

James P. McClung1, Ran Yanovich2,3, J. Philip Karl1, Sonya J. Cable4, Andrew J. Young1, Yuval Heled2,3, Daniel S. Moran5 1Military Nutrition Division, United States Army Research Institute of Environmental Medicine, Natick, MA 01760 2The Warrior Health Research Institute, Israel Defense Forces, Medical Corps, Tel Hashomer, Israel 3Heller Institute of Medical Research, Sheba Medical Center, Tel Hashomer, Israel 4Initial Military Training Center of Excellence, Fort Eustis, VA 23604 5Ariel University Center of Samaria, Ariel, Israel Iron is an essential nutrient for sustaining Warfighter health and performance. This presentation will summarize a series of longitudinal studies conducted over the past decade with initial military training (IMT) recruits from both the US Army and the Israeli Defense Forces (IDF) that investigated the effects of IMT on iron status, the effects of poor iron status on Warfighter performance, and the relationship between iron status and the prevalence of injury. Initially, studies with US Army recruits demonstrated that while the prevalence of iron deficiency (ID, diminished iron stores) and iron deficiency anemia (IDA, ID with diminished hemoglobin) was similar between the US population and recruits beginning IMT, iron status declined significantly in response to training. Declines in iron status were associated with diminished physical performance. A series of subsequent studies tested countermeasures for the prevention of declines in iron status during US Army IMT. Studies investigating the use of iron supplements (15 mg elemental iron/day, provided as capsules) demonstrated protection against declines in iron status and improvements in mood and physical performance as compared to placebo-treated controls. Studies utilizing an iron fortified ration item (First Strike Bar, 56 mg elemental iron/day) also demonstrated protection against declines in iron status. Studies conducted by the IDF also demonstrated declines in iron status during IMT, and established that IDA was associated with the incidence of stress fracture. In those studies, Soldiers with reduced iron status were more susceptible to develop stress fractures during military service, particularly during IMT, as compared to their counterparts with better iron status. Future studies should aim to determine the mechanism by which iron status declines during military training and focus on the development of sustainable policies for the prevention and treatment of ID and IDA in Warfighters. Research supported by the IDF and USAMRMC.

Can a Culture of Fitness Contribute to Increasing the Health, Fitness and Operational Readiness of Our Militaries?

Presenter: Michael Spivock (Canada)

Michael Spivock, PhD(1), Judd Allen, PhD(2) (1)Canadian Forces Morale and Welfare Services. Directorate of Fitness. Human Performance Research and Development. (2)Human Resources Institute, LLC. Corresponding author: michael.spivock@forces.gc.ca Background: It is generally accepted that the health and physical fitness of sailors, soldiers, airmen and airwomen are essential and critical components of operational readiness. The Canadian Armed Forces (CAF), as well as most modern other militaries, provide state of the art fitness programs, facilities, and benchmarks to their personnel. Despite these services, approximately 1/3 of CAF personnel report being inactive. Purpose: The purpose of this study was to better understand the contextual determinants of physical activity in the CAF at the local level. The information obtained would serve to inform local actors in the development of physical activity promotion strategies as well as to orient national CAF-wide policies and programs. Methods: The Lifegain Wellness Culture Survey was adapted in collaboration with the original author and completed by a stratified sample of nearly 3000 CAF personnel across 24 bases/wings in Canada (including Navy, Army and Air Force personnel). This survey contains 33 questions and is designed to assess 5 validated dimensions of fitness culture: 1. Shared Fitness Values (commonly held beliefs about fitness), 2. Cultural Norms (expected and accepted behaviours within the unit), 3. Peer Support (both social and resource-based support from coworkers or friends/family), 4. Cultural Touch Points (policies, resources and leadership) and 5. Social Climate (general work atmosphere). Results: Scores for the 5 dimensions were calculated for each of the 24 locations as well as being aggregated to the national level. Dimension scores ranged from 3.35/5 (behavioural tendencies) to 3.83/5 (peer support). In general expectations relating to fitness are well understood by personnel, with over 75% of respondents stating that they agree or strongly agree with the statement that "In my unit, it is normal and expected to be physically active". Most respondents also felt that resources were being used appropriately, with nearly 60% having a positive reaction to the statement "The use of time, base facilities, money and other resources demonstrates our organisation's commitment to the fitness of our personnel". Finally half of respondents agreed or strongly agreed that their commanding officer is a fitness role model. Binomial logistic regression analyses show that these individuals have nearly 20% higher odds of being active (based on self-report) when compared to those who feel their commanding officer is not a fitness role model (βex: 1.187; p:0.02). Conclusions: It is important for fitness personnel, military leadership and health promotion personnel to consider environmental determinants of physical activity (be they of a social, policy or physical nature) in military personnel. Distinct differences have been noted across elements and even particular locations, indicating that many of these determinants would be best addressed at the local level.

Healthy Eating, Activity, Lifestyle Training Headquarters (H.E.A.L.T.H.): Preliminary Evidence on an Internet/ Population-Based Behavioral Weight Management Program for the U.S. Army

Presenter: Tiffany Stewart (USA)

Tiffany Stewart, Ph.D. 1, Hongmei Han, M. App. Stat.1, H. Raymond Allen, Ph.D.1, Donald Williamson, Ph.D.1, Karl Friedl, Ph.D.2, Andrew Young, Ph.D.2 1 Pennington Biomedical Research Center (PBRC) 2 United States Army Research Institute of Environmental Medicine (USARIEM) Military personnel are not immune to the effects of overweight and obesity. A significant number of Soldiers exceed the maximum allowable weight standards, or have body weights approaching the maximum allowable weight standards as defined by AR 600-9, The Army Weight Control Program (AWCP). The present study is a cluster randomized design that tests the impact and broad dissemination of an Internet and Smartphone based program (H.E.A.L.T.H.; Healthy Eating, Activity, Lifestyle Training Headquarters) in National Guard Soldiers and their family members. The targeted 5,800 Soldiers from fourteen units were randomly assigned to an immediate intervention or delayed intervention group for the first 30 months, followed by two years of intervention available for all Soldiers. A prompting/marketing program was put in place to enhance broad dissemination of the program throughout the targeted population and to encourage sustained usage of the tool. Results from the first 30 months include: 1)2,504 Soldiers and 258 civilian family members (N=2,762) logged on to the website program in the first 30 months, 2) Soldier demographics include: mean age= 28, Body Mass Index (BMI)= 27, 23%=female, and 66% = Caucasian; 3) civilian demographics include: mean age=38, BMI=30, 85% =females, and 63% =Caucasian; 4) participants who utilized the H.E.A.L.T.H. program lost weight; 5) overall, the target population (over screening table weight/overweight) logged on to the program more frequently and utilized the website more often over time; 6) participants who utilized the website program more often lost more weight; 7) participants reported overall satisfaction with the website program. Preliminary evidence from the H.E.A.L.T.H. program suggests that Soldiers (and family members) will utilize an Internet/Smartphone based program for weight management/ weight gain prevention if given the opportunity and are prompted to do so. The present study also shows that sustained use of an Internet/ Smartphone based weight management/weight gain prevention program was associated with weight loss in overweight individuals and prevention of weight gain in non-overweight individuals. Finally, individuals who utilized the tool more often, had greater success.

United States Army Soldiers' Perceived Barriers to Optimal Sleep, Activity and Nutrition

Presenter: Laura Vasquez (USA)

Laura Vasquez, Theresa Jackson, Jessica Rawlings, Wana Jin. United States Army Public Health Command. LTC Anne Andrews, United States Army Office of the Surgeon General. Purpose: To identify Soldiers' perceived barriers to optimal sleep, activity and nutrition that detract from the overall health of the force, and to make recommendations for Army programming and initiatives designed to improve these behaviors. Methods: This study is part of a larger evaluation project to evaluate the effectiveness of the Performance Triad Pilot, a U.S. Army program designed to increase readiness and resiliency by focusing on improvements in sleep, activity and nutrition (SAN). As part of baseline data collection, USAPHC scientists conducted 31 focus groups and 3 structured interviews across three sites between AUG-SEP 2013 (N=202). Qualitative sessions were stratified by rank/status (E4 and below squad members (n =74), Squad Leaders (n=64), Platoon Leaders or higher (n=54), and Medics (n=10)). These focus groups and interviews gathered information on Soldiers' SAN, including barriers, facilitators, perceptions, and needs to attain optimal SAN. During qualitative sessions, facilitators specifically asked Soldiers, "What affects whether you get optimal sleep, activity or nutrition?" and probed them on what prevents them from engaging in these behaviors. USAPHC scientists identified key themes for each behavior and aggregated results across groups from all three sites to determine if there were consistencies across sites, within groups, or overall. The team used a rapid-action analysis approach to summarize findings and generate recommendations. Results: Soldiers across all three sites and all groups perceived ineffective physical training regimens, including physical readiness training (PRT), and levels of personal motivation as the top barriers to optimal activity. Soldiers perceived that time constraints, access issues (including the dining facility's [DFAC] options and lack of availability of healthy food on the installation), and mission prioritization over meals as the top barriers to optimal nutrition. Soldiers' perceived personal commitments, work schedule or work-related stress, and personal decisions or self-discipline as the top barriers to optimal sleep. Some differences existed across group strata and sites. Less commonly identified SAN barriers or SAN barriers unique to the military included injuries, profiled Soldiers, barracks life, and time in the field. Conclusions: Across the three behaviors, environmental, cultural and individual factors all serve as barriers to optimal SAN. Any program or initiative designed to change Soldiers' SAN must take these barriers into account and teach Soldiers strategies to overcome them. Army leaders should also address commonly identified environmental barriers such as time in the field, the nutrition environment, and barracks life when attempting to improve Soldiers' SAN.

THEMATIC FREE COMMUNICATIONS/POSTERS – THERMOREGULATION

Practical Real-Time Assessment of Thermal Work Strain from Measures of Heart Rate for CBRNE Operations

Presenter: Mark Buller (USA)

Mark J. Buller, William J. Tharion, Cynthia M. Duhamel, and Miyo Yokota U.S. Army Research Institute of Environmental Medicine, Natick, MA Purpose: Soldiers are particularly vulnerable to thermal strain and possible heat illness when encapsulated in personal protective equipment (PPE) in response to chemical, biological, radiological, nuclear, and explosive (CBRNE) threats. Heat strain can impair soldier decision making and result in heat casualties. The primary cause of thermal strain comes from metabolic heat production from physical work in heavy equipment, and heat retention due to the thermally and occlusive nature of their PPE. One way to reduce the likelihood of heat illness is to improve awareness of thermal work strain by using a real-time physiological status monitor (PSM). A simple physiological strain index (PSI) that uses a weighted combination of heart rate (HR) and core body temperature (Tcore)1 has been previously demonstrated as a good indicator of thermal work strain for military. However, while HR is readily measurable on active warfighters, Tcore is problematic. In this paper a new technique was used to estimate Tcore from a sequence of HR observations and then use this estimate to compute an estimated PSI. Estimated PSI was compared directly to observed PSI as a possible method for real time assessment of warfighter thermal work strain. Methods: Soldiers (24/2 men/women) from the 22nd Chemical Battalion Technical Escort, the 1st and 95th Weapons of Mass Destruction – Civil Support Teams volunteered to participate in 40 to 75 min CBRNE training exercises for two/three consectutive days. Individual's HR and Tcore were collected using a PSM system (Equivital™ EQ-02, Hidalgo, Cambridge, UK) and PSI computed. Estimated PSI was computed using HR alone (PSIest) by estimating Tcore according to a core temperature surrogate filter algorithm2. Comparisons of PSIHR and observed PSI were examined by computing overall root mean square error (RMSE), bias, and the 95% confidence interval for PSIest. Means are reported ± standard deviation (SD). Results: Overall RMSE was 0.39±0.33 PSI units, with a bias of -0.05±0.50 PSI units. The 95% confidence interval was ±0.99 PSI units indicating that over 95% of all PSIHR fell within ±1 PSI unit of the actual. The Bland-Altman plot shown below (bias – solid; limits of agreement ±1.96•SD – dashed) indicates good agreement between observed and estimated PSI. Conclusions: Most PSIest points showed close correspondence to observed PSI. There was a small negative bias but over 95% of PSIest points were within 1 PSI unit of the observed. These results appear consistent whether at low or high levels of thermal work strain. Most errors beyond 1 PSI are overestimates and would err on the side of caution. Utilizing this core temperature surrogate algorithm to provide an estimate PSI appears to provide a good indicator of thermal work strain when for Soldiers encapsulated in CBRNE-PPE. References: 1Moran et al. (2008) Am. J. Physiol. Regulatory Integrative Comp. Physiol. 275:129-134. 2Buller et al. (2013) Physiological Measurement 34:781–798.

Cardiovascular and Thermal Responses During a 3-Day Metabolically Demanding Cold Weather Military Operation

Presenter: John Castellani (USA)

John W. Castellani, Marissa G. Spitz, Svein Martini, Nancy E. Murphy, Lee M. Margolis, Andrew J. Young, Janet-Martha Blatny, Yngvar Gundersen, Scott J. Montain, and Stefan M. Pasiakos. United States Army Research Institute of Environmental Medicine, Natick, MA, USA Norwegian Defence Research Establishment, Kjeller, Norway Physiological responses to metabolically demanding military operations in extreme cold weather environments are not well described. Understanding the cardiovascular and thermal responses to an acute, metabolically demanding cold weather operation will enable greater insights into the performance capabilities and cold injury risk of Soldiers during combat. Purpose: To characterize cardiovascular and core/skin temperature responses during metabolically challenging cold weather military training. Methods: Twenty-one Soldiers (mean ± SD, 20 ± 1 y, height: 182 ± 7 cm, weight: 82 ± 9 kg) were studied during a 3-d, 54-km ski march along the Norwegian-Russian border. Mean ambient temperature was -15 ± 4°C and ranged from –26°C to -6.2°C. Soldiers wore physiological monitoring systems (Equivital-1, Hidalgo Ltd. Cambridge, UK) and ingested core thermometer pills (Jonah™ Core Temperature Pill, Respironics, Bend, OR) daily throughout the ski march to measure heart rate (HR), core (Tcore), and torso skin (Ttorso) temperature. Total daily energy expenditure (TDEE) was measured using doubly labeled water. Soldiers throughout the 3 days skied in 50:10 min work to rest ratios for 10 hr/d (total = 30 hr), travelling nearly 20 km per d, while carrying ~45 kg of additional equipment. Two intervening, overnight rest periods (13 h and 10 h) were given between exercise bouts. Results: TDEE for the 3 d ski march was 6851 ± 562 kcal/d. Mean HR (n = 18) was 130 ± 7 bpm (~65% age-predicted HRmax) while skiing, whereas HR during the rest periods ranged from 85-90 bpm. The mean maximal Tcore (n = 9) during skiing was 38.2 ± 0.2°C (highest value = 38.4°C). At rest, the mean minimal Tcore was 36.0 ± 0.3 (lowest value = 35.5°C). Ttorso (n = 18) was 34.1 ± 1.7°C during skiing, but increased to 35.5 ± 0.7°C at rest. Conclusions: Although the relative exercise intensity was moderate, metabolic demand was high, as daily energy expenditure was among the highest observed for a military training exercise. However, the 3 d cold weather ski march did not elicit significant cardiovascular and thermal strain.

Strategies for Increasing Evaporative Cooling During Simulated Desert Patrol Missions

Presenter: Ursa Ciuha (Slovenia)

Ursa Ciuha(2,3), Ola Eiken(4), Igor B. Mekjavic(1) and Mikael Grönkvist(4) (1) Department of Automation, Biocybernetics and Robotics, Jozef Stefan Institute; (2) International Postgraduate School Jozef Stefan, Ljubljana, Slovenia; (3) Biomed d.o.o., Ljubljana, Slovenia; (4) Environmental Physiology, Royal Institute of Technology, Stockholm, Sweden. Introduction: The study evaluated the efficiency of different heat-dissipation strategies under simulated desert patrol missions. Methods: During a 4-week period, ten healthy heat-unacclimatised males participated in five 130-min trials, during which they walked on a treadmill at a speed of 3.2 km·h-1, with an incident laminar wind at the same velocity. Each trial commenced with 10-min baseline at 25°C, 40% relative humidity (RH); followed by a simulated desert (45°C, 20% RH) patrol mission in a climatic chamber. The trial comprised two 50-min walks interspersed by a 20-min rest period. In all conditions, total skin-out weight was 35.2 kg. The first (Naked Condition 1; NC_1) and last (NC_2) trials were conducted with the subject wearing only shorts, socks and boots, with a backpack load of 29.3 kg. All subjects entered and completed the study with the NC condition in order to observe adaptation to heat during the study. The remaining three trials were conducted in random order. In one condition, the subject wore full protective equipment (FP), including body armour. Two field cooling strategies were compared; in both these conditions the subject wore a reduced uniform outfit. Active cooling was provided continuously, by a ventilated vest (AC), while passive cooling (PC) was achieved during the 20-min rest period, by partly undressing the subject and spraying the drier surfaces of his body with water and ventilating the area. Results: In the FP condition, 5 of the 10 subjects could not complete the task due to heat exhaustion. No signs or symptoms of heat exhaustion were encountered in the NC_2, AC, or PC conditions, whereas in the NC_1 condition, one subject had to discontinue after 45 min of the 2nd walk due to heat exhaustion. In the FP condition, rectal temperature (Tre) increased steadily throughout the trial. In the NC_1, and particularly in the NC_2 condition, Tre rose substantially less than in the FP condition. Both cooling strategies (AC, PC) were efficient, since Tre and heart rate (HR) responses were similar to those in the NC_1 trial. During walking, unweighted average skin temperature (Tsk) was higher, and skin heat flux (HFsk) lower in the PC than in the AC condition, whereas conversely, during the rest period, Tsk was lower and HFsk higher in the PC condition. Likewise, subjects felt cooler in the AC condition during the baseline and walking periods, but hotter during the rest period, than in the PC condition. Conclusion: Both cooling strategies were almost comparable to the NC in terms of heat loss and storage. As a consequence of participating in several trials, subjects exhibited a significant degree of heat acclimation, as reflected in lower HR, Tre and rate of perceived exhaustion in NC_2 than in NC_1.

Sustaining Thermoregulation by Microclimate Cooling: Limitations and Developments

Presenter: Karl Jochen Glitz (Germany)

Karl Jochen Glitz(1), Uwe Seibel(1), Ulrich Rohde(1), Willi Gorges(1), Claus Piekarski(2), Dieter Leyk(1,3) (1) Central Institute of the Bundeswehr Medical Service Koblenz - Department Military Ergonomics and Exercise Physiology (2) University of Cologne - Institute and Policlinic for Occupational Health, Environmental Medicine and Prevention Research (3) German Sport University Cologne - Department of Physiology and Anatomy Military threats as well as the exposure to hazardous substances during civilian activities require an increasing need for more complex protective clothing. The weight of these garments as well as motion restrictions cause frequently considerably increased muscular work and, thus, higher metabolic heat production. At the same time the thermal insulation of the protective clothing stresses thermoregulation by limiting heat dissipation. As a result performance losses and the risk of hyperthermia require limitations of tolerance time (DGAUM 2013). PURPOSE: Different microclimate cooling systems (ice-packet vests, garments using circulating pre-cooled liquids, ventilation with ambient air) can be helpful to sustain thermoregulation Where are their limitations? Which optimization potential can be identified? ICE-PACKET VESTS AND GARMENTS USING CIRCULATING PRE-COOLED LIQUIDS: Vests and garments dissipate heat via conduction by cooling the skin. The conductive approach, however, is self-limited as skin cooling triggers peripheral vasoconstriction, reducing the heat exchange by reducing the peripheral blood flow, which is essential for heat loss. This disadvantage might be reduced in protective garments by controlling the circulation of the cooling liquids before vasoconstriction sets in (Stephenson et al. 2007). VENTILATION WITH AMBIENT AIR: Protective clothing can be ventilated with ambient air by integrated fans. This method is suitable e.g. for ballistic protection vests and can contribute to heat dissipation under favourable conditions (Hadid et al 2008). However, as it depends on the ambient climate conditions the effect can be small or even adverse at high ambient temperatures and air humidities. VENTILATION WITH CONDITIONED AIR: The disadvantages of ambient air can be circumvented by using conditioned air (Glitz et al. 2005). A laboratory study (march – rest cycle; total exposure time 130 min) shows the significant lower heat burden of subjects wearing protective garments ventilated with conditioned air (<< 5% rH, 25°C) in the microclimate (17% reduction of max. HR) compared to absent ventilation (max. core temperature remaining below 38°C). CONCLUSIONS: Sweat evaporation is the most effective way to dissipate heat from a physiological point of view. It is impeded, however, or even stopped completely by protective clothing. Evaporation can be promoted by ventilating protective clothing with conditioned air. A sufficient amount of dry air (water vapour adsorption capacity according to sweat rate), adequate temperature (avoiding vasoconstriction) and skin near distribution (regionalization of the sweat evaporation) are prerequisites for effective sweat evaporation. As a result tolerance time of wearing thermal insulating protective clothing might be prolonged substantially. REFERENCES: DGAUM (ed.): Guideline. www.awmf.org/leitlinien/detail/ll/002-040.html (2013) Glitz et al., WMM 49 (1), 16-20 (2005) Hadid et al., Eur J Appl Physiol 104 (2), 311-319 (2008) Stephenson et al., Aviat Space Environ Med 78 (4) 377-382 (2007)

Self-Reported Signs & Symptoms of Cold Exposure During Basic Military Training in Relation to Race and Habitual Cold Exposure

Presenter: Julie Greeves (UK)

Ruth M. Hobson1, Graham Ball1, Craig Sale1, Kathryn McKinnon2, Christopher Imray3, Paul R. Richards2, Julie P. Greeves2 1 SHAPE Research Group, Nottingham Trent University, Nottingham, UK; 2 Headquarters Army Recruiting & Training Division, Ministry of Defence, Upavon, UK; 3 Warwick Medical School & General & Vascular Surgery Department, University Hospitals Coventry & Warwickshire NHS Trust, UK Non-Caucasian populations are considered to be at highest risk of developing signs and symptoms of cold exposure during training in the UK (Izard and Bilzon, 2008, MSSE, 40, S229), but symptoms and diagnosis of cold injuries are commonly seen amongst British and other nationalities from temperate climates. It is unknown whether race or habitual exposure to cold during childhood and adolescence can alter susceptibility to, or perception of, cold. Purpose: This study aimed to establish self-reported signs and symptoms of cold exposure in populations with different degrees of habitual cold exposure and of different race, during British Army basic Infantry training. Methods: A bespoke, validated questionnaire was administered in week 23 of training and included questions relating to signs and symptoms that occurred as a result of cold exposure during training. Anonymised responses collected from participants (n=502) were categorised by geographical upbringing (+45 degrees to +66.5 degrees latitude (Northern Temperate North; NTN) compared to all other latitudes) and by race (Caucasian or non-Caucasian). Data on signs and symptoms of cold exposure in the feet and hands were explored by determination of the frequency of occurrence across populations. Results: The percentage of recruits reporting signs and/or symptoms of cold exposure in the hands and feet is shown in table 1. The results indicate that numbness was the most common symptom experienced by recruits in response to cold exposure during training. No clear pattern in the frequency of self-reported signs and symptoms of cold exposure between Caucasian and non-Caucasian, or between those raised in NTN or outside NTN, was evident. Conclusions: These findings demonstrate no clear influence of race or previous habitual cold exposure on the incidence of pattern of self-reported signs and symptoms of cold exposure. Further work is needed to establish the clinical relevance of self-reported signs and symptoms, irrespective of race or previous cold exposure. Table 1. The percentage of recruits within each category who reported the sign or symptom in the hands or feet, caused by cold exposure. Sign/Symptom (%) Raised in NTN Raised outside NTN Caucasian (n=406) Non-Caucasian (n=19) Caucasian (n=10) Non-Caucasian (N=34) Swelling Feet 16 16 50 21 Hands 22 32 20 27 Colour change Feet 48 53 40 24 Hands 69 58 70 21 Numbness Feet 79 100 70 62 Hands 82 94 50 65 Prickly Feet 50 32 60 50 Hands 39 44 50 47 Pain Feet 44 47 40 41 Hands 55 61 40 56

Fidelity of Laboratory Trials in Simulating Winter Patrols

Presenter: Igor Mekjavic (Slovenia)

Igor B. Mekjavic(1), Michail Keramidas(2) and Ola Eiken(2) (1) Department of Automation, Biocybernetics and Robotics, Jozef Stefan Institute; (2) Environmental Physiology, Royal Institute of Technology, Stockholm, Sweden. Introduction: The NATO Human Factors and Medicine (HFM) Research Task Group (RTG) 238 is concerned with reducing the dismounted soldiers' burden. Within the context of developing a decision-making aide for prioritising strategies (Defence Line of Developments, DLODs) based on laboratory and field simulations, one subtask is to assess the fidelity of laboratory simulations. The aim of this study was to compare the thermoregulatory responses of soldiers conducting a Winter hike and Guard duty in the field, with the results obtained during laboratory simulations of these activities. Methods: Subjects (10 males, 10 females) wearing a standard military issue winter clothing ensemble, participated in two separate trials. In one, they conducted a 12-km hike carrying a 20-kg backpack, on trails surrounding the Alpine military training facility Pokljuka, Slovenia (altitude 1360m). The hikes ranged from 3 to 4 hours. In the second trial, they conducted a 3-hr guard duty. During the 3-week study, the trails were covered with snow. The average (SD) ambient temperature during hikes and guard duties was 2.0±3.8°C. In both trials we monitored the average skin temperature and heat flux at four sites, gastrointestinal temperature (core temperature) with a radio pill, heart rate and breath-by-breath oxygen uptake with a portable oxygen uptake system. Environmental variables during the field trials were derived from a single weather station, and were used in the subsequent laboratory simulations with 9 male subjects. Results: The ambient temperature (Ta) and relative humidity (RH) in the field (Ta=-4.6+4.6°C; RH=74.5+20.9%) and laboratory trials (Ta=-4.6+4.6°C; RH=74.5%) were similar. As evident from the table below the laboratory simulations underestimated the thermoregulatory and cardiorespiratory responses observed during the field trials. Variable Field trial Laboratory simulation Start End Start End GUARD DUTY Heart rate (beats/min) 107.5±10.5 88.7±16.9 78.5±8.6 68.6±7.7 Oxygen uptake (ml/min) 635±212 645±261 Ventilation (L/min) 22.9±5.5 21.7±3.9 Core temperature (°C) 37.5±0.3 37.5±0.3 37.7±0.5 37.1±0.1 Skin temperature (°C) 35.6±0.3 34.4±0.5 38.6±0.8 35.1±8.9 Heat flux (W/m) 48.5±23.4 103.1±17.0 46.1±11.5 70.4±12.7 HIKE Heart rate (1/min) 106.7±15.1 105.8±13.2 93.3±13.0 99.5±16.3 Oxygen uptake (ml/min) 738±226 1392±274 587±147 935±332 Ventilation (L•min-1) 24.8±6.2 36.0±8.7 17.8±2.9 28.9±6.9 Core temperature (°C) 37.2±0.2 37.6±0.3 37.2±0.3 37.5±0.2 Skin temperature (°C) 35.4±0.5 32.0±1.4 37.7±0.8 36.7±3.2 Heat flux (W•m-2) 48.5±23.4 103.1±17.0 101.3±16.5 106.3±16.2 Conclusions: The likely reason for the laboratory results underestimating the field values are: the hike activity in the laboratory was conducted on a treadmill and did not simulate the varied terrain traversed in the field study; variations in wind and solar radiation were not appropriately simulated in the laboratory tests; the difference in altitude of approximately 1000m between the laboratory and field trials. Commonly in laboratory simulations the environmental factors are maintained constant, and may not reflect the spatially and temporally varying environmental factors in field trials, which may significantly influence physiological responses.

Fluid, Electrolyte and Thermoregulatory Responses to Ad Libitum Water Replacement Using Two Different Water Delivery Systems

Presenter: Heinrich Nolte (South Africa)

H.W. Nolte1 & J van der Meulen1 ERGOTECH, Research and Development, Armscor, Pretoria, South Africa Background: Commercially available hydration systems are often advocated for improved hydration and performance in military populations. Supposed advantages are that they provide "hands free" hydration to the soldier and that readily available fluid will encourage soldiers to drink more, therefore improving their hydration status and maintaining their performance. Purpose: The purpose was to assess whether such systems indeed result in improved performance and "better" fluid, electrolyte and thermoregulatory responses in exercising soldiers when compared to drinking from traditional canteens. Methods: The fluid replacement preferences of participants were established by a questionnaire in order to categorise them into one of four drinking styles. Participants were randomly assigned to either a standard issue canteen (C) or hands free hydration system (HF) group. Participants were required to complete a 19km speed march, the only prescription for fluid intake was to consume water ad libitum. Results: Forty five participants volunteered to take part in the study. There were no differences between the groups for their mean water consumption during exercise [$t(45) = -0.31$, $P > 0.05$]. Intakes of 539 ml/hr (HF) and 534 ml/hr (C) resulted in no differences for changes in body mass (BM) [$t(45) = -1.64$, $P > 0.05$], post exercise serum [Na+] [$t(45) = -1.00$, $P > 0.05$], POsm [$t(45) = 1.27$, $P > 0.05$] and total body water (TBW) [$t(45) = -0.16$, $P > 0.05$]. Despite average BM losses of 1.8kg (HF) and 1.4kg (C), serum [Na+] and POsm remained unchanged. TBW decreased 0.9kg (HF) and 1.0kg (C) [$t(45) = -0.04$, $P > 0.05$]. There was no difference between the two groups for the time required to complete the route march [$t(45) = -1.37$, $P > 0.05$]. Due to similar work rates there were no differences between the respective peak exercise core body temperature (Tc) of the HF (38.9°C) and C (38.7°C) groups [$t(45) = 0.06$, $P > 0.05$]. Discussion: Changes in BM did not accurately predict changes in TBW as a 1:1 ratio. In both groups there was a relationship (negative slope) between post-exercise serum [Na+] and changes in both TBW and BM. There was no relationship between percent BM loss and peak exercise Tc or time required to complete the route march. Conclusion: We conclude that there were no differences in fluid balance, thermoregulation or performance between the groups drinking from either the HF system or traditional C. This is a novel but not surprising finding since the amount of fluid consumed during exercise will be determined by changes in serum osmolality and not the fluid delivery system as often proposed. We propose that the participants were able to maintain their POsm, serum [Na+] and safe exercise Tc by adopting a pacing strategy, ad libitum fluid consumption and a reduction in both BM and total body water, although not in a 1:1 relationship, to maintain serum [Na+].

Evaluating the Associated Heat Strain from Working in Different Body Armour Vests

Presenter: Min Sze Pearl Tan (Singapore)

TAN Min Sze Pearl1, TEO Ya Shi1, ANG Wee Hon1, LEE Kai Wei Jason1,2,3 1 Defence Medical and Environmental Research Institute, DSO National Laboratories, Singapore 2 Yong Loo Lin School of Medicine, National University of Singapore, Singapore 3 Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore PURPOSE Donning the body armour (BA) vest aids in providing ballistic protection for soldiers in combat. However, it poses an additional heat strain on soldiers. The RYKEN vest (as compared to the integrated load bearing vest (iLBV)) has an open design prior to the insertion of armour plates, aimed at allowing better heat dissipation. The present study investigated the associated heat strain resulting from working in two different BA vests in the heat. METHODS This study comprised: (i) thermal testing of both BA vests; and (ii) laboratory trials to study the associated heat strain from working in both BA vests. Thermal testing comprised a thermal insulation and an evaporative resistance test. Both tests were carried out on a Newton thermal manikin in an environmental chamber on two configurations (without and with armour plates) for each BA vest. The thermal insulation test was performed at an ambient temperature of 20°C and 50% relative humidity, while the evaporative resistance test was performed at 35°C and 40% relative humidity. Fifteen healthy heat-acclimatised males performed a 15 km route march on a treadmill at a fixed speed while donning either the iLBV or the RYKEN BA vest in a counter-balanced design. Trials were conducted in an environmental chamber (dry bulb temperature: 32.1 ± 0.2°C, relative humidity: 68 ± 1%, solar radiation: 400 W/m2). Each trial was 245 min in duration and consisted of 5 work-rest cycles. Body core temperature, heart rate and subjective responses were measured throughout the trials. RESULTS Thermal testing: Without armour plates, the RYKEN vest had similar thermal insulation (iLBV: 0.22 m2·°C/W vs. RYKEN: 0.20 m2·°C/W) and lower evaporative resistance as compared to the iLBV (iLBV: 37.4 m2·Pa/W vs. RYKEN: 34.0 m2·Pa/W). With armour plates, both vests were largely similar in thermal insulation (iLBV: 0.22 m2·°C/W vs. RYKEN: 0.22 m2·°C/W) and evaporative resistance (iLBV: 38.3 m2·Pa/W vs. RYKEN: 39.2 m2·Pa/W). Laboratory trials: Work tolerance was similar between the BA vests (iLBV: 155 ± 26 min vs. RYKEN: 152 ± 29 min; P=0.74). The change in body core temperature tended to be better with the RYKEN vest (iLBV: 1.3 ± 0.3°C vs. RYKEN: 1.1 ± 0.4°C; P=0.08). There was no difference in mean heart rate between trials (iLBV: 125 ± 15 beats/min vs. RYKEN: 125 ± 12 beats/min; P=0.95). Subjective responses of the ratings of perceived exertion and thermal sensation were similar between trials. CONCLUSIONS Although evaporative resistance was marginally more superior in the RYKEN vest without the armour plates, the associated physiological and subjective responses were largely similar. Field trials will be conducted to assess the implementability of both BA vests in an operational context.

THEMATIC FREE COMMUNICATIONS/POSTERS – LOAD EFFECTS ASSESSMENT PROGRAM

United States Marine Corps Load Effects Assessment Program (MC-LEAP): An Emerging Mobility Assessment Metric

Presenter: Mark Ritcher (USA)

The mobility of Marines is a critical attribute in accomplishing the wide variety of missions of the Marine Corps. Individual Marines today have enhanced protection and capability over previous generations but risk sacrificing combat mobility. MC-LEAP is new standardized test course that provides an objective assessment of mobility with various equipment configurations, including effects on combat performance and design and material property attributes. MC-LEAP was used with infantry Marines at Camp Lejeune, North Carolina, testing seven infantry equipment configurations, ranging from relatively unburdened to significant burdens of increased capability. Measurements of static range of motion compared with individual performance measurements through the MC-LEAP provided assessments of weight, stiffness and bulk as components of burden or decreased mobility. MC-LEAP was also used to assess the effect of various equipment configurations to optimize the spatial distribution of equipment. Assessments of prototype equipment and loads compared to previous baseline assessments enabled decisions on equipment design. MC-LEAP is being established in other representative environments to provide quantitative data for infantry equipment design decisions and other actionable data based the actual ability of infantrymen to negotiate unique conditions associated with various structures in geographic areas of the world. MC-LEAP has already emerged as an important tool to enable mobility to be a key performance parameter for requirements and to support systems engineering in the acquisition process.

Load Effects Assessment Program (LEAP): A Systematic Multinational Approach to Understand and Address Soldier Physical Burden

Presenter: Linda Bossi (Canada)

Linda Bossi1, Mark Richter2, David Tack3, Alison Kelly3, Mark Patterson4, and Mike Lafiandra5 1Defence Research & Development Canada, Toronto, Canada 2Marine Expeditionary Rifle Squad, US Marine Corps Systems Command 3HumanSystems Incorporated, Guelph, Ontario, Canada 4Defence S&T Organization, Australia 5Army Research Laboratory, Aberdeen Proving Ground, Maryland Physical overload remains a reality for warfighters. New technologies, demands of modern asymmetric warfare, and motivation to protect soldiers from emerging threats are contributing to soldiers loads that, even in combat, are nearing if not surpassing body weight. Much research has focused on the effect of carried or worn loads on soldier physiology and biomechanics. However, there remains a significant knowledge gap relating to the effect of soldier load on performance of combat-related tasks, vulnerability to enemy action, or mission outcome. Particularly poorly understood are the trade-offs between protection, performance and ultimate survivability. Understanding load effects on battlefield performance and outcome is critical for effective combat mission planning (i.e., distribution of load across teams, appropriate protective posture). Similarly, knowledge of the relative contributions of load parameters (weight, bulk, stiffness) to performance degradation or vulnerability will be important for the design, specification and acquisition of next generation soldier systems that aim to minimize burden and casualties. In order to objectively measure the impact of loads on soldier operational task performance, the Marine Corps Load Effects Assessment Program (MC LEAP) was developed in 2009, in consultation with subject matter experts experienced in combat mobility requirements. MC LEAP comprises a timed series of obstacles combined with several separate accessory task performance stations. Initial testing and validation of the LEAP concept sparked interest in the international defence community. In March 2011, Defence R&D Canada procured a LEAP system of their own (CAN-LEAP), and in November 2013, the Australian Department of Defense followed suit (AUS-LEAP). Over the past 4 years, five different experimentation campaigns have been successfully completed using the LEAP, in both indoor and outdoor settings, to assess the impact of operationally-relevant soldier ensembles or equipment on soldier performance. The LEAP course has also been used as a part of several soldier equipment user evaluation trials by multiple nations. Currently, there is an international collaborative research project, under The Technical Cooperation Program (TTCP) to exploit the outcomes of a further-refined and standardized LEAP. This presentation will be the first of several international LEAP presentations at this conference and will describe the rationale and plans for a coordinated international effort, under TTCP, to: 1) standardize the measurement of operationally-relevant soldier task performance; 2) collect soldier performance data across a wide range of load, user and environmental parameters; 3) model the contributions of load parameters and other factors to soldier performance; 4) assess the impact of performance decrements on soldier survivability and small unit outcome; and 5) develop decision tools that unit leaders and acquisition stakeholders can use in future to mitigate the negative effects of soldier burden.

Application of an Instrumented Obstacle Course within a Dismounted Combatant Mobility Assessment Framework: An Australian Perspective

Presenter: Jace Drain (Australia)

Jace Drain, Sheena Davis, Dan Billing Land Division, Defence Science and Technology Organisation, Melbourne, Australia Corresponding author: jace.drain@dsto.defence.gov.au With rapid advancement in technology and ongoing feedback from combatants, military organisations need to ensure clothing and equipment is fit-for-purpose in order to maximise the capability and survivability of its personnel. An evidenced-based approach to the incremental improvement, procurement, configuration and integration of clothing and equipment is critical to supporting decision making. Purpose: To describe a structured and progressive framework to evaluate the mobility implications of dismounted combatant clothing, equipment and configuration. Methods: The first step in evaluating the potential impact of the introduction of new clothing or equipment is to directly compare specifications of the current in-service item versus options proposed. In addition it is important to understand which military employment/assignments the item will be relevant to (user requirements) and the potential for this to impact upon task execution (human-equipment/clothing interactions). For instance, movement patterns, muscle groups and energy system use may be altered. This step would also include a visual inspection identifying likely bulk, stiffness and integration issues. The next step is to conduct a functional assessment where the key activity categories of the dismounted soldier (i.e. tactical, administrative movement) and associated transit platforms (i.e. ground transport, fixed/rotary wing) are considered with respect to the item to be introduced. In addition, the environments (i.e. jungle, desert) in which the items would be used are examined. Results: A valid and sensitive means to evaluate the introduction of new clothing and equipment is defined by the structured and progressive framework outlined above. The Load Effects Assessment Program (LEAP) system, as an instrumented obstacle course, is most relevant to tactical (engaged or not engaged) dismounted combatant movement given the intensity (maximal) and duration (~ 5 min) of individual trials. Further, specific LEAP obstacles may not be relevant in some environments (i.e. jungle) so an abbreviated obstacle course may be appropriate. When implementing the LEAP system it is important to capture both quantitative (time to complete each obstacle and time to complete the course) as well as qualitative (obstacle negotiation technique and adherence to doctrine) information. To have a systems level view on mobility implications for the introduction of new clothing and equipment it is also important to consider non tactical (i.e. administrative, transit) movement where appropriate given a considerably greater percentage of a soldiers time could be spent in this activity class. Conclusions: This structured and progressive framework allows for the evidenced-based application of LEAP as part of the incremental improvement, procurement, configuration and integration of clothing and equipment.

Intra- and Inter-Individual Reproducibility of the CAN-LEAP Obstacle Course

Presenter: Michel DuCharme (Canada)

DuCharme MB1, Jones MLH1, Terhaar P1, Pavlovic N1, Kelly A2, Wojtarowicz D3, Bossi LM1 1Defence R&D Canada – Toronto Research Center, Toronto, Ont., Canada 2HumanSystems Inc., Guelph, Ont., Canada 3Quality Training and Consulting, Markham, Ont., Canada Introduction. The Canadian version of the Load Effects Assessment Program (CAN-LEAP) was developed in 2011 to better understand the effect of soldier physical load, bulk and stiffness on physical performance of combat-related tasks. The CAN-LEAP comprises a timed series of 10 physical obstacles (tunnel traverse, sprint, stairs and ladder climbs, agility run, casualty drag, window climbs, bounding rushes, balance beam, front and back low crawl, and wall climbs) followed by three separate performance tasks stations (marksmanship, vertical jump, weight transfer). Objective. The objective of the present study was to investigate the reproducibility of the CAN-LEAP data within the same subjects (intra-individual reproducibility) and between subjects for the same experimental condition (inter-individual reproducibility). Methods. For the intra-individual study, 34 military male participants volunteered [mean age 28.0 ± 4.5 years; stature 1.77 ± 0.06 m; body mass 93.5 ± 16.8 kg; body mass index 29.6 ± 4.9 kg/m2; estimated VO2max 44.4 ± 5.1 mL/kg min; estimated adiposity of 18.7 ± 4.4 %] and were required to perform the CAN-LEAP course twice within a one week period using the same clothing and physical load. For the inter-individual study, a second population of 32 military male participants volunteered [mean age 26.7 ± 3.9 years; stature 1.77 ± 0.07 m; body mass 82.4 ± 12.4 kg; body mass index 26.3 ± 3.2 kg/m2; estimated VO2max of 48.1 ± 4.4 mL/kg min] and were required to perform the CAN-LEAP course using the same clothing and physical load as for the first population. Both populations were of combat arms occupations. During both studies, the environmental conditions were similar (indoor with air temperature of 15.3 ± 1.4°C and 16.7 ± 0.8°C for the intra and inter-individual studies respectively) and the subjects donned a baseline condition of combat trousers, t-shirt, combat shirt, combat boots, combat eyewear, and soft hat; and a loaded condition, which in addition of the baseline condition, comprised of a C7A2 rifle and sling (one fully weighted magazine), in-service helmet, tactical vest with standard combat load (4 loaded dummy magazines, 2 dummy frag, 2 dummy smoke, water, Personal Role Radio, 2 field dressing). The total weight of the clothing and equipment for the condition tested was 18.4 kg. Results. The times to perform each obstacle were compared between two trial repetitions performed within the same population (intra) and for the two trials performed for different populations (inter). The results demonstrate that the times for each obstacle were similar for the two trials performed within the same population and similarly for the two trials performed for different populations. Conclusion. The present results show that the performance data generated by CAN-LEAP obstacle course can be reproduced within the same test population and between comparable test population when similar experimental conditions are being compared.

Use of a Standardized Combat Readiness Course for Evaluation of Soldier Equipment Effects on Physical Performance

Presenter: Leif Hasselquist (USA)

K. Blake Mitchell, Leif Hasselquist, & Carolyn K. Bensel Natick Soldier Research, Development and Engineering Center, Natick, MA The Army strives to improve the equipment used to protect Soldiers. Integral to achievement of this goal are evaluation methods that are repeatable and allow for objective assessments of clothing and individual equipment (CIE) effects on Soldier performance. Purpose: A study was conducted to investigate use of a modified version of the Army Combat Readiness Test (mACRT) to differentiate between CIE configurations, including impacts on Soldier performance during a non-fatigued and a fatigued effort. Methods: Participants (enlisted infantrymen, N=23) wore four randomly ordered configurations with mean weights (kg) of: A – minimal load, 7.36; B – plate carrier with fighting load, 19.02; C – body armor vest with fighting load, 23.62; and D – body armor vest with ancillary armor and fighting load, 25.96. The mACRT was completed at maximal effort in the following order: 200-m straight run, low hurdles, high crawl, under/over obstacles, casualty drag, balance beam carrying ammunition cans, point-aim-move, sprint carrying ammunition cans, zig-zag run, and a final 200-m straight run. Participants completed the mACRT once in the morning when fresh and once in the afternoon following a 5-km march and a MOUT course run. Two-way (configuration, time of day), repeated measures ANOVAs were performed with post–hoc tests when significant (=.05). Results: The interaction was not significant (p>.05), but configuration and time of day were (p<.05): afternoon completion times were slower than morning times. Times (sec) for configuration A (mean±SD; 286.55±27.39) were significantly faster than those for configurations B (345.52±39.31), C (365.63±40.67), and D (382.80±45.40). Configuration B had significantly faster times than configurations C and D, which did not differ. Configuration B, C, and D times to course completion were slower than the configuration A time by 19, 25, and 32%, respectively, for the morning run of the mACRT and by 22, 30, and 35%, respectively, for the fatigued afternoon run. Excluding the 200-m straight runs, configuration A (mean±SD; 179.87±22.70) was again significantly faster than all other configurations. Configuration B (209.87±32.52) was significantly faster than configurations C (221.57±33.28) and D (231.24±34.11), which did not differ significantly. Correlational analyses between the weights of the configurations and mACRT completion times indicated a positive, moderate relationship (r(92)=.67, p<.001): as configuration weight increased, completion times increased. Conclusions: Overall, the mACRT successfully differentiated a minimal load configuration from configurations in which body armor was worn, and performance was also sensitive to the presence and absence of a fighting load. Times to complete individual obstacles did not detect differences among configurations. Fatiguing exercise influenced the results of the mACRT by increasing completion times, but the relationship among configurations was not affected by the fatigue state of the participants. From study findings, it appears that mACRT total course times can be used to differentiate between CIE configurations, but times for individual obstacles should be used with caution when assessing CIEeffects.

Relative Contribution of Bulk, Stiffness, & Load Weight of PPE on Soldier Performance

Presenter: Monica Jones (Canada)

Monica L.H. Jones; Glenn Jenkins; Michel B. DuCharme; Linda M. Bossi Defence R&D Canada – Toronto Research Centre, Toronto, Ontario, CANADA Introduction. Enemy threats and counter-insurgency operations have dramatically increased the focus on soldier personal protective equipment (PPE) and its critical role in ensuring survivability and mission outcome. While soldier ensemble provides essential protection, it can also interfere with a soldier's ability to tactically manoeuvre and accomplish mission critical tasks. Significant knowledge gaps persist, with respect to the relative contributions of load weight, bulk, and stiffness of a soldier's ensemble to operational task performance. Load weight refers to the skin-out weight and load distribution; bulk is defined as the additional spatial volume; and stiffness refers to the malleability of material. These attributes can be difficult to isolate and evaluate their individual contribution to mobility. Little is known about the performance degradation or costs of the cumulative or inter-dependent effects of these physical stressors on the soldier. Objective. The objective of this work was to differentiate and quantify the effect of bulk, stiffness and load weight, each systematically donned about the soldier's torso, on operational task performance. Methods. The effects of encumbrance on military representative tasks were quantified by the Canadian Load Effects and Assessment Program (CAN-LEAP) of 17 infantry and combat engineer soldiers of the Canadian Armed Forces (CAF) with a range of body sizes. Participants donned a baseline condition of fatigues only, followed by an experimental vest filled with soft ballistic fills: i) a Bulk Fill that was 20 mm in thickness, and ii) a Stiff Fill that was 6 mm. Both fills had a mass of 2.8 kg and equivalent ballistic protection; conversely, the malleability of the fills differed significantly. Load weight conditions comprised of the addition of a tactical vest equipped with full fighting order and a C7 weapon (total weight of 14.4 kg) to the two fill levels of experimental vests. Results. A 2-factor, repeated measures analyses of variance (ANOVA) demonstrated that total course time was sensitive to the difference between bulk (282.1± 48.7 sec) and stiffness (274.4 ± 49.2 sec) effects in the presence of a load weight, but not as isolated, independent effects (Bulk Fill: 198.5 ± 34.1 sec; Stiff Fill: 198.6 ± 29.7 sec). Individual obstacle times differed between the load weight conditions, with and without the experimental vest, irrespective of the soft armour fill. In comparison, the subjective ratings of the perceived "bulk" and "mobility" of the test conditions did differ significantly between the Bulk and Stiff fills, both with and without the additional load weight. Conclusion. Sensitivity of the CAN-LEAP course to differences of bulk, stiffness and load weight donned on the torso reveal an interaction between these effects with respect to soldier operational task performance. Subjective ratings indicate that participants perceive the differences in material properties at a higher fidelity than the results indicate from the course and obstacle performance times.

Load Affects Assessment Program (LEAP): Creation, Evolution, and Lessons

Presenter: Alison Kelly (Canada)

Alison E. Kelly1, Mark Richter2, David W.Tack1, Ken Ueno3, Philip TerHaar3, Eric Kramkowski4, Dorothy Wojtarowicz4, and Linda Bossi3, 1HumanSystems Incorporated, Guelph, Ontario, Canada 2Marine Expeditionary Rifle Squad, Systems Command, United States Marine Corps, Quantico, Virginia 3Defence Research & Development Canada, Toronto Research Centre, Toronto, Canada 4Quality Training and Consulting, Markham, Ontario, Canada The overburdened soldier will experience problems such as fatigue, heat stress, injury, and performance degradation; this is a fact few would dispute. The relationship between the magnitude of the soldier's burden and the degree of decrement on their battlefield performance was an area of research that had been given little attention to date. The development of a comprehensive, objective methodology to quantify the effects of soldier loads upon operational task performance was needed in order to examine this load / performance relationship. To address this need, The Marine Corps Load Effects Assessment Program (MC LEAP) was created in 2009 in conjunction with the Program Manager (PM) of the Marine Expeditionary Rifle Squad (MERS) of the United States Marine Corps (USMC). The development of the LEAP was a multi-staged iterative spiral design process that involved input from USMC experts in combat mobility requirements. Elicitation of information from subject matter experts (SMEs) via focus groups and design workshops resulted in a preliminary LEAP concept that identified general combat tasks and mobility requirements. Further reviews and input from SMEs resulted in a downselection to combat tasks that were deemed critical to Marines in the areas of mobility, lethality, and survivability. Different measurable attributes of human performance, such as speed, agility, and power were identified and related back to these specific combat tasks. Subsequent focus sessions resulted in the identification of a series of specific combat-related tests that could produce measurable performance attributes. These combat-related tests were then assembled into a detailed conceptual obstacle course design, which was reviewed, revised, finalized, and eventually physically constructed. Topics such as specific obstacle dimensions, order of obstacles/tasks, course duration, method of measurement, soldier safety, and transportability of the obstacle course were all addressed during this iterative spiral design process. Once physically constructed, the 10-obstacle and 3-accessory station LEAP underwent verification testing prior to being employed in subsequent Marine and soldier performance data collection efforts. Several experimentation campaigns have been successfully executed using the LEAP, with soldier feedback being collected from most studies. The soldiers' subjective feedback indicated a high level of face validity, relevancy, and overall participant satisfaction with the LEAP. The addition of a horizontal jump as well as a few protocol alterations have been made between successive LEAP data collection campaigns. An upgrade in the timing system has also allowed for a more discrete level of analysis and understanding of soldier burden upon combat performance. From the days of early paper based design through to the prove-out testing and the completion of data collection, many valuable lessons have been learned that have helped the LEAP evolve from both a technical and logistical standpoint.

CONCURRENT SYMPOSIA – WEDNESDAY

Integration of a Multidisciplinary Research Model for Human Performance Optimization and Injury Prevention in Special Operations Forces

Presenters: Mita Lovalekar (USA), Timothy Sell (USA), Kim Beals (USA), Takashi Nagai (USA)

Special Operations Forces (SOF) are unique in their physical training requirements. They suffer a wide range of injuries and must execute missions in demanding environmental and geographical conditions where physical demands are extreme. Preparation for these missions requires a multidisciplinary and integrated approach to ensure that tactical demands and injury prevention requirements are met through physical training. This approach should be scientifically guided and begin with a thorough examination of injury epidemiology; task and demand analysis; nutritional requirements for training and mission; and risk factors for injury and predictors of performance. These initial studies guide the development and refinement of physical training with follow-up validation of training to ensure that protocols are matching the tactical demands and injury prevention needs of the SOF. This symposium will describe an integrated, multidisciplinary, and scientific model for human performance optimization and injury prevention in SOF. A description of the unique injury epidemiology of SOF will be followed by presentations on injury risk and the effects of previous injury on current capabilities; the relationship between nutrition, performance, and injury; and physical training validation to match tactical demands and injury requirements.

Fueling the Warfighter – An International Perspective

Presenters: John Clarke (UK), Pal Stenberg (Norway), Scott Montain (USA)

Meeting the nutritional requirements of the modern warfighter presents many challenges. Heat and humidity alter dietary preferences and while freezing temperatures make rations built for temperate conditions inedible (frozen). Moreover, the missions vary from low to high physical demand and of varying length and frequency. The purpose of this symposium is to share data regarding the energy requirements of Warfighters during mission execution, and the approach various countries are taking to meet the nutritional needs of their Warfighters.

Novel Cooling Methodologies for the Military Training and Operational Environment

Presenters: Jason Kai Wei Lee (Singapore), Robert Kenefick (USA), Samuel Cheuvront (USA)

Numerous military training and operational scenarios can expose the Warfighter to considerable heat stress due to high environmental heat and/or high rates of metabolic heat production. As a result, body heat storage and associated cardiovascular strain limit work/exercise performance and increase the risk of exertional heat illness. In a number of military settings it may be difficult to dissipate body heat due to very hot ambient conditions and/or wearing required protective clothing or equipment. This symposium will present novel cooling methodologies either in use or in development for use by military personnel in the training and operational environment.

Historical Aspects of Military Physical Performance

Presenters: Bruce Jones (USA), Karl Friedl (USA), Anders Sookermany (Norway), Whitfield East (USA)

Soldiers need to maintain high levels of physical fitness to perform their duties and to complete physically demanding missions. As a consequence of the physical activity and training that soldiers engage in to stay fit injury rates are high. The Army health care system manages more than 1,000,000 injury encounters per year affecting over 250,000. These rates are about the same or a little higher than similarly active U.S. populations. The Army Institute of Public Health applies the step public health approach to prevent these injuries. Factors affecting injury risks include current activity levels, type of activity, past physical activity, level of physical fitness, health behaviors, and demographic factors. For running, injury risks increase with increasing running mileage. One of the first epidemiologic studies of running showed that injury risks increased from 21% per year to 71% as weekly running miles increased from 5 miles to over 50 miles per week. Several other civilian and military studies document a similar effect. A couple of studies show that there are thresholds of training above which fitness plateaus or goes down but injury rates rise. Type of activity has been shown to affect injury risks as well. In Army and Marine Corps male recruits those who report being the most physically active experience injury rates 50% to 60% lower than the least active. Physical fitness is an important factor in injury risks too. Recruits who are the least aerobically fit (i.e. run the slowest on an initial entry run test) have 1.5 to 3.0 times as many injuries as the most fit. Likewise, recruits with low levels of muscle endurance as measured by pushups and sit ups are at higher risk. Recent studies show similar results for women and infantry Soldiers. Those Soldiers who are the least flexible and the most flexible appear to be at greater risk of injury than the average ones, while %body fat and BMI show inconsistent relationships with injury risk. Among health behaviors smoking cigarettes has consistently been shown to be associated with higher injury risks. Studies of basic training show that rates of injury in women are 1.5 to 3.0 times higher than for men, however, rates for women of the same fitness levels as men have the same risks. Regarding prevention, reductions in running mileage coupled with more cross-training have been shown to reduce injury rates in Army basic training. On the other hand, stretching, warm-ups, footwear, shock absorbent insoles, and prescription of running shoes based on foot morphology have not been shown to prevent injuries. Conclusions: Physical activity/training causes injuries and greater amounts of physical activity increase risks. More past activity and higher levels of fitness protect against injury. Also, men and women of the same fitness level experience similar injury risks. Modifiable risk factors include: sedentary lifestyle, leanness with low fitness, and cigarette smoking. The best way to prevent physical training-related injuries is to prevent over training.

POSTER SESSION III – EQUIPMENT/INSTRUMENTATION

Load Effects Assessment Program (LEAP): Sensitivity to Operationally-Relevant Clothing and Equipment Conditions

Presenter: Linda Bossi (Canada)

Linda Bossi1, Alison Kelly2, Dorothy Wojtarowicz3, Monica Jones1, and Michel DuCharme1 1Defence Research & Development Canada, Toronto, Canada 2 HumanSystems Incorporated, Guelph, Canada 3 Quality Training and Consulting, Markham, Canada Background. Several nations are implementing the Load Effects Assessment Program (LEAP) to help understand and mitigate the effects of soldier load on operational performance and survival on the battlefield. LEAP comprises a series of timed obstacles, plus several accompanying accessory test stands, each of which represents operationally-relevant soldier tasks, or helps to characterize the soldier system (e.g., weight, stiffness, bulk, range of motion). Objective. The objective of this study was to determine the sensitivity of LEAP outcomes (time to complete the obstacle course, individual obstacle completion times, distance jumped, marksmanship scores, etc) to the weight and weight distribution of Canadian soldier baseline clothing and equipment. Method. This sensitivity analysis takes the following indoor LEAP studies into consideration: 1) Fall 2012 Baseline Study: 29 regular force fit combat arms soldiers completed LEAP in 7 baseline Canadian soldier incremental clothing and equipment conditions, using a repeated measures counterbalanced study design at an ambient temperature of 15.3±1.4°C. Conditions ranged from combat fatigues alone (5 kg above nude weight) to full fighting order with body armour, ballistic plates, C7A2 weapon and 10x 32-round magazines (28.4 kg load). 2) Winter 2014 Weapon Study: 34 regular force combat arms soldiers completed LEAP in 8 different simulated weapon weight and length conditions, using a repeated measures counterbalanced design at an ambient temperature of 16.7±0.8°C. Conditions included 3 baseline conditions (fatigues only, full fighting order (FFO) with in-service C7A2 weapon, repeat of FFO with C7A2) and five simulated future weapon configurations (weighted weapon test rigs of either C7 or C8 length, or 4.6, 6.9 or 8.4 kg weight). Results. Study 1) Results indicate a strong correlation between condition weight and overall obstacle course completion time (r = 0.97). A repeated-measures ANOVA of total obstacle course time identified a significant difference between load order conditions (F(6,168), p=0.0000). A Duncan's post-hoc analysis revealed that all conditions were significantly different from each other at $p \leq 0.05$, except for Conditions B & C (addition of CG639 helmet to combat fatigues plus weapon). Similar results were obtained for many but not all of the individual obstacle/test stands, suggesting changes to the LEAP protocol. Study 2) Soldier performance overall, and for many individual obstacles/test stands, was generally negatively affected as heavier rifles were carried. Certain obstacles were better able to discriminate between weapon weight or length as the contributing factor in mobility task performance. Conclusions. Overall performance on the LEAP is sensitive to subtle changes in the load characteristics of representative soldier system ensembles and loads. Individual obstacles and test stands vary in their sensitivity to load parameters, suggesting modifications to LEAP protocol for the purposes of load effects modeling, although the LEAP, in its current configuration, remains relevant for the comprehensive objective testing of soldier system usability or "fightability" assessment.

Using GPS and Radio Frequency Identification (RFID) Based Systems for Timing Military Endurance Performance Events

Presenter: Peter Frykman (USA)

PN Frykman, SA Foulis, MA Sharp, EJ Zambraski, US Army Research Institute of Environmental Medicine, Natick, MA The challenges of evaluating events such as combat road marches require timing systems that can handle large numbers of participants, provide high resolution data and allow ease of data analysis with minimal post processing. These systems must be robust and adaptable for use in widely ranging weather and terrain conditions. RFID systems make it easy to time discrete portions of events giving split times between mile markers and the time spent at planned rest stops. GPS measurement systems provide a stream of position data allowing the evaluation of road march performances. Purpose: To evaluate the feasibility of RFID and GPS systems for timing combat road marches. Methods: To measure the movement time and rest time during a 20 km combat road march, 9 male volunteers (height 1.77±0.07 m, total mass 124.6±10.9 kg) wore a 46 kg combat load and were each fitted with GPS logging devices (Travel Recorder X, QStarz, Taipei, Taiwan) and a RFID based sport timing system (SIAC, SPORTident, Arnstadt, Germany) . The GPS collected coordinate position data every 5 seconds during the march. RFID logged when volunteers passed the start, finish and each 1.6 km along the road march course. Times were collected at the start and finish of 3 planned rest breaks (~5, 10 and 15 km) during the march. Paired t-tests compared the time between each checkpoint of the two timing systems. To compare RFID and GPS based performance times, we determined the time to travel 1.6 km (between the 1.6-3.2 km RFID control points, and from the 1.6-3.2 km position in the GPS log). Mean±SD and p-values are shown. Results: Elapsed time measured by RFID (including rests) was 308.6±27.8 min. Timing metrics (min) throughout the course are shown in the table. Both systems were similar for all measures. Additionally, there was no difference in time to complete 1.6 km (19.5±2.4, 19.6±2.6 min, p=0.66). RFID(point-to-point time, min) GPS(track time, min) p-value Start – Rest 1 60.4±6.0 60.3±5.7 0.59 Rest 1 – Rest 2 52.9±4.0 53.4±4.6 0.30 Rest 2 – Rest 3 56.6±7.9 57.2±8.1 0.48 Rest 3 – Finish 72.2±14.8 72.7±13.9 0.47 Total Movement Time 242.5±23.0 243.7±22.4 0.39 Discussion: Times were similar on both systems; however each system has its strengths and weaknesses. While the GPS provided continuous position data it required significant post-event processing effort to derive performance times. The RFID system was easy to set-up, provided accurate timing with minimal processing for multiple subjects and allowed investigators to track who was on the course and who had finished, and to get their performance results immediately. Conclusions: While RFID and GPS provided accurate performance times during the road march, the RFID was easier to deploy and required much less effort to get usable performance data. Opinions or assertions herein are private views of author(s) not those of the US Army or DoD.

The Utility of a Tablet Controlled Wireless Timing System to Run and Manage Military Physical Performance Testing

Presenter: Jay Hydren (USA)

Jay R. Hydren, Peter N. Frykman, Marilyn A. Sharp, Edward J. Zambraski. U.S. Army Research Institute of Environmental Medicine Simulations of military job tasks had been previously limited to simple continuous tasks with time to complete as the primary data. New technology allows for cost efficient portable timing equipment to accurately and repeatedly measure tasks that require rapid movements followed with short defined rest periods simulating taking cover or concealment from an enemy. The purpose of this study was to demonstrate the utility of a tablet controlled wireless timing system to measure the effects of fatigue while moving under direct fire with variations in fighting position and rush distance. Ten male subjects (age: 23.2±2.0yrs; height: 181.2±5.7cm; body mass: 81.6±10.1kg) participated and all data collection was approved by the USARIEM IRB. Using the fitLight Trainer TM (Aurora, Ontario, Canada), the LED light was set to a five second delay. After the timing light turned green subjects, wearing 34-41kg, rose from the fighting position, rushed to the next timing stations to trip the proximity sensor set to 50cm (measured to a thousandth of a second) and assumed the next fighting position; this continued for eight rush segments. There were two 15m sections, four 10m sections followed by two 15m sections. Fighting position rotated in order through prone (starting position), kneeling and crouching. Data are reported as mean and standard deviation, students paired t-test was used to compare reaction times and alpha was set at 0.05. Total time to complete the course was 85.2±2.5 seconds. Time from when the light turned on until the subject activated the timing sensor for each fighting position and rush distance combination can be seen in Table 1. During the test, three fighting and distance combinations were repeated. Times for prone to 15m rush and crouch to 10m rush increased during the second rush 0.8±0.6 and 0.2±0.2 seconds ($p<0.05$), respectively, but kneeling to 15m rush did not change, 0.0±0.3 seconds; indicating that the kneeling fighting position is less sensitive to fatigue than the other two positions. During pilot testing limitations to this technology where identified to be the reliability of the wireless connection, in 3 out of 30 tests one light did not activate, and the proximity sensors can automatically trip from ambient light, which occurred once out of 30 tests. In conclusion, tablet controlled wireless timing systems provide a high resolution, repeatable solution for the measurement of complex military tasks with little technical assistance required during testing. The opinions or assertions contained herein are the private views of the author(s) and are not to be construed as official or as reflecting the views of the Army or the Department of Defense. Table 1: Segment times for moving under direct fire. Fighting Position 10 meter Rush 15 meters Rush Prone 5.8±0.5*† 7.3±0.7*† Kneeling 4.7±0.3*† 5.5±0.3*† Crouching 4.3±0.3* - *indicates significant difference between firing positions. †Indicates significant difference between rush distances.

The Utility of Using a Personal Fitness Device to Track Sleep, Activity, and Nutrition in an Infantry Battalion

Presenter: Theresa Jackson (USA)

Theresa K. Jackson (1) Jacqueline Watkins (1) Laura Vasquez (1) LTC Mark Mellott (2) COL Deydre Teyhen (2) LTC Anne Andrews (2) 1. U.S. Army Public Health Command 2. U.S. Army Office of the Surgeon General Purpose: To provide Infantry Soldiers' perceptions, experiences, and feedback regarding wearable technology to monitor their sleep, activity, and nutrition (SAN) behaviors, and to discuss the feasibility and utility of such technology as a tool to improve Infantry Soldiers' SAN. Methods: This study is part of a larger project to evaluate a U.S. Army Office of the Surgeon General Performance Triad initiative to improve SAN among Soldiers. The program provided Soldiers with health education via communication products, weekly SAN training via their squad leaders, and a Personal Fitness Device (PFD), to assist in self-monitoring of these behaviors. From September 2013-March 2014, a full Infantry Battalion of Soldiers at one installation in the Southern region of the United States participated in the program. Upon completion of the six-month pilot program, a team of U.S. Army Public Health Command scientists conducted 20 structured focus groups with 146 Soldiers within the battalion in March 2014. Facilitators asked participants about their experiences with the overall program as well as with the wearable technology. The analysis team summarized feedback across groups and themed based on the most common responses. Results: Soldiers overwhelmingly defined the program in terms of the PFD, and this component dominated the education and training aspects. Leaders invested time to ensure their Soldiers were wearing, synching, and using their PFDs, which they perceived as burdensome. Soldiers most commonly used the PFD to track their steps and then their sleep behaviors; they rarely utilized it to monitor their nutrition behaviors. They enjoyed competing with other units using information tracked by the PFD. There were several barriers to PFD use: perceived inaccuracy of the information monitored, issues charging the device, problems synching the device and with compatibility to various smartphones, durability issues (e.g., broken wristbands), perceived unreliability of information, and lack of technical support. Infantry Soldiers in this battalion were more likely than the leaders to perceive the PFD as valuable, but commonly perceived their use as a "Big Brother" tactic to track their activities. Several Soldiers considered the PFD fun and useful until its novelty wore off or its use was mandated. Problems with the PFD were more noticeable when infantry Soldiers were in field conditions. Several focus group participants noted that such devices would be better suited for individuals who are sedentary or those not in an infantry unit. Conclusions: Although randomized controlled trials have demonstrated the benefits of PFD, implementation in a mandated and military environment limits the acceptance and utility of these devices. Further, training leaders on how these devices can help them improve performance of their Soldiers is required to improve buy-in. A better understanding on how to incorporate PFD in the military is required.

Application of a Graphene Heater to Korean Military Winter Uniforms and Its Physiological Evaluation: A Pilot Study

Presenter: Young Joon Jang (Korea)

Young-Joon Jang1* Sang Min Kang2, Byeong-Hui Hong2, Joo-Young Lee1 1 Department of Textiles, Merchandising and Fashion Design, Seoul National University, Korea 2 Department of Chemistry, Seoul National University, Korea South Korea has adopted the conscription system serving two years since the outbreak of the Korean War. Standing guard during winter nights, especially, in alert holding areas or near the border require soldiers to stay outside and hold their position for a long time. Although heavy uniforms are provided, they are not sufficient to maintain soldiers' body temperature during severe winter nights. Recently a newly-developed and provided heating jacket in which a hot-wire system was retrofitted with a portable battery, but the efficiency is not sufficient. At this point, 'graphene' has received attention as a new heating material, because of its flexible, fast-heating, and homogeneous temperature distributing nature. No study has, however, been applied the graphene heater to military winter uniforms. Therefore, the purpose of the present study was to explore the possibility of graphene as an inner-clothing heater and to investigate the body regional influences of graphene-heating on physiological responses in a cold environment. Graphene films were synthesized by a chemical vapor deposition (CVD) method. A graphene heater (7cm×5cm) was attached on the inner side of a winter jacket. A male student (23 years in age, 179 cm in height, 72.3 kg in body weight, and 1.94 m2 in body surface area) volunteered as a subject in the pilot test. A climate chamber was maintained at an air temperature of -6°C and a relative humidity of 20% with an air movement of 4~5 m•s-1. The surface temperature of the graphene heater was maintained at 44.9±3.5°C. To investigate the effective body region where the graphene heater was attached, four regions were chosen: the upper arm (AH), the back (BH), and chest (CH) and no heating condition (Control). After 20-minutes sitting on a stool at the climate chamber, the grapheme heater was activated for 30-minutes followed by a 10-minute recovery. Mean skin temperature was estimated by the DuBois' 7-points equation. Rectal temperature at the depth of 13 cm was recorded every five seconds. Subjective perceptions, such as thermal sensation, thermal comfort, shivering sensation, and humidity sensation, were asked every ten minutes using categorical scales. The results showed that the change in rectal temperature was smaller in the graphene heating conditions than in the control, while the changes in mean skin temperature showed similar tendencies over four conditions. The subject expressed more severe shivering sensation for the control when compared to the three heating conditions, but no apparent difference among the three heating conditions (AH, BH and CH) was found. In the present study, the applicability of a graphene heater to the military winter uniform for reducing the cold-induced strain of watch guards in winter was found. The most effective and efficient heating temperature, total area, and body regions will be investigated through further studies.

Prediction of Landing Forces During Static Line Parachuting

Presenter: Tong Lee (Singapore)

Tong LEE1, Kaizhen CHEN1, Chee Hoong CHEONG1, Qing Xiang YEE1, Carolyn Jiaming FU1, MAJ(Dr) Alexander Gorny2, MAJ(Dr) Junren ZHANG2 1DSO National Laboratories, Singapore 2HQ Army Medical Services, Singapore Armed Forces PURPOSE Ground reaction forces (GRF) must be quantified during static line descent to give an indication of skeletal loading and lower limb injury risk. However, it is not possible to directly capture landing forces via force platforms during actual live descent. Instead, unobtrusive tibial accelerometers may be mounted on the paratrooper to provide a surrogate measure of landing GRF. METHODS To infer GRF from tibial acceleration (TA) measurements, a correlation between the two measures was first established via a laboratory trial. 20 parachute jump instructors (Age 41.6 + 7.7years; Height 174.5 + 7.6cm; Mass 76.1 + 7.7kg) performed jump landings onto a pair of force platforms (Bertec Corporation, OH, USA) from three different heights – 30cm, 60cm, and 90cm. A pair of triaxial accelerometers (Gulf Coast Data Concepts LLC, MS, USA), mounted on the flat antero-medial aspect of the mid-tibial shaft, was used to capture tibial shock during impact. Both GRF and TA were recorded at 512Hz. At least 3 successful jumps were captured at each jump height. A successful landing was defined as a bilateral landing with each foot landing on individual force platforms. Raw TA data was filtered using a fourth-order, zero-lag Butterworth low pass digital filter (cutoff frequency 100Hz) to remove skin movement artifacts. Peak axial TA values, along with the corresponding anterior-posterior and the medial-lateral accelerations, were extracted. The orientation of the tibia upon impact was derived via application of the same Butterworth filter (cutoff frequency 1.2Hz) to raw TA data to yield pitch and yaw angles. Triaxial TA and peak GRF measures were next correlated by constructing a linear multivariate model in R software Version 2.15.1 (The R Foundation for Statistical Computing, 2012). The model was subsequently applied to TA data collected from 73 trainees (Age 19.0 + 1.2years; Height 174.5 + 5.9cm; Mass 68.6 + 7.2kg) from the 213th Basic Airborne Course, performing a total of 101 live descents, to predict actual landing forces. RESULTS A mathematical correlation equation to predict GRF from TA in the x, y, and z directions, tibial orientation, and paratrooper mass was derived (R^2 0.7145, $F(8,266)$ 83.2, $p<0.01$). The average GRF predicted per leg during live descent was 2796.0 + 1473.0N (4.19 + 2.17 times body weight). CONCLUSIONS A linear, multivariate model relating TA to GRF was explored instead of applying the simple linear $y=mx+c$ regression technique commonly found in literature in an attempt to more accurately represent the influencing factors on GRF. Some limitations exist, however – the mathematical model cannot account for inter-individual variations in tissue and bone properties, which may influence shock transmission through the skeletal system. Nonetheless, the use of TA measures to estimate GRF is widely accepted. Knowledge of impact forces during actual live descent, together with injury epidemiology, can inform future interventions for injury prevention.

Methodology for Measuring Effect of Protective Gear on Soldier Physiological Performance

Presenter: K. Blake Mitchell (USA)

James R. Williamson, Brian A. Telfer, Tadd B. Hughes and K. Blake Mitchell* MIT Lincoln Laboratory, Lexington MA *Natick Soldier Research, Development and Engineering Center, Natick MA Purpose: Develop and apply a methodology to measure objective Soldier physiological performance data as impacted by individual protective gear. Methods: Data from the Soldier Protection Benchmark Evaluation (SPBE, 17 Sep-9 Oct 2012, Fort Greely AK, n=34) were analyzed. SPBE's goal was to develop a methodology for assessment and differentiation of Soldier clothing and individual equipment, and utilized four uniform configurations (A – minimal load, 7.36kg; B – plate carrier with fighting load, 19.02kg; C – body armor vest with fighting load, 23.62kg; and D – body armor vest with ancillary armor and fighting load, 25.96kg). The configurations included individual uniform items, equipment, and Soldier's load. Physiological data collected with Hidalgo EQ-2 monitors consisted of heart and respiration rate, torso-mounted accelerometry, skin temperature, and core temperature from an ingestible capsule. A Kestrel 4400 portable weather monitor recorded ambient temperature and wind speed. Of the ten SBPE events, this analysis focused on the timed, maximal effort 5km march. To evaluate the impact of different levels of protective gear on Soldier performance, we first derived estimates of "effort" based on average individual heart rate on each 5km march. In comparing any two equipment configurations, we assessed the relationship between within-subject changes in effort to within-subject changes in average marching speed. Across all subjects, we used a maximum likelihood linear regression fit of these relationships to estimate the average relative equipment effect. Results: By incorporating estimates of Soldier effort, we demonstrated an improved ability to differentiate the effect on performance of similar equipment configurations. The standard approach for assessing equipment effect is to use group-level performance measures, without regard to individual variations in Soldier effort. By incorporating Soldier effort, we showed statistically significant differences in marching speed between all four equipment configurations. In particular, we obtained a statistically significant estimate of a small average performance decrement due to switching from configuration B to configuration C (1.7% decrement, $p = 10\text{-}4$). The standard technique, which does not incorporating Soldier effort, finds no significant difference in this case ($p = 0.69$). Conclusions: It is important to quantitatively assess physiological effects of equipment, but individual Soldier variations must be properly normalized to accurately distinguish between equipment configurations. This methodology points the way forward for field data assessments in general, as pervasive physiological sensing promises greater discriminative power in detecting subtle effects due to changes in equipment or other contextual factors of interest.

Portable Method for Measuring Live-Fire, Shooter-in-the-Loop Weapon Recoil Dynamics

Presenter: Frank Morelli (USA)

Frank Morelli, Jennifer M. Neugebauer, Courtney Webster, and Michael LaFiandra U.S. Army Research Laboratory, Human Research and Engineering Directorate, Dismounted Warrior Branch Aberdeen Proving Ground, MD 21005 When considering target engagement scenarios with shoulder-fired small arms systems, recoil is a primary factor that affects marksmanship performance. Recoil is defined as weapon momentum in the opposite direction of the projectile trajectory, and may be categorized into physical and perceived recoil. Physical recoil refers to the physics of the recoil energy, while perceived recoil can be defined by the shooter's subjective experience. While physical recoil can be calculated using equations of impulse-momentum and known information about the weapon and ammunition1, the relationship between physical and perceived recoil is currently underdeveloped. This effort details a portable method developed to quantify recoil dynamics including forces, moments, accelerations, and motion of both the weapon and shooter during shooter-in-the-loop (versus mount fired) live fire. Once quantified, recoil dynamics can be related to the shooter's subjective recoil perceptions and marksmanship performance to improve understanding of shooter-in-the-loop recoil dynamics. Independent variables that varied recoil energetics included ammunition type, muzzle devices, and weapon type. Variables included weapon/shooter velocity and acceleration before, during, and after a shot, forces and moments exerted on the shooter at the support hand and shoulder, subjective metrics from the shooter, and shooting performance. Three-dimensional motion analysis was used to calculate weapon/shooter velocity, a quantity included in standard equations describing weapon recoil. Force transducers placed at the buttstock and vertical grip were designed and fabricated to be fully compatible with standard buffer tubes and rail systems. Dynamic ranges for both force transducers were based on recoil data collected from rifle and shotgun systems. Additionally, accelerometers on the weapon and shooter provided redundant measures of motion and a means of quantifying shooter tremor. The three main components of the portable measurement suite included: (1) force transducers at the stock and vertical grip, (2) three-dimensional motion capture of shooter and weapon, and (3) accelerometers on the shooter and weapon. This suite allowed for high resolution (2000 samples/sec) collection of a novel weapon recoil dynamics data simultaneously with shooter weapon control and reaction dynamics for 14 subjects firing 3 weapon systems (M4 using 5.56 mm, M4 using 6.8 mm, and M110 using 7.62 mm), both with and without suppressors. The force transducer ranges (500 ft-lb along the barrel axis) were appropriate for use on the 3 weapon systems with varying recoil energetics. Subjective assessments of recoil as well as marksmanship accuracy enabled quantification of shooter-in-the-loop recoil dynamics as well as shooter recoil perception and shooting performance. A portable method to quantify weapon recoil was developed and used during collection of marksmanship performance data. Combined with metrics of perceived recoil, this method provides a comprehensive assessment of weapon system dynamics and the related performance during shoulder-fired scenarios. 1. U.S. Army Test and Evaluation Command. (1977). Test Operations Procedure (TOP) 3-2-504, Safety Evaluation of Hand and Shoulder Weapons. Aberdeen Proving Ground, MD.

CAF Military Task Simulations: Impact Analysis

Presenter: Philip Newton (Canada)

Philip Newton, MSc Canadian Forces Moral and Welfare Services, Directorate of Fitness, Human Performance Research and Development Background: Project FORCE (Fitness for Operational Requirements of CAF employment) was established to develop an occupationally relevant and scientifically valid minimum fitness standard for Canadian Armed Forces (CAF) Personnel. As part of the research process military Subject Matter Experts (SME) established performance standards for 13 common military tasks. Purpose: The physical demands of these tasks needed quantifying in order to compare and potentially eliminate any redundant components. Two of the more complex tasks to quantify were the use of a "thumper" to drive metal pickets into the ground and the use of a pick axe to break hard compact ground to dig a latrine. Field trials were unsuccessful at standardising and evaluating the physical demands of repetitive impacts therefore task simulators were required to be developed. Methods: All forces, distances and paces were accurately simulated to ensure the full range of motion was captured and appropriate energy systems were recruited. Thumper: Construction of a wire fence requires driving pickets into the ground with a thumper (15kg capped metal tube with handles) requiring repetitive overhead lifting, shoulder mobility and coordination. A thumper was designed with a modified weight to create a 1 person task. A single picket was replicated with metal angle iron and the final design involved an extended range, gas pressurised, shock absorber. A pivot point at the base allowed the thumper to slide over the picket at a comfortable height before being lifted into the upright position. The thumper was dropped repeatedly from full extension. After the appropriate number of impacts a latch would be used to hold the picket down so the thumper could be removed at the appropriate height for a CAT 1 fence. Pick Axe: An older piece of kit used by firefighters was modified to accurately reflect the postural biomechanics of working with a pickaxe. This included selected a sledge hammer with identical shaft length (36") and head mass (6lb) and creating a target area that dampened the impact. A static and dynamic calibration process was performed to match the shaft deflection of each tool using a strain gauge. The total force required to loosen hard compact ground could then be quantified and equated to the total force to move a weighted beam a set distance. Results: While thumping at the specified pace (n=4), average heart rate ranged from 102-134 beats/min and average oxygen consumption averaged 1-1.9L/min-1. For the pick axe excavating 180 litres of hard compact ground with a pick axe equated to moving a weighted beam 400cm along a track with a sledgehammer. Conclusion: The physical demand of thumping in a picket was quite low and deemed to be below the requirements of the other military tasks. The Physical demand of the picking simulator however was greater in both intensity and duration and required inclusion in the final test battery.

Effects of Three Different Types of Standard Issue British Army Footwear on Vertical Ground Reaction Force in Marching Drills

Presenter: Alex Rawcliffe (Scotland)

Rawcliffe, A, Psycharakis, S and Graham, SM, Edinburgh Napier University, Simpson, RJ and Connaboy, C University of Houston, USA INTRODUCTION: The high incidence of lower-limb musculoskeletal injury (LL-MSI) sustained by military recruits during basic military training (BMT) is the principle cause of training day's lost5 and has been defined as the main cause of morbidity of recruits during BMT3. Stress fractures of the lower-extremities are responsible for a significant portion of attrition in BMT with associated financial implications for military budgets4. Previous research has determined that repetitive high-loading activities such as running/marching are the most frequently reported causes of stress fracture during BMT2 and has identified high incidence rates of LL-MSI during the early phases of BMT1. Furthermore, recruits who sustain a stress fracture during BMT are four-times more likely to be discharged from training programmes1 and are at a higher risk of sustaining additional stress fractures during subsequent training (10.6% incidence within twelve-months of injury, versus 1.7% in injury-free recruits)1. An understanding of the multi-factorial nature of the aetiology of LL-MSI in conjunction with the importance of repetitive high-loading activity on the incidence of LL-MSI suggests the development of a series of measures which could each act to marginally reduce the magnitude (absolute vertical ground reaction force - vGRF and rate of force development - RFD) of the load experienced in a variety of military tasks which in turn would reduce the accumulative load experienced. PURPOSE: This study examined the effects of wearing three different types of footwear on the vGRF and RFD when performing five marching drills to determine the respective force mitigating properties of each type of footwear. METHOD: Fifteen recreational active males (mean ± SD; age 22.4 ± 1.7 years; height 177 ± 5.6cm; weight 83 ± 8.7kg) performed 10 trials of the 5 marching drills: (i) Halt, (ii) Stand-at-Attention, (iii) Stand-at-Ease, (iv) Quick-March and, (v) Walking. This process was repeated wearing each of the issued footwear (Combat boot, Ammo boot and Hi-Tech Silver Shadow training shoe). Force plate data (sampled at 1000Hz) were analysed to determine vGRF and RFD. A within-participant repeated-measures design was utilised to analyse differences between kinetic variables in each marching drill wearing the three different types of footwear. RESULTS: The training shoe significantly ($p<0.05$) attenuated the vGRFs of Stand-at-Attention, Stand-at-Ease and, Halt when compared with the other footwear. There was no significant difference observed in the walk and quick march drill between footwear. CONCLUSION: In comparison to the combat boot and ammo boot, the training shoe significantly reduced both vGRF and RFD during the execution of the specific marching drills. Given the repetitive nature and high-loading characteristics associated with marching drill during BMT, the utilisation of the training shoe could act to reduce the magnitude of accumulative load experienced by the recruits. Other measures need to be identified and utilised for other military activities as a means of reducing injury.

Acoustic Dosimetry in Tactical Environments to Support Auditory Damage Modeling and Hearing Protection

Presenter: Christopher Smalt (USA)

Hearing loss in active duty US service personnel has reached unacceptable proportions. In 2010 alone, there were ~30,000 cases of noise-induced hearing loss (NIHL) injuries. Enhanced noise dosimetry data in tactical environments are needed to more accurately characterize the sounds that warfighters experience in real-world situations. In partnership with the Marine Expeditionary Rifle Squad and USARIEM, MIT Lincoln Laboratory sought to make environmental/tactical noise measurements and completed an initial study in August 2013 focused on collection of dismounted warfighter exposure data in tactical environments in Afghanistan. This data quantified noise exposure through warfighter-worn sensors for both continuous and impulsive sounds, including spectral characteristics and high intensity SPLs. Noise exposure events included enemy sniper fire and simultaneous capture of a gun battle on both vehicle mounted and dismounted Marines. Such phenomenological data, when processed with auditory damage models, would have several critical applications, including the following: support prediction of NIHL, inform the effective design of hearing protection devices, and identify activities and environments associated with high risk of NIHL.

Foot Type Symmetry and Change in Foot Structure from Sitting to Standing Conditions

Presenter: Jinsup Song (USA)

Jinsup Song1, Michael Neary2, William Brechue2, Rebecca A. Zifchock2, Howard Hillstrom3 1Temple University School of Podiatric Medicine, Philadelphia, Pennsylvania, USA 2United States Military Academy, West Point, New York, USA 3Hospital for Special Surgery, New York, New York, USA Foot symmetry and change in foot structure as a function of weight bearing status have not been investigated in a large cohort study. The foot structure of 1,054 incoming cadets at the US Military Academy (172 female, 18.5±1.1 years, 24.5±3.0 kg/m2) was examined. Arch Height Index (AHI) was assessed in sitting and standing, and its value was used to classify each foot into 3 foot types as previously described [1]. Based on standing AHI, 68.1%, 24.5%, and 7.5% of the study subjects' left foot was categorized into planus, rectus, and cavus foot types, respectively. Asymmetrical foot type was noted in 28.6% of subjects in sitting and 23.6% standing conditions. Foot length increased from sitting to standing conditions; this change was significantly greater in cavus and rectus foot type groups than the planus group. In contrast, arch height flexibility (AHF) was significantly greater in the planus group than both cavus and rectus foot type groups. Results of this study suggest the importance of controlling for weight bearing status when assessing foot structure or fitting footwear. Given that about a quarter of participants demonstrated an asymmetrical foot type, findings also suggest the importance of assessing both feet independently. Table 1. Mean arch height flexibility and change in foot length across the 3 foot type groups Cavus Rectus Planus P-value N (female) 53 (5) 184 (34) 711 (133) AHF (mm/kN) 13.2 ± 7.4 14.8 ± 7.4 16.6 ± 7.4 0.0001 a,c ΔFoot Length (mm) 4.8 ± 2.6 4.3 ± 2.2 3.6 ± 2.1 <.0001 a,c Arch height flexibility = [(arch height in sitting – arch height in standing) / (0.4 * body weight)]. A significant difference (P<0.05) was observed between a cavus and planus foot types and c between rectus and planus foot types.

Health Promotion and Wellness Physiologic Monitoring at Point of Injury/Care (Theater/Deployed Settings)

Presenter: David Williams (USA)

David L. Williams, MS, FACHE, US Army MRMC, TATRC, Fort Detrick, Frederick, MD, USA, 21702. dave.williams@tatrc.org, 301.619.1398 Abstract: BACKGROUND: Smart Telemedicine at point-of-injury (care-delivery) is a three-year, three-phase research study designed to markedly improved electronic medical record capture and enhance 1st Responder care delivery at Role-0. JPC-1 funded research effort. The Problem: Medics operate in the least connected area for deployed providers. Smart devices and cellular networks have the demonstrated potential to bridge this gap. Three years: 1 Connectivity, 2 Sensors, 3 Medical Alerts / JCIDS (TC3) Para 6b. Materiel. METHODS: Year-2-SENSORS The integration of Sensor-Apps on the Nett Warrior cell-phone provides digital connectivity, which can replace the "Medical Golden hour to "Platinum-Minutes". Smart Mobile Hand-Held (MHH) device research focused on apps to improve Population Health in the field, soldier worn and medic carried bio-sensors. This new capability sends tele-vials from Solider worn clinical sensor to Medics that can respond to just-in-time alerts; an historic first for Military Medicine. Year-3 research will introduce "Tele-Coaching," with intervention by PAs, expanded field lab results, and will feature a large capacity, Personal Health Record-CAC. RESULTS: During NETMOD-13, (Connectivity) Combat Medics captured and forwarded clinical/encounter data ahead of patient movements, both air & ground. On-site treatment capture included voice, tap, live-video, and clinical data streaming to the CSH EHR seven miles away. In NETMOD-14 Patient Alerts sent from Nett Warrior- phone, provided soldiers an increased situational awareness of their personal wellness norms to improve resiliency. Additionally, "other-than-normal" sensor readings, "algorithm driven" were sent to Medics as clinical alerts. CONCLUSION: The successes with Year-1 Connectivity – provided tele-vitals capture and transfer capability. Sensor Research in Year-2 provided health information exchange (HIE) between the Medic on a NW-phone proved PA "Tele-Coaching capability; added HH-Field Screening Laboratory; and WIN-T supported Tele-BH between Ft. Gordon/Dix. The projection for Year-3 is Alerts from advanced sensors for Public Health 101- with enhanced clinical data and SA for soldier resiliency. 298-words Biography: Mr. Williams is a healthcare IT-consultant, who has excelled in acquisition management at DOD Health Affairs. Currently, Dave is the Telebehavioral Health Research Project Manager for theater, at TATRC. Previously, he helped manage the implementation of 8-world-wide clinical systems for the Military Health System, collectively known as the AHLTA (military EHR). Dave areas of specialization are: contract management, industry best practices implementations, and IEEE/ CMMI/Quality Improvement (software testing). While serving as the Principal Consultant to the DOD (HA), he led the support team that turned the Patient Safety concept into reality. Locally, Mr. Williams is Past President, National Capital Healthcare Executives, nationally; he is Board Certified Health care Executive and a Fellow in ACHE. 114- words 2014 Research Area: Health Promotion and Wellness Physiologic Monitoring (Theater / Deployed settings Objectives: Smart Telemedicine - mobile devices – near point-of-injury/care

Signal Processing for Exercise Dosimetry

Presenter: Brian Telfer (USA)

Purpose: To develop signal processing algorithms for small body-worn accelerometers that can be used to: 1) automatically and objectively characterize activities, and 2) detect early onset of overuse injuries. For purpose 1, the goal is to replace the expensive manual observation and logging that has been required in past Soldier studies. The algorithms need to measure the times spent in different body positions and activities, and to estimate the loads carried while walking or marching. For purpose 2, the goal is to detect when the movement patterns within a known activity type become asymmetric or otherwise anomalous. Methods: Data from two sources were used for algorithm development: the Soldier Protection Benchmark Experiment (SPBE, n=34) and MIT Lincoln Laboratory employees (n=30). Accelerometers (Actigraph, 100 Hz) were worn on each foot and on the torso (Hidalgo, 25.6 Hz). Loads for SPBE soldiers varied from 45 to 90 lbs, and for Lincoln Laboratory employees from 0 to 41 lbs. The Lincoln Laboratory data also includes subjects with gait asymmetries, artificially induced from a weight (1/3-2 lbs) worn on one ankle. The SPBE data were measured on an outdoor 5 km march at varying, uncontrolled marching speeds. The Lincoln Laboratory data were measured in both indoor and outdoor walking trials at varying, uncontrolled walking speeds. Specific algorithms have been developed to: 1) classify walking, running, and sedentary / menial activities, 2) estimate approximate load, and 3) detect gait asymmetries. The algorithms are always trained and tested on out of sample data, so that there is never any data from a test subject in the training set. Results: Activities have been automatically classified to support load estimation and gait asymmetry detection. Loads are estimated from torso accelerometry obtained in walking trials that range in duration between 15 and 117 minutes, each with a fixed load ranging from 0 to 90 lbs. The root mean square error for load estimates is 14 lbs, with correlation between estimated and actual loads of $R > 0.9$. Gait asymmetries are detected from foot-worn accelerometers, given walking trials of approximately 5 minutes duration. Detection rates are summarized using area under the receiver operation characteristic (ROC) curves. Given ankle weights of 1/3, 1/2, 1, and 2 lbs, the average area under ROC curves obtained is 0.66, 0.75, 0.92, and 0.98, respectively. includes subjects with gait asymmetries, artificially induced from a weight (1/3-2 lbs) worn on one ankle. The SPBE data were measured on an outdoor 5 km march at varying, uncontrolled marching speeds. The Lincoln Laboratory data were measured in both indoor and outdoor walking trials at varying, uncontrolled walking speeds. Specific algorithms have been developed to: 1) classify walking, running, and sedentary / menial activities, 2) estimate approximate load, and 3) detect gait asymmetries. The algorithms are always trained and tested on out of sample data, so that there is never any data from a test subject in the training set. Results: Activities have been automatically classified to support load estimation and gait asymmetry detection. Loads are estimated from torso accelerometry obtained in walking trials that range in duration between 15 and 117 minutes, each with a fixed load ranging from 0 to 90 lbs. The root mean square error for load estimates is 14 lbs, with correlation between estimated and actual loads of $R > 0.9$. Gait asymmetries are detected from foot-worn accelerometers, given walking trials of approximately 5 minutes duration. Detection rates are summarized using area under the receiver operation characteristic (ROC) curves. Given ankle weights of 1/3, 1/2, 1, and 2 lbs, the average area under ROC curves obtained is 0.66, 0.75, 0.92, and 0.98, respectively. Conclusions: Pervasive sensing using accelerometers allows estimation of activity type and intensity, and important contextual factors such as the amount of load being carried. Furthermore, accelerometry allows detection of activity anomalies and asymmetries, which may indicate the early onset of overuse injuries.

POSTER SESSION III – TESTING

Effects of Ambient Temperature on Exercise-Induced Muscle Damage and Inflammation

Presenter: Sébastien Banzet (France)

SIRACUSA Julien, SANCHEZ Hervé, CHABERT Clovis, MALGOYRE Alexandra, BOURDON Stéphanie, KOULMANN Nathalie, BANZET Sébastien. Institut de Recherche Biomédicale des Armées, BP 73, 91223 Brétigny/Orge, France. Performing strenuous physical work in hot ambient temperature is a reality of modern military conflicts and is a challenge for human homeostasis. Hyperthermia is frequently reported as capable of inducing skeletal muscle damage and rhabdomyolysis. Exercise-induced muscle damage (EIMD) is associated with local inflammatory response, and EIMD prior to an exercise bout performed in the heat has been shown to result in a greater heat strain. However, the effects of heat exposure on muscle are unclear, especially the effect of exercise performed in hot ambient temperature on muscle damage is poorly described in the literature. Purpose: To investigate whether or not exercise performed in the heat is associated with more muscle damages than the same exercise performed in thermal neutrality. Methods: 36 male Wistar rats were equipped with a PhysioTel transmitter surgically inserted in the peritoneal cavity under anaesthesia in order to continuously monitor core temperature Tc. The rats were then randomly assigned to four experimental groups: thermal neutrality sedentary rats (CON; n=8), thermal neutrality exercising rats (NE; n=8), hot temperature sedentary rats (S30; n=8), hot temperature exercising rats (E30; n=12). Exercising animals ran on a treadmill (18 m/min; 5° grade) in neutral (NE; 22°C) or hot ambient temperature (E30; 30°C) for 45 min. Resting animals were passively exposed to neutral (CON; 23°C) or hot ambient temperature (S30; 30°C) for 45 min. All animals were euthanized 24 h later. Plantaris muscles were collected for inflammation, cell damage or stress varibles and macrophage staining studies. Plasma was collected and frozen at -80°C for further protein quantification. Results: Tc were not different in sedentary rats (CON = 37.06°C ± 0.34°C, S30 = 37.42°C ± 0.27°C, $P = 1$). Exercise induced a significant increase in Tc, with higher values in hot than neutral ambient temperatures (NE = 39.12°C ± 0.46°C, E30 = 40.89°C ± 0.87°C, $P < 0.001$ at the end of exercise). Plasma markers of inflammation, Il6 and Tnf were undetectable. Muscle levels of cytokine mRNA Il6, Il1b and Il10, were undetectable in most of our samples. Exercise or ambient temperature did not affected Tnf mRNA and inducible receptor Tnfrsf1b and Tlr4, and Tnfrsf1a was undetectable. Tnf-α sensitive mRNA, Nfκbia was not affected by the experimental procedures. Plasma markers of cell damage as Creatine Kinase (CK), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) remained unchanged. Muscle markers of apoptosis Bax and Bcl-2, markers of sarcoplasmic reticulum stress Ddit3 and Calr were not different between conditions while Ddit4 was significantly increased in exercise groups ($P < 0.05$) independently of ambient temperature. Ubiquitin-proteasome related mRNA Trim63 and Fbxo32 were not different between conditions. Conclusions: An exercise session performed at the same workload in neutral or hot ambient temperature does not result in a difference of EIMD.

Combining Physical Tests to Determine Student Outcomes in US Air Force Pararescue Development Course

Presenter: Neal Baumgartner (USA)

Neal Baumgartner, Orben C. Greenwald, Rodney C. Hayden, Alaina D. Dooley, Kimberly N. Hale INSTITUTIONS: USAF Fitness Testing and Standards Unit, USAF Occupational Analysis Division, and AETC Studies and Analysis Squadron, Randolph Air Force Base, TX, and USAF 342 Training Squadron, Lackland AFB, TX. BACKGROUND: Selection and classification of US Air Force (AF) recruits into Battlefield Airmen (BA) career fields is determined by the Physical Abilities Stamina Test (PAST), Armed Services Vocational Aptitude Battery, and medical clearances. Despite these assessments, BA students continue to experience high rates of attrition in technical training (TT), especially Pararescue (PJ) which has high attrition due to extensive sub-surface water training. However, sub-surface testing has not been used in BA assessment/selection. Therefore, we developed a three part Basic Water Skills Test (BWST) to assess PJ candidates. PURPOSE: Determine the relationship between BWST and PAST entry scores and pass-fail outcome in initial two week PJ Development Course (Dev), and predict Dev pass-fail outcome using BWST and PAST components. METHODS: PJ Candidates (n = 374 males) completed BWST and PAST upon initial entry into the AF. PAST consisted of 500 meter surface swim, 1.5 mile run, pull-ups, sit-ups, and push-ups. BWST consisted of up to six repeat 25 meter underwater (UW) swims, with return surface swim, each on cumulative 1 min 45 secs; timed treading water (TW) in deep water keeping wrists and ears above the surface for up to 3 minutes; and snorkel (SN) test alternating snorkel breaths while floating with face in water for up to 2 minutes. After completion of Basic Military Training trainees were tracked for Dev outcome. RESULTS: Mean values for all eight components were significantly ($p < .05$) different between pass (n = 169) and fail (n = 206) groups although the entire group was fairly homogeneous in PAST. Logistic regression on all variables, per the equation $\hat{y}=1/(1+e^{-(-x_i \beta)})$, showed the BWST components significant ($p < .01$) for predicting outcome, with the estimate β values of 0.64 SN, 0.40 TW, and 0.24 UW. Prediction models built using Akaike Information Criteria (AIC) model selection with a subset of the data (n = 225) were applied to the remaining data (n = 149) and correctly predicted pass-fail with up to 70% accuracy. CONCLUSION: BWST significantly complements PAST for predicting success in the PJ water-centric Development Course. The BWST can contribute to efficiency improvements in recruit selection for the high-demand, high attrition PJ career field.

Comparison of Dynamic Balance Level of the Polish Special Forces Soldiers and Civilians During Survival School Training

Presenter: Jerzy Bertrandt (Poland)

Tomczak A.[1,3], Bertrandt J.[2], Kłos A.2 Bertrandt B.4, Kler P.4, Kosciuszenko K.4 [1]General Staff of the Polish Armed Forces, Department of Physical Education and Sport, Warsaw, Poland [2]Military Institute of Hygiene and Epidemiology, 4 Kozielska St., 01-163 Warsaw, Poland 3Faculty of Physical Education and Sport in Biala Podlaska, Poland 4Military research and Deployment Center for Food Services, 112 Marsa St. 04-470 Warsaw, Poland One of the most important indicators of coordination of motor skills is the ability to maintain balance. It is a well-functioning in life and efficient performance of military tasks. The aim of the study is to compare the balance level of special forces soldiers and civilians during survival school training. Methods: The “Rotational Test” was applied during 36 hours of continuous training and sleep deprivation. Measurements were made three times, i.e. before the beginning of the study (C), and 24 hours (M), and 36 hours after training (E). 8 men, soldiers of special forces unit and 11 young men who have not received military service, students of University of Physical Education, were examined. Mean values of age, height, body mass and time of experience of soldiers and civilian men are as follows: Soldiers - 28.9± 2.7y, 181.0 ± 6.0cm, 83.6 ± 7.9kg, 6.1± 2.9y; Civilians - 6.1± 2.9y, 180.1 ± 1.6cm, 80.6 ± 1.6kg. Results: The “Rotational Test” revealed that after 36 hours there has been a deterioration of the balance of soldiers. The number of mistakes in rotational test was increased significantly from session C to E ($P<0.05$). There was no difference between M and E measurements. The “Rotational Test” found that until after 24 hours there has been a deterioration of the balance of civilians (C-M, $P < 0.05$ and C-E, $P < 0.01$). Conclusion: The “Rotational Test” results showed a steady, significant deterioration with time, which was bigger by students. Probably it is connected with military experience.

The Physiological Demands of Air Force Security Personnel: Controlling A Working Canine

Presenter: Joanne Caldwell Odgers (Australia)

Joanne N. Caldwell*, Greg L. Carstairs- and Benjamin Beck- *Centre for Human and Applied Physiology, University of Wollongong, Australia -Land Division, Defence Science and Technology Organisation, Melbourne, Australia Corresponding author: jo_caldwell@uow.edu.au Purpose: The physiological demands of correctional officers have previously been reported, however, Air Force Security personnel, who provide protection, security and operations support, are required to work with a Military Working Dog. Since the mass, power and level of aggression of each dog dictate the forces dog handlers must apply when controlling a dog, the required physiological demands are largely influenced by the characteristics of each dog. The physiological demands of such tasks currently remain unknown. Therefore, the aim of this study was to determine the physiological demands of Air Force Security personnel while controlling a working canine. Methods: To determine the physiological demands for this trade, physiological data (heart rate and oxygen consumption) and descriptive parameters (mass, height of lift, task duration, distance covered) were collected for 21 previously identified physically demanding tasks for Air Force Security personnel. This list included both dog- and non-dog-handling tasks. Trials were performed in the field, where data were collected from ten dog handlers (7 males, 3 females) and their dogs (varying in age, mass and experience). The data from these trials were then used to rank tasks from the most to the least physically demanding. Results: Of the 21 tasks observed, five required dog handling, twelve involved manual handling (inanimate objects) and four required whole-body endurance. Of these, only five tasks achieved a rating of perceived exertion higher than 13. When tasks were ranked according to physical demand, three of those five tasks involved dog handling. These tasks included tracking in open terrain, tracking over undulating terrain and searching a building, and these activities had an average oxygen cost (metabolic demand) between 1.3 (±0.2) to 1.8 (±0.2) L.min-1, and peak oxygen consumptions from 2.6 (±0.3) to 3.7 (±0.3) L.min-1. In addition, two of these tasks achieved a rating of perceived exertion greater than 13. In comparison, the other whole-body endurance task, which did not involve dog handling (establishing security control point), had an average oxygen cost of 1.3 (±0.1) L.min-1, a peak oxygen consumption of 2.7 (±0.3) L.min-1 ($P<0.05$) and a perceived exertion >13 ($P>0.05$). Thus, the non-dog-handling task had a lower oxygen cost. Conclusion: To develop valid screening tests and standards for Air Force Security personnel, the physiological demands of both dog and non-dog handling tasks were investigated. The results demonstrate that dog handling tasks, at least within this job classification, were of a whole-body endurance nature and of higher physiological demand than non-dog-handling tasks. Therefore, these tasks will form the basis for developing valid and defensible employment standards for this trade.

Developing a Proficiency Test for Elite Forces

Presenter: Kaizhen Chen (Singapore)

Carolyn FU1, Wee Hon ANG1, Michelle CHEN1, Kaizhen CHEN1, Siao Ying CHIOU1, Yee Siang CHNG1, Lydia LAW1, Tong LEE1, Boon Kee SOH1, Pearl TAN1, CPT Benedict KOH2, MAJ Benson ZHAO2, Jason LEE1,3,4 1DSO National Laboratories, Singapore 2Singapore Armed Forces 3Yong Loo Lin School of Medicine, National University of Singapore, Singapore 4Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore PURPOSE We are developing a proficiency test for Elite Forces (EF), to be used as a gauge to assess EF trainees' operational readiness, as well as areas for improvement and further training in sub-specialty units. Unlike typical military operations, EF tasks are extremely varied, unpredictable and comparatively inaccessible, thus requiring a customized approach for a Job Task Analysis (JTA) on which to base an operationally-relevant test of physical and cognitive fitness. This paper highlights the mixture of qualitative and quantitative methods used to determine the proficiency test's requirements. METHODS The JTA balanced subject matter expertise and objective measurements of operational demands. Given limited opportunities to profile the relatively unbounded range of EF tasks, the JTA focused on a qualitative rather than quantitative task analysis. The qualitative JTA comprised a document review of existing training material, which was then expanded upon with instructors to discern any additional tacit requirements. Acceptable levels of performance and important sub-tasks were further elicited through interviews with EF commanders. This was supplemented by a smaller-scale quantitative JTA, measuring heart rate, breathing rate and joint kinematics during outfield exercises. These provided limits of physical demands to constrain the test's demands. Physical and cognitive lab profiling was also conducted, to elicit potentially differentiating attributes of the EF population. RESULTS 116 training items were discerned from the document review. These were presented in a skill-oriented format, requiring translation into 149 unique tasks through interviews with instructors. 42 of these tasks were prioritized using a questionnaire, by selecting those which were above a set threshold of importance (computed from ratings of criticality and frequency) for each sub-specialty in the community, and similarly for each sub-category of activity (e.g. insertion, execution). The constituent sub-tasks and required standards of performance were determined for each of these 42 tasks through interviews. Outfield physical measures supplemented information on the comparative intensity of mission phases, helping to determine the ideal intensity of the proficiency test. These results were however only sufficient for developing task-based proficiency tests. Separately, lab-profiling demonstrated significant differences in selected physical attributes, which can be used to develop attribute-based tests in the future. CONCLUSION EF test development involves a unique balance between task fidelity and test feasibility, requiring a unique mix of qualitative and quantitative JTA to approach the broad spectrum of possible tasks. The tasks identified are currently being integrated into a proficiency test which imposes realistic operational demands in terms of tasks, chronology and environment.

Biomarker Indices of Physical Exhaustion in a Firefighter Community

Presenter: Leanne Dykstra (USA)

Regina M. Shia1, Lindsey K. McIntire2, Josh A. Hagen3, Chuck D. Goodyear2, Leanne N. Dykstra4, and Andrea R. Myers5 1 711th Human Performance Wing, Warfighter Interface Division, Applied Neuroscience Branch 2 Infoscitex, Inc., Dayton, OH 3 711th Human Performance Wing, Human-Centered ISR Division, Molecular Signatures Branch 4 SOCHE Intern, Dayton, OH 5 UES, Inc., Beavercreek, OH Previous research focused on identifying an index of physical exhaustion and individual differences in the ability to perform under exhaustive states. Seventeen active duty male Air Force members completed a multitasking test during an exhaustive treadmill exercise. Blood samples were collected at baseline, post treadmill as well as 10 and 20 minutes post treadmill. Cognitive testing was administered at low incline levels and following the treadmill protocol. Results showed that increases in serotonin during the exercise were related to early performance decrements, whereas higher serotonin levels 10 minutes following the treadmill exercise exhibited the best performance for both accuracy and reaction times. Results also showed that DHEAS and Cortisol increases occurred at 10 minutes following the treadmill exercise and at 20 minutes following the treadmill exercise. Changes in Cortisol from baseline were positively correlated to greater changes in accuracy immediately following the exhaustive task. However, changes 20 minutes later revealed a negative relationship with accuracy. This negative relationship was even more pronounced for individuals who completed the last phase of the exhaustive exercise. Changes in cortisol 10 minutes post exercise were positively correlated with increases in reaction time. DHEAS:Cortisol ratios reversed this positive relationship with increases in reaction time 10 minutes post treadmill as well as reversed the pronounced negative relationship in accuracy for those who made it to the last stage. The data presented will be obtained from a follow-on study. The current study aims to replicate these results within the active firefighting community. Because firefighters endure extreme temperatures and high levels of exhaustion, it is important to analyze their physical workload with the biomarkers and biometrics found to accurately predict high physical exertion. Twenty active duty firefighters between the ages of 22-57 are currently participating in the study. Testing takes place in both laboratory and field settings. First, volunteers from the Wright-Patterson firefighting community completed the VO2 Maximal Treadmill test for an individual baseline of physical fitness. Firefighters also completed a modified Astrand Treadmill Running Protocol while equipped with their standard uniform and oxygen pack. This portion of the study serves as the validation of identified predictive metrics using our targeted population of interest. The second portion of this study serves as the field validation taking these same metrics into the firefighter community and testing them in their testing environment. Orexin A, Cortisol, Brain Derived Neurotrophic Factor (BDNF), Dopamine, Serotonin, Epinephrine, and Norepinephrine will be analyzed in each session in regards to physical exertion and cognitive performance to determine the interaction and changes that occur within these biomarkers as a result of physical exhaustion.

The Danish Armed Forces' Core Test – Background and Development

Presenter: Henriette Albinus Hasselstrøm (Denmark)

Hasselstrøm, H.A. Hilt K. Kilen, A. Sørensen, K.G Centre for Physical Training and Education at Danish Armed Forces Health Services E-mail of corresponding author: Dr H.A. Hasselstrøm, FSU-CFI215@mil.dk. Abstract. Background Being a soldier is physically demanding and leads to physical fitness being an important element of basic military skills. Assessments of soldiers' over all physical capacity play an important role in ensuring soldiers are capable of successfully fulfilling their military tasks. Reports from Danish Battle groups in Afghanistan (ISAF 4-6) indicated a large number of the soldiers were re-deployed or temporarily taken out of theatre shortly after deployment due to physical injuries and physical fatigue. Danish Armed Forces Health Service, Centre for Physical Training decided, based on these reports, to investigate and evaluate the physical work demands for the infantry soldiers in Afghanistan. The workload analysis identified the importance of endurance, speed, strength and core stability as physiological factors (un published data), and lead to development of a new set of physical fitness tests': The Armed Forces Physical Tests' are used for establishing fitness levels reflecting the different physical requirements of a given assignment defined by the nature of the specified duties. At the same time, in order to minimize the number of re-deployments, the Danish Armed Forces Health Service, Centre for Physical Training and Education started deploying physiotherapist to Afghanistan (2009). The physiotherapists were situated both in the main camp (Price) and at the patrol bases. Purpose: The aim of this study was to evaluate the injury prevalence and injury site in order to develop a physical test measuring the relevant physical capacities according to the findings and thereby minimizing the risk of injuries. Methods All data were collected in the Helmand region of Afghanistan from August 2009 (ISAF 8) to February 2011 (ISAF 10), by deployed physiotherapists from Centre for Military Physical Training and Education. Subjects: From 2009 to 2011 a total of 2296 (n=101 women, n=2.195 men) soldiers from ISAF 8-10 were deployed to Afghanistan. Of these soldiers 635 (n=41 women, n=594 men) consulted the physiotherapists and provided data for the evaluation. Data were collected from the medical records made by the physiotherapists. The data collected were the number of first attendances to the physiotherapist and type of injury. The injuries were categorized into 6 categories: 1. Back, 2. Head/Neck, 3. Hip/knee, 4. Shoulder, 5. Upper Extremity and 6. Lower Extremity. Result The study showed that, on average, 50% of all injuries were categorized as back injuries and there were a relatively high prevalence of shoulder (13%), hip/knee (11%) injuries. Conclusion This study indicates that low core stability among soldiers could be the reason to the high prevalence of back injuries and the Armed Forces Cores test was developed. The Core test consists of 8 exercises. Static back extension, 90o static sit-ups, Horizontal Chin-ups, side plank left and right, back plank right and left, and finally lunges.

A Ten-Year Descriptive Study Following the Introducing of the "Physical Education and Sports System of the Brazilian Air Force"

Presenter: Kin Hwang (Brazil)

Introduction: in the early 2000's, the Brazilian Air Force (FAB) decided to make efforts to improve the physical fitness of his troop. Then, it was published the NSCA 54-1, a document with some principles and attributions to follow. With this document it was born the SISEFIDA. After that, it was published another document called ICA 54-1, regulating a set of physical tests objecting to measure anthropometric variables and physical qualities, twice a year, in all of the military. After ten years of SISEFIDA, it's time to evaluate how is the troop's fitness. Purpose: to describe the physical conditioning of the military of the Brazilian Air Force from 2003 to 2013 by means of three physical fitness tests. Methods: the subjects of the study were military of the FAB evaluated by the tests normatized by the ICA 54-1: push-ups, sit-ups (POLLOCK & WILMORE, 1993) and Cooper test (COOPER et al., 1968). The tests were applied during the months of September and October. The data was divided accordingly to the ranks: Officers (OF), Sub-officers and Sargeants (SO) and Soldiers and Corporals (SD). Were calculated averages and standard deviations, with the software Excel 365 Home Premium (Microsoft, USA). Graphics were made using the Prism 6 (Graphpad Software, Inc.). All the military were subjected to a battery of medical avaliation prior to the tests. Results: it was possible to evaluate that it is a trend to increase the performance in the push-up and sit-up tests. The OF's group performance was less consistent, and their Aerobic Power tended to decrease. The SO group tended to increase in time, but remaining lower than the OF. The SD group presented the best condition in all the three tests.

TABLE 1. Averages of the results in OF, SO and SD

Year	Push-ups			Sit-ups			Cooper		
	OF	SO	SD	OF	SO	SD	OF	SO	SD
2003	28,5	24,4	30,6	41,3	37,8	44,2	2356,9	2258,7	2415,1
2004	26,8	23,6	28,9	38,0	35,6	41,1	2219,1	2232,8	2434,3
2005	27,1	24,1	30,0	37,6	36,3	42,3	2202,2	2230,1	2421,5
2006	27,1	24,5	30,5	40,7	36,4	42,6	2211,6	2231,7	2407,7
2007	27,7	24,7	31,1	38,2	36,6	43,1	2219,6	2227,1	2415,1
2008	28,2	25,5	31,9	39,4	37,6	43,8	2230,8	2227,1	2435,8
2009	27,0	25,8	32,3	37,9	38,2	44,2	2166,6	2216,6	2404,3
2010	27,9	26,3	32,4	38,4	38,3	43,8	2182,9	2295,4	2394,6
2011	24,9	27,0	33,8	32,1	38,9	45,0	1888,1	2216,7	2405,3
2012	29,2	27,7	33,9	39,1	40,2	45,5	2186,4	2222,1	2401,4
2013	30,1	28,2	34,6	40,3	41,1	46,6	2212,2	2236,7	2427,7

Conclusion: it is necessary to improve the SISEFIDA and to promote the physical training at the FAB, specially the Aerobic Power. The military needs to stimulate the arise of a culture of physical activity practice.

The Physiological Strain Index Does Not Predict Heat Exhaustion

Presenter: Igor Mekjavic (Slovenia)

Igor B. Mekjavic(1), Ursa Ciuha(2,3), Mikael Grönkvist(4), and Ola Eiken(4) (1) Department of Automation, Biocybernetics and Robotics, Jozef Stefan Institute; (2) International Postgraduate School Jozef Stefan, Ljubljana, Slovenia; (3) Biomed d.o.o., Ljubljana, Slovenia; (4) Environmental Physiology, Royal Institute of Technology, Stockholm, Sweden. Introduction: One objective of NATO Human Factors and Medicine (HFM) Research Task Group (RTG) 238 is to develop a decision-making aide to assist in reducing the dismounted soldiers' burden. Specifically, one task in the development of this aid is the prioritisation of strategies based on modelling, of laboratory results and field simulations. Within the context of missions in hot and arid regions, we evaluated the utility of the Physiological Strain Index (PSI) as a potential component of such a decision-making aide, particularly its approach in predicting the physiological strain of subjects conducting desert patrol missions. Methods: Ten healthy heat-unacclimatised males participated in two 130-min trials, where they walked on a treadmill at a speed of 3.2 km·h-1, with an incident laminar wind at the same velocity. Each trial commenced with a 10-min baseline at 25°C, 40% relative humidity (RH); thereafter the subjects transferred to a climatic chamber and started their simulated desert patrol mission of two sorties, comprising two 50-min walks interspersed by a 20-min rest period. The trial was conducted twice, in both cases ambient temperature was 45°C. In one trial RH was 20% (FP20), and in the other 10% (FP10). In both conditions the subjects wore the same full protective equipment including body armour (carried mass: 35.2 kg). The physiological strain index (PSI) according to Moran et al. (1998) was used to evaluate the level of heat strain; the index rates physiological strain on a scale of 0 to 10, based on rectal temperature (Tre) and heart rate (HR). Results: The trials had to be discontinued on 7 occasions (5 in FP20 and 2 in FP10) due to heat exhaustion, where the subjects reported sudden fatigue, nausea, headache, dizziness, paresthesia in the arms. PSI for the 7 subjects that suffered heat exhaustion ranged from 3.9 to 8.5 upon termination. The only subject who's PSI indicated a very high strain (8.5), neither reported any discomfort, nor requested termination of the trial, but was taken out of the chamber due to a high rectal temperature (39.7°C). The average PSI for subjects that were not able to complete the trial was 6.7 (moderate to high stress) upon termination. Conclusion: The development of an index as an aide in predicting soldiers' physiological strain is an essential component of a decision-making aide for planning missions in hot arid environments. By predicting the optimal workload, it may assist in reducing the dismounted soldiers' burden. The present data suggest that the formula proposed by Moran et al. should be revised to better predict impending heat exhaustion during desert patrol missions. 1 - Moran D.S. et al. (1998). A physiological strain index to evaluate heat stress. Am. J. Physiol. 275: R129-134.

Young Men's Self-Assessed Fitness Status and Recruits Physical Fitness Test Results

Presenter: Leila Oja (Estonia)

Young men's self-assessed fitness status and recruits physical fitness test results. Leila Oja 1, H.Märks 2, M.Stamm2 Estonian National Institut for Health Development 1, Headquarters of the Estonian Defence Forces 2 The purpose of this study was to evaluate the self assessment fitness status based on population study and compared with the young men of the same age group of conscript's physical fitness test (FT) results. 52% of recruits were able to successfully pass the FT before the soldier's basic training courses (BC). A lifestyle-related cause is considered a key to why the young men's physical fitness is low. Comparing the lifestyle-survey data reveals that the reason may be also in the inadequate assess to their fitness status. Methods. For this analysis were used population-based survey data, and the same year started conscripts fitness test results. Survey data have been taken from the public based study included 5,000 residents of Estonia aged 16-64 years. In this analysis, the data is used for young men ages 16-21 years old (n=127). The questions was used to measure the respondents' scores which are characterized their own assessment of their physical fitness status. For this analysis, responses were scaled as follows: 1 = good, 2 = average, 3 = bad. 788 recruits (mean age 20 years) randomly selected the 5 different army units of the Estonian Arm Forces and tested before and after BC. Following FT has been used: push-ups, sit-ups and 3,2km run. Results. Population-based survey data suggest that a good level of physical fitness is an average of 56.2% of young men (ages 16-18y 61.9% and aged 19-21 y 50,6%). Only 11.8% of young people 19-21 years recognize that their physical fitness is below average (Figure 1). The FT analysis revealed, that 15% of the conscripts could not, even after the basic course to successfully meet the test standards (push-up test 3.1%; sit-up test 26.9% and 2-mile run test 15.4%), Figure 2. Figure 1. Self assessed fitness status in young men ages 18-21 years (Finbalt, 2012). Figure 2. Comparison of conscripts who have not passed the FT (%). Conclusions. In view by the total amount of points (minimum 190 points), then after the basic course test standards met about 92% of the conscripts. But, on the basis of individual tests, it appears that there are large differences in test performance standards for push-up, sit-ups and 2-mile run test. So far in Estonia, we do not have monitoring systems in place to assess the fitness status of young men before the start for military service. Such a large gap between self-assessed fitness and actual test results is possible to decrease using preparation programs those young men's, who assessed their physical fitness in "average" level there are about one third of man like this. . Future studies need to develop fitness programs which would provide objective feedback and help to evaluate the physical fitness of the young men.

Differentiation or Uniformity in Physical Fitness Testing: A Single-Track Discussion

Presenter: Trond Sand (Denmark)

Trond Svela Sand (Researcher) Major Anders McDonald Sookermany (Dr.Philos & Research Officer) The Norwegian Defence University College – Norwegian School of Sport Sciences, Defence Institute Abstract The purpose of this presentation is to apply a multidisciplinary approach that can open for new perspectives in choices and priorities in the armed forces in relation to the growing debate on differentiation or uniformity in military physical fitness testing. To be physical fit has been seen traditionally as a prerequisite for military personnel and physical fitness tests are perceived to be an effective instrument to recruit individuals with such abilities. The Norwegian Armed Forces uses a standardized battery of physical fitness tests in their selection process and all candidates have to pass the tests before they are admitted to the NCO schools or the military academies. All branches use the same battery of tests, but candidates to the military academies have slightly stricter minimum requirements. Correspondingly, there are differentiated minimum requirements for women and men. However, few changes have been made since the present tests were introduced more than 30 years ago and there is an ongoing debate whether the test arrangement should be updated so that it fulfills the needs of today's flexible expeditionary force. A predominant topic in the Norwegian debate of physical fitness testing is whether they should be differentiated instead of the present standardized regime. This can be illustrated by the focus in the governmental White Paper on the Norwegian Armed Forces from 2013, "Competence for a new era". The present selection process is criticized for being uniform and differentiation is addressed as essential as the flexible expeditionary force involves a great variety in the soldiers' tasks and actions where different intellectual and physical capacities are needed. The request for greater variation in the selection process releases a variety of questions. Should there be more branch- and function-specific fitness tests? Are different minimums requirements more relevant? Is it necessary that all candidates complete physical fitness tests? Is it appropriate with different minimum requirements between women and men? A literature study will be used as method to reveal empirical examples that can exemplify how differentiation of physical fitness tests can be understood. Expected findings are that a multidisciplinary approach will reveal several perspectives that have received little attention in the debate of reformation of physical fitness tests so far.

Footwear-Dependent Correlations Between Vertical and Standing Long Jumps

Presenter: Brian Schilling (USA)

Brian K. Schilling1, John R. Harry1, Max R. Paquette1, Lawrence W. Weiss1, and David Peterson2. 1The University of Memphis, 2US Navy, ASTC Patuxent River Footwear type may affect jumping performance, and allowable footwear for physical readiness tests in the various US military service branches is disparate. As the US Navy and Army are considering adding jump performance to their respective tests, an understanding of the relationship between footwear type and jump performance is relevant. Furthermore, an understanding of the association between different styles of jump might be useful for logistical decision making, especially if styles are highly correlated. Purpose-to examine associations between footwear-matched vertical and standing long jump performances. Methods- Fifteen men (179.8±6.5 cm, 84.6±8.6 kg, and 23.8±2.4 y) voluntarily provided written informed consent as approved by the University IRB. At least 48h after a comprehensive practice session, subjects performed countermovement vertical jump and standing long jump tests in the following footwear conditions: barefoot, minimal shoes (Vibram Five Finger™ KSO), and cross-training shoes (MX623, New Balance). The minimal condition consisted of a <3.5 mm heel-toe drop and a mass of about 161.5 grams, while the cross-training shoe had a 10 mm heel-toe drop and a mass of about 358 grams. Following a standardized warm-up, subjects practiced jumping in the starting footwear condition. Practice jumps were also performed immediately prior to testing in the remaining footwear conditions. Subjects completed three attempts each of a vertical jump (VJ) and standing long jump (SLJ) presented in a counterbalanced order. Subjects utilized a self-selected countermovement depth and arm swing for all jumps. A one-minute rest period was provided between each attempt. Vertical jump displacement was measured using a Vertec jump device, and the best jump height was recorded to the nearest 1.27 cm, subtracting out one-hand reach height from a plantar-flexed position. Horizontal displacement for the standing long jump was measured using pre-marked long jump mats, with the point of heel contact upon landing determined visually by two investigators. Pearson-product moment correlations were used to compare performance within each of the three footwear conditions. Statistical significance (2-tailed) was set a priori at $p < 0.05$, and all data are presented as mean±SD. Results- Vertical and standing long jump displacements were 46.48±10.78 cm and 211.91±27.99 cm respectively when barefoot, 46.38±10.62 cm and 209.98±28.75 cm when in minimal shoes, and 45.97±10.43 cm and 211.33±26.82 cm when shod. All correlations between the vertical and standing long jump were significant ($p<0.01$). Correlation coefficients were highest for the barefoot condition ($r=0.856$), followed by the VFF condition ($r=0.794$), and the shod condition ($r=0.688$). Conclusions-Many factors likely influence the correlation between the vertical and standing long jump, including familiarity with each type of jump, as well as methods of measurement. It appears from these preliminary data that the type of footwear may also play a role in the correlation between these jump types. Future consideration of the vertical or standing long jump as a PT test should consider these many influences.

Fitness Testing in the Bundeswehr – Tracking Individual and Force Wide Baseline Fitness Using Quality Controlled BFT Data

Presenter: Alexander Sievert (Germany)

Purpose: High physical demands of military tasks make physical fitness an essential part of soldiering. Hence, regular fitness assessments with valid testing methods are an important step for achievement and maintenance of physical fitness. In the German Armed Forces, the mandatory Basic-Fitness-Test (BFT) measures physical performance in three dimensions (upper body strength (flexed arm hang), speed/agility (110m shuttle sprint) and endurance (1000m run)). However, for BFT data to provide a reliable source of information on fitness levels and training progress, as stipulated in the 4-level concept of military fitness of the Bundeswehr in 2012, standardized tools for data-handling, quality control and fine grained analyses are needed in addition to regular force-wide data collection. Methods: In the ongoing research project "Evaluation of the BFT-rating system and implementation of quality control measures" (QM-BFT), a new and dedicated database system was created for the force-wide collection of individual BFT results combined with age, gender and other relevant information. Quality-management routines were developed and implemented into the database to automatically inspect, verify and reassess the aggregated datasets and to provide a clean database for force-wide cross-sectional and longitudinal fitness assessment. Furthermore, reporting and analyzing tools were implemented for the semi-automated analysis of quality controlled BFT data. Results: Preliminary analyses of BFT data yield reliable basic information on soldier's fitness. Cross-sectional analyses stratified by age and gender show gender related differences and age related deterioration in all fundamental performance parameters. Longitudinal analyses show the ability to track changes in performance over time, stratified by age and gender. Further levels of detail can be added to compare performance of designated subpopulations i.e. branch of service, company/squad level and rank groups/rank. Conclusions: The new BFT database and implemented tools permit fine grained analyses of basic military- fitness. Clean BFT data, enhanced with quality management routines, provide a solid foundation for fitness assessment. Regular cross-sectional and longitudinal analyses deliver valid, important information and constitute a reliable tool for controlling, the semi-automated nature of the analyses allow for scheduled and ad-hoc fitness reports. Level and focus of information can be tailored to suit the need of a wide range of personnel (soldiers, field commanders, decision makers). Hence, results can be used to define specific performance baselines and track changes in performance over time, thus enabling the maintenance of fundamental fitness and targeted training in the three dimensions of performance. The QM-BFT system constitutes the first building block in the valid assessment of physical fitness as core component of military fitness in the German Armed Forces.

Development of a Standardised Functional Performance Assessment for Dismounted Close Combat Systems

Presenter: Kimberley Strickland (England)

Kimberley Strickland, Nicola Armstrong Defence Science and Technology Laboratory (Dstl) Background Dstl has developed the Human Factors Assessment Framework (HFAF) to provide a coherent and consistent approach to Human Factors (HF) assessments of Dismounted Close Combat systems. The HFAF is a tool used to select the most appropriate method for HF data collection to support capability management, design and system analysis as well as HF Integration (HFI) activity. The HFAF utilises a 3 level approach: 1. Initial HF Assessment - Specification or parameter paper-based review, visual inspection and / or functional assessment. 2. Functional Performance Assessment – Assesses the function and performance of a system for a number of users during a range of simulated military tasks, using standardised HF data collection methods. 3. Controlled Environment Assessment - A lab-based assessment which ensures a controlled environment. Used where high confidence, reliable physiological, psychological or performance related data is required to answer a specific question. Purpose Level 1 and Level 3 assessments have become well established through the conduct of support to operations research studies. As Level 2 assessments are less mature, this work explored and developed methodologies that would form the basis of HFAF level 2. This included testing the utility of obstacle courses, range of motion assessments, respiratory function, alongside subjective measures. Methods Methodologies and accompanying procedures were developed, which included designing an obstacle course with representative features of the battlefield. Eight Infantry soldiers completed the study wearing one of five armour configurations (a no armour control, UK military body armour and three flexible body armours). The study took place indoors at ~21.50C and ~37.4% RH. Physiological and subjective measurements were taken throughout. Results Overall time to complete the obstacle course was 2.58 ± 0.10 min, with statistical differences identified for 5/8 obstacles but not overall time. Range of motion assessments identified significant differences compared to the no armour control and between the armours for shoulder and thoracic-lumbar (TL) measurements using goniometry, and TL measurements using XSENs Motion Analysis. Forced Vital Capacity (FVC) and Forced Expiratory Volume (in one second) (FEV_1) were significantly reduced by 4-6 % without reduction in FEV_1/FVC in 3 of the 4 armours. Subjective measures identified significant differences between the armour characteristics (i.e. bulk and mobility) and some of the obstacles. Conclusions This work identified the merit of using obstacles to differentiate between similar systems using a combination of physiological and subjective measures. Furthermore, these measures were recommended for their utility in HFAF Level 2 assessments. The step forward that this represents is the move to objectivity from the classically subjective nature of larger-scale equipment assessment using obstacles, which will have direct exploitation into future Equipment Programmes. The HFAF has been defined across all three levels, providing confidence for it to become a recognised framework that can be used by industry, academia and internationally – to this end a HFAF Technical Guide and Training Package will be available in April 2014.

The Rigors of "Boot Camp": Identification of Physically Demanding Tasks Within Canadian Armed Forces Basic Military Qualification Courses

Presenter: Mark Buller (USA)

Daniel Théoret MSc, Michael Spivock PhD, Kara Lee Casselman BSc, Sarah Saucier BSc, Paige Mattie MHK. Canadian Forces Morale and Welfare Services, Directorate of Fitness, Human Performance Research and Development. Corresponding author: daniel.theoret@forces.gc.ca INTRODUCTION The Basic Military Qualification Course (BMQ) is the 12-week tri-service basic training program which all Canadian Armed Forces non-commissioned members must complete upon enrolment. The Basic Military Officer Qualification Land (BMOQ-L) course is a training program designed to produce an Officer capable of performing the common duties of an Officer in the Land Forces. All Land Forces Officers, as well as select support trades, are required to complete the BMOQ-L course. PURPOSE A high rate of attrition is observed in both courses, with an approximately 15-25% failure rate. The Human Performance Research & Development (HP R&D) team was asked to assess the physical demands of these courses, in order to provide information that would assist in explaining the attrition, and eventually propose a screening process to address the situation. METHODS Participants in both courses must satisfy Performance Checks (PCs) to ensure successful course completion. The research team facilitated a review of all course PCs during which the physical demands were rated anonymously by Subject Matter Experts (SMEs). An electronic polling system with a 7-point Likert scale was used to anonymously rank each task. PCs that were given an average rating of 4 or greater were classified as physically demanding and were retained for further review. Additionally, the SMEs indicated the significance of Upper Body Strength, Upper Body Endurance, Lower Body Strength, Lower Body Endurance, Balance/Agility, Aerobic Capacity and Anaerobic Capacity of each physically demanding task. These five fitness constructs were ranked on a 5 - point Likert scale using the electronic polling system. RESULTS For BMQ, a total of 5 elements (3 PCs and 2 additional course activities) were identified as having a physical demand of 4 (Somewhat Hard) or higher: First Aid Sentry Patrol; Completing the Obstacle Course; The 13km Ruck March; Climbing and descending stairs to and from quarters with equipment; and Supplemental training. For BMOQ-L, a total of five PCs were identified as having a physical demand of 4 (Somewhat Hard) or higher: Section Attacks; Defensive Operations; Recce Patrol; Navigate Dismounted; Supervise Army Physical Fitness Training. In addition to these 5 PCs, three course activities were identified as physically demanding were excluded from the data collection for operational reasons. CONCLUSIONS The HP R&D team was successful in applying a task classification process to two distinct Canadian Armed Forces courses. The HPR&D team is currently in Phase 2 of these projects, which consists of quantifying the demands of these tasks in terms of weights, distances, aerobic demands and other factors. The final step of this research process will entail linking these demands with the profiles of those who do not successfully complete the course, in order to recommend a pre-course screening process.

THEMATIC FREE COMMUNICATIONS/POSTERS – HORMONAL/METABOLIC

Cortisol as a Possible Predictor for Optimism and Persistence in Military Training Settings

Presenter: Olaf Binsch (Netherlands)

Olaf Binsch1,3, Bertil Veenstra2, Fred Buick3, Herman van Wietmarschen4 & Pierre Valk1 1Netherlands Organization for Applied Scientific Research (TNO), Department of Human Factors, Soesterberg, Netherlands; 2Netherlands Royal Netherlands Army / Training Medicine and Training Physiology (TGTF), Utrecht, Netherlands; 3Defence Research and Development Canada (DRDC), Individual Behaviour and Performance Section, Toronto, Canada; 4Netherlands Organization for Applied Scientific Research (TNO), Department of Microbiology, Zeist, Netherlands. Introduction The Dutch Ministry of Defense seeks to maximize operational readiness and minimize dropout rates of trainees and servicemen during military education and training. The aim is to limit the risk of permanent mental and physical health issues and to optimize specific mental and physical health care after military deployment. To contribute to this aim, we focused on high dropout rates, up to 70%, of trainees during their attempt to join Special Operational Forces (SOF, e.g., tank infantry, air mobile brigade, marines). We first determined which mental and physical factors were responsible for such dropout rates. Then we assembled, developed, and tested measurement tools to monitor those factors for a longer period before our method was implemented within the setting of military training institutions (see also Veenstra et al., 2014 in the current proceedings of the ICSPP). Before implementation, the method was tested by conducting a pilot experiment at a school for Dutch SOF. One of the factors that showed to be relevant was cortisol as a predictor of optimism and persistence. This factor was the focus in the current study. Method We monitored the persistence of 29 military trainees (i.e., one school platoon) during their efforts to join the SOF. During week 6 and 7 of their training, we conducted a field study using a control and experimental set-up. During the experimental set-up, soldiers in the field responded to the sudden explosion of a dummy grenade with defense of their foxholes. Saliva samples were used to obtain cortisol levels of the trainees before and after the grenade explosion, and optimism scales were used as a daily monitoring instrument. After twelve weeks of training (i.e., the first half of the training period), 8 trainees dropped out due to a self-reported lack of motivation. Results Results showed that the 21 trainees who persisted for the 12 weeks of the training course had a higher cortisol level during the experiment compared to those who dropped out. A regression model revealed that soldiers' cortisol indeed predicts persistence and that this relationship is moderated by a self-reported level of optimism. Conclusion Cortisol might have application as an objective marker for optimism and persistence in military settings (i.e., high pressure environments). Cortisol will be cautiously discussed as a predictive marker for operational readiness. The intention is to further investigate the relationship between cortisol and optimism, as well as persistence, in other military settings like recruitment and selection, Special Forces training, preparation of deployments, and in the military domain of primary and secondary prevention and health care.

Effects of Patrol Operation upon Hydration Status and Autonomic Modulation of Heart Rate of Brazilian Peacekeepers in Haiti

Presenter: Antonio Duarte (Brazil)

Antonio F. A. Duarte, Jairo J. M. Morgado Brazilian Army Research Institute of Physical Fitness, Rio de Janeiro, Brazil A positive balance of cardiac autonomic control and a preserved hydration status are linked to cardiovascular health and have been shown to influence combat readiness. The stress of operational missions may, in turn, pose challenges to the maintenance of body homeostasis and compromise soldiers' performance. Purposes: To verify the effects of peacekeepers patrol operation in Haiti upon soldiers' hydration status and cardiac autonomic modulation, and to evaluate whether the fluctuations in autonomic modulation are associated to the change in hydration status, the energy expenditure of the mission and the aerobic fitness of the militaries. Methods: A group of 22 soldiers (22.3 ± 4.5 yr; 175.1 ± 6.7 cm; 74.5 ± 7.8 kg, VO2max 53.1 ± 4.3 ml.kg-1.min-1) accomplished an operational patrol mission with mean duration of 163.5 (± 32.4) min. Before (Pre) and after (Post) the operation, urine specific gravity (USG) was measured and sequences of 5 min R-R intervals were recorded at rest to estimate heart rate variability [HRV; low (LF) and high-frequency (HF) power component, and sympatho-vagal balance (LF/HF)]. During the mission, energy expenditure (EE) was measured using heart rate monitors (Polar RS 400, Polar Electro) calibrated with subjects' individual data. Changes from Pre to Post in USG (Δ USG) and LF/HF (Δ LF/HF) were used to estimate, respectively, the variation in the hydration status and autonomic modulation due to the mission. Paired t-tests and Pearson Correlation Coefficients were calculated to analyze the data, at a significance level of $p \leq 0.05$. Results: The mean EE to accomplish the operation was 705.2 ± 222.0 kcal. From Pre to Post, there was an increase in USG (1023.3 ± 8.0 vs. 1029.3 ± 6.0; respectively; $p < 0.001$), LF n.u. (49.8 ± 16.6 vs. 63.4 ± 13.5; $p < 0.001$) and LF/HF (1.43 ± 1.61 vs. 2.34 ± 1.60; $p < 0.01$); and a decrease in R-R interval (1006.1 ± 113.9 vs. 855.8 ± 132.7; $p < 0.001$) and HF n.u. (50.1 ± 16.5 vs. 36.5 ± 13.6; $p < 0.001$). The variation in the sympatho-vagal balance (Δ LF/HF) was correlated to EE ($r = 0.49$; $p = 0.02$) and VO2max ($r = -0.42$; $p = 0.05$) but not with Δ USG ($r = 0.32$; $p = 0.15$). Conclusions: An operational peacekeeper patrol with mean duration of approximately 160 min promoted dehydration and inbalance in autonomic modulation of HR. The reduction in the sympatho-vagal balance observed was correlated with the energy expenditure of the activity and to the militaries' aerobic fitness status, but not with dehydration. These results reiterate the relevance of aerobic fitness to the combat readiness.

Maximal Strength, Body Composition, Load Carriage Performance and Serum Hormone Concentrations During 8-Weeks of Specialized Military Training: The Effect of Added Low Volume Resistance Training

Presenter: Juha Kokko (Finland)

Juha Kokko1, Jani P. Vaara1, Manne Isoranta1 and Heikki Kyröläinen1,2 1Department of Leadership and Military Pedagogy, National Defence University, Finland 2Department of Biology of Physical Activity, University of Jyväskylä, Finland. Previous studies have shown interference in strength gains during military basic training due to high aerobic load during service (1) and a plateau in improvement of physical performance during a specialized training period (STP) has been reported (2). The purpose of this study was to examine the effect of added low volume resistance training on physical performance, body composition and serum hormone profiles during STP. Methods: 25 male conscripts (age ± SD 19.0±2.0 yrs.) were assigned to two groups: specialized training with added low volume resistance training (RTG, n= 13) and normal service groups during STP (NTG, n= 12). The RT group performed 2 resistance training sessions per week for 8 weeks: hypertrophic maximal strength (weeks 1-3), neural maximal strength (weeks 4-6) and power training (weeks 7-8). Performance measurements, body composition and serum hormone concentrations were measured before (pre) and after (post) STP. Maximal strength was measured with isometric tests for the upper and lower extremities as well as for trunk muscles. Load carriage performance was measured during a 3.2-km run test with a load of 27 kg. Results: Both groups improved ($p<0.001$) their load carriage performance time (RTG: 1162±116 s vs. 1047±81 s; NTG: 1142±95 s vs. 1035±81 s) but decreased ($p<0.05$) maximal strength of the lower extremities (RTG: 5250±1110 N vs. 4290±720 N, NTG: 5170±1050 N vs. 4330±1230 N) and back muscles (RTG: 4290±990 N vs. 3570±480 N, NTG: 3920±720 N vs. post: 3410±530 N). Maximal strength of the upper extremities improved in NTG (990±320 N vs. 1140±360 N, $p<0.05$) but not in RTG (1040±200 N vs. 1140±200 N). Maximal strength of abdominal muscles improved in RTG (3260±510 N vs. 3740±750 N, $p<0.05$) but not in NTG (3840±1440 N vs. 3420±890 N). No differences were observed for body composition variables. Testosterone concentration increased in NTG (15.2±3.6 nmol/L vs. 21.6±5.0 nmol/L, $p<0.01$) but not in RTG (18.6±4.3 nmol/L vs. 19.5±9.4 nmol/L). No changes occurred in cortisol or sex hormone binding globulin in either group. Conclusion: STP improves load carriage performance due to the specificity of training since STP includes load carriage tasks comparable to those performed in the basic training period. Moreover, a decreasing trend for most of the maximal strength characteristics was observed in both groups, which may be evidence of neuromuscular overreaching at the end of STP. Finally, low volume resistance training in the STP induced little or no training effects, which might relate to interference of strength gains due to the aerobic nature of the STP. Therefore, careful training monitoring and periodization should be adopted to improve physical fitness in STP. REFERENCES Santtila et al. (2009) J Strength Cond Res 23:1300-1308. Santtila et al. (2013) J Strength Cond Res 26:745-751.

Muscle Strength and Serum Hormone Concentrations During the 8-Week Basic Military Training Period in Non-Overreached and Overreached Finnish Conscripts

Presenter: Vesa Linnamo (Finland)

Vesa Linnamo, Jarmo Piirainen, Minna Tanskanen, Jukka Huovinen, Keijo Häkkinen, Heikki Kyröläinen Department of Biology of Physical Activity, University of Jyväskylä, Finland During the past two decades drop outs of the conscripts during the first 8 weeks of basic military training have increased, most likely due to decreased physical fitness of young Finnish males entering the army (Santtila et al. 2006). For some conscripts the military training can be too strenuous and may lead to poor recovery and even to an overtraining state (Tanskanen et al. 2011). Purpose: To examine if development of muscle strength and hormonal responses would be different between conscripts suggested to be overreached and those without overreaching symptoms after 8 weeks of military training. Methods: 24 subjects were divided in the non-overreached (NOR n=16) and overreached (OR n=8) groups based on 5 criterions (Tanskanen et al. 2011). Body mass, body fat%, maximal isometric knee extension and elbow flexion torques as well as and bench press force were measured in the beginning (1 week), middle (5 week) and at the end (8 week) of basic training period. Morning blood samples for the determination of serum testosterone and cortisol concentrations were collected after the second, fourth and seventh week. Results: Body mass (-2.1±2.2% $p<0.001$) and fat% (-7.2±7.1% $p<0.001$) decreased significantly in NOR after the 5th week of training which was not observed in OR. Maximal isometric knee extension (19.4±27.4% $p<0.01$) and elbow flexion (20.0±17.0% $p<0.001$) torques as well as bench press force (17.1±26.6% $p<0.05$) increased significantly in NOR after 8 weeks of training but no significant changes were observed in OR. No significant changes were observed in serum testosterone concentrations in either group. Serum cortisol concentration decreased and Testosterone/Cortisol ratio increased after the 4th (-8.1±15.0% $p<0.01$ and 18.6±26.9% $p<0.05$, respectively) and 7th (-14.3±22.8% $p<0.001$, 29.3±39.5% $p<0.01$, respectively) week in NOR, while no significant changes were observed in OR. Discussion: Based on the developments in body composition and muscle strength for the conscripts who did not show any symptoms of overreaching, the military training seemed to be quite beneficial. Decreased serum cortisol concentrations and increased testosterone/cortisol ratio support that the training was not too strenuous for the NOR group. On the other hand, the conscripts who showed symptoms of overreaching did not show any improvements in muscular strength or positive changes in serum hormone concentrations. This indicates that the training program for the OR group might have been too strenuous. Conclusion: To avoid overreaching and to create positive training development for all conscripts, one suggestion could be that the overall training load would be adjusted according to the initial physical condition levels when entering the army. In general, it is suggested that the military training should be both properly periodised and more individualized in order to avoid overreaching symptoms. References: Santtila et al. 2006, Med Sci Sports Exerc, 38(11):1990-1994 Tanskanen et al. 2011, Med Sci Sports Exerc, 43(8):1552-1560

Depressed Physical Performance Outlasts Hormonal Disturbances and Changes in Body Composition After a One Week of Arduous Military Exercise

Presenter: Truls Raastad (Norway)

Raastad, T.1,2, Hamarsland, H.1 Solberg, P.A., Slaathaug, O. G., Paulsen, G.1,2 1: Norwegian School of Sport Sciences 2: The Norwegian Defence University College The aim of this study was to investigate the effect of, and the recovery from, an extremely demanding one-week military course with measures of physical performance, body composition and blood biomarkers. Participants were recruited from a group of apprentices participating in an annual selection course to join the Norwegian Special Forces. During this selection course 15 soldiers (23±4 yrs., 1.81±0.06 m, 78±7 kg) completed a “Hell-week” in which they were in activity most of the time, only interspersed by 2-3 hours of sleep per day. For the whole week the soldiers were given 10 000 kcal which means that they had a large caloric deficit during the course. Testing was conducted before the “Hell-week”, on the last day of the “Hell-week”, and thereafter 1, 7 and 14 days after the end of the “Hell-week”. Physical performance was measured as muscle strength in isometric leg-press and bench-press and as jump height in a counter-movement jump. Body composition was measured by a bioelectrical impedance scale (Inbody 720, Biospace, CA, USA). Blood samples were collected in the morning (09:00-10:00) and analyzed for testosterone, cortisol, sex hormone binding globulin (SHBG), IGF-1, TSH, thyroxin (T_3 and T_4),, creatine kinase (CK), and C-reactive protein (CRP). Body mass was reduced by 5.3±1.9 kg during the “Hell-week” and returned gradually back to baseline during next week. Fat mass was reduced by 2.1±1.7 kg and lean mass by 1.9±0.9 kg. Muscle mass recovered through the next week whereas fat mass was still reduced by 0.9±1.0 kg 2 weeks after the “Hell-week”. Muscle strength in isometric leg-press and bench-press was reduced by 16.8±7.2% and 8.7±6.5%, respectively, and both were ~10% lower than baseline after two weeks of recovery. Jump-height was reduced by 28.3±15.5% and was still 13.9±4.8% lower than baseline after 2 weeks of recovery. Testosterone was reduced by 70±12% and recovered gradually during the next week. Cortisol was increased by 154±74%, but had recovered after 24 hrs rest. IGF-1 was reduced by 51±10% and recovered gradually during the next week. T_3 and T_4 was reduced by 12-30% and recovered gradually during the next week. The one-week arduous military exercise resulted in reductions in body mass and performance, as well as considerably hormonal disturbances. Our most important observation was that while the hormonal systems and body composition normalized within one week of rest and positive energy balance, the lower body strength and jump performances were depressed even after two weeks. This indicates that the lower body muscles suffered from significant muscle damage, which apparently required weeks of regeneration.

Potential Neurobiological Benefits of Exercise in Chronic Pain and PTSD

Presenter: Erica Scioli-Salter (USA)

Erica R. Scioli-Salter, Ph.D.-1,2,3; Daniel E. Forman, M.D.-1,4,5; Kelly Allsup, B.S.-1; John D. Otis, Ph.D.-1,3; Laura Bajor, D.O.-1,5; Christine Marx, M.D., M.A.-6,7; Richard Hauger, M.D.-8,9; Anna Tyzik, B.S.-1 & Ann M. Rasmusson, M.D.-1,2,3 1-VA Boston Healthcare System; 2-National Center for PTSD, WHSD; 3-Boston University School of Medicine; 4-Brigham and Women's Hospital; 5-Harvard Medical School; 6-Duke University School of Medicine; 7-Durham VA; 8-University of California at San Diego; 9-San Diego VA. The high comorbidity between chronic pain (CP) and posttraumatic stress disorder (PTSD) may be explained in part by a shared underlying molecular pathophysiology. Neuropeptide Y (NPY) and the GABAergic neuroactive steroid allopregnanolone (ALLO) play critical roles in pain gating at the spinal and supra-spinal levels, are lower in the blood and cerebrospinal fluid in PTSD, and correlate negatively with PTSD symptoms. Exercise in healthy participants and/or rodents increases plasma levels of NPY and ALLO. This pilot study assessed the effects of maximum load exercise on NPY and ALLO levels and their relationship to pain threshold and tolerance measured by the cold pressor test in two groups: a) healthy trauma-exposed male and female Veterans, and b) Veterans with CP/PTSD. A symptom-limited maximum load cardiopulmonary exercise test was performed in accordance with guidelines published by the American College of Cardiology. During exercise, the rates of oxygen (O_2) consumption and carbon dioxide (CO_2) production were calculated from continuous recordings of expired ventilation rate, and expired fractions of O_2 and CO_2. Blood sampling from an intravenous line was performed prior to exercise, during the last minute of each exercise workload, and at 5' and 30' after exercise for measurement of NPY, ALLO, and other hormones of interest. Pain threshold and tolerance were measured via the cold pressor test 30 minutes before and 30 minutes after exercise testing. The pilot sample (N=12) was 58.3% male (n=7), 41.7% female (n=5) with mean age of 38 years; 42% identified themselves as Black, 33% White, 8% Asian and 16.7 as "other. Half of the participants had PTSD and comorbid chronic pain; the rest were trauma-exposed but healthy. Across all participants, peak VO_2 correlated with change from baseline in ALLO ($r=0.77$, $p<.01$), NPY measured at the anaerobic threshold ($r=.61$, $p<.05$), and NPY measured 5' post-exercise ($r=.81$, $p<.01$). Pain threshold measured after exercise by the cold pressor test correlated with changes in ALLO ($r=.61$, $p<.05$) and NPY ($r=.81$, $p<.01$), but not cortisol or DHEA. A regression model in which NPY and ALLO changes predicted post exercise pain threshold was significant: $F(2,9) = 13.38$, $p<.01$. Exercise-induced changes in NPY and pain tolerance were also correlated ($r=.64$, $p<.05$). This is the first study of exercise-associated increases in the anti-stress, anti-nociceptive compounds NPY and ALLO in healthy trauma-exposed participants compared to persons with comorbid PTSD and chronic pain. As exercise training increases VO_2max, we are now investigating whether it will also increase the capacity for release of these protective anti-stress, anti-nociceptive molecules and reduce chronic pain in CP/PTSD.

Acute Neuromuscular and Hormonal Responses to a Fatiguing Strength Loading Followed by Active or Passive Recovery

Presenter: Ritva Taipale (Finland)

Taipale RS1, Kyröläinen H1,2, Nindl B3, Ahtiainen J1 and Häkkinen K1 1 Department of Biology of Physical Activity, University of Jyväskylä, Finland 2 Department of Leadership and Military Pedagogy, National Defence University, Helsinki, Finland 3 United States Army Research Institute of Environmental Medicine, Natick, Massachusetts, USA The purpose of this study was to examine the acute neuromuscular and hormonal responses to a strenuous strength loading [bilateral leg press (LP) 10x10x70% 1RM] followed by loading specific active (AR, LP 10x10x30% 1RM) or passive (PR, seated) recovery. Male reservists (n = 18), age: 26±4 years, height: 174±8 cm, weight: 75±13 kg completed the loading with 7 performing AR and 11 performing PR post loading. Maximal bilateral force production (MVC) and serum hormonal concentrations of testosterone (T), cortisol (C), insulin like growth factor 1 (IGF1), and insulin like growth factor binding proteins 1-6 (IGFBP1-6) were measured before, during and after the loading as well as 24 hours post loading. MVC was significantly decreased following the present loading ~50±13% (3205±92N to 1590±63N, $p<0.05$). At 24 hours, MVC had not recovered to baseline with MVC of the AR group still reduced by 14±24% and MVC of the PR group still reduced by 6±11% from baseline ($p<0.05$). The difference between AR and PR on MVC was not significant. There were no statistical differences in the relative changes of C, IGF1 and IGFBP2-6 during the loading or following AR and PR. T and IGFBP1, however, were affected by recovery methods. T was lower than baseline in both AR and PR 24h post loading, but T in the AR group was closer to baseline than T in the PR group, and a significant difference ($p<0.05$) in relative response was observed. The relative acute increase of IGFBP1 was greater in AR than in PR ($p<0.05$) at 24 hours post loading. It appears that neuromuscular recovery is similar between active and passive recovery, but the recovery of T and IGFBP1 are better when active recovery is performed. The suppression of T after training indicates physiological stress (3) and may suggest a protein catabolic state (1). The higher levels of IGFBP1 may indicate a positive effect on glucose counterregulation and metabolic homeostasis (2, 4). In addition, as increasing levels of IGFBP1 has been suggested as a novel approach to prevent cardiovascular disease (5), the effects of AR are encouraging. In conclusion, the results of this study provide valuable insight into the development of training programs that may help to support the health of individuals involved in military operations. From a hormonal perspective, active recovery appears to be a more optimal recovery method. 1 Adlercreutz H et al. (1986) Int J Sports Med 7 Suppl 1: 27-28. 2 Heald AH et al. (2001) Diabetologia. 44:333-339. 3 Häkkinen K, Pakarinen A (1993) J Appl Physiol 74: 882-887. 4 Lewitt MS et al. (1991) Endocrinology 129(4):2254-2256. 5 Rajawani A et al. (2012) Diabetes 61: 915-924.

Physical Fitness and Hormonal Profile During a 9-Week Paratroop Training Period

Presenter: Jani Vaara (Finland)

Jani Vaara1, Riikka Kalliomaa1, Petri Hynninen3 and Heikki Kyröläinen1,2 1Department of Leadership and Military Pedagogy, National Defence University, Finland 2Department of Biology of Physical Activity, University of Jyväskylä, Finland 3Utti Jaeger Regiment, Finland Physical fitness and serum hormone concentrations have been shown to vary during military basic training. However, no previous studies have monitored physiological responses and changes in fitness in paratroopers. Methods: 52 male conscripts (19.5±0.6 yrs.) participated. Serum hormonal profile and body mass were assessed at five measurement points during paratrooper training. The first measurement (M1) was conducted two weeks after the beginning of military service and the second one (M2) two weeks after M1 at a time when specialized parachute training (4 weeks) started. The third measurement (M3) took place 3 weeks after M2 and the fourth measurement (M4) two weeks after that. Before M4, conscripts were involved in strenuous military field training (4 days) consisting of restricted sleep and high physical activity. The final measurement (M5) took place two weeks after M4. Testosterone (TES), sex-hormone binding globuline (SHBG), cortisol (COR) and IGF-1 and body mass were measured at M1-M5, as well as maximal isometric force of the lower and upper body. 12-minute running test, sit-ups, push-ups and standing long jump were measured at M1, M3 and M5. Results: 12-minute running distance decreased ($p<0.001$) at M3 compared to M1 and M5 (M1: 3219 ±142, M3: 3146±163, M5: 3226±190 m). Push-up performance increased ($p<0.001$) during the 9-week period compared to baseline (M1: 52±11, M3: 61±13, M5: 60±13 reps/min), as did sit-up performance ($p<0.001$) (M1: 54±6, M3: 55±7, M5: 56±7 reps/min). Standing long jump decreased ($p<0.001$) from baseline compared to M3 and M5 (M1: 248±13, M3: 241±13, M5: 242±13 cm). No changes in upper body maximal strength were observed across the study period (M1: 1090±210, M2: 1090±230, M3: 1060±230, M4: 1020±230, M5: 1080±230 N), whereas maximal lower body strength decreased at M4 compared to all other time points (M1: 4350±1290, M2: 4660±1500, M3: 4520±1350, M4: 4370±1500, M5: 4600±1640 N) ($p<0.05$). Body mass was lower ($p<0.05$) at M4 compared to all other time points (M1: 74.7±8.7, M2: 74.7±8.5, M3: 74.9±8.3, M4: 73.3±7.8, M5: 74.2±7.7 kg). TES and IGF-1 decreased and SHBG increased ($p<0.001$) at M4 compared to all other time points (TES: M1: 13.0±3.1, M2: 12.7±3.7, M3: 13.2±4.5, M4: 7.0±5.2, M5: 12.7±4.7 nmol/L), (IGF-1: M1: 32.3±9.7, M2: 31.4±8.0, M3: 32.2±7.8, M4: 23.1±7.6, M5: 32.2±8.8 nmol/L), (SHBG: M1: 34.8±9.7, M2: 33.5±7.9, M3: 36.7±9.7, M4: 43.4±12.1, M5: 34.8±10.4 nmol/L). COR was higher at M5 compared to M2-M4 (M1: 514.7±108.3, M2: 468.8±139.5, M3: 471.1±95.4, M4: 491.2±113.2, M5: 537.6±141.5 nmol/L). Conclusion: The 3-week period of specialized military training of paratroopers decreased maximal aerobic capacity and lower body neuromuscular performance, while increasing muscle endurance. In addition, 5 days of military field training resulted in decrements in serum androgen hormone concentrations. To avoid decrements in physical performance and disadvantageous changes in serum hormone profiles, training should be periodized, even in fit paratroopers.

THEMATIC FREE COMMUNICATIONS/POSTERS – INJURY I

Association of Functional Movement Screening with Injury Risk in Army Soldiers

Presenter: Tim Bushman (USA)

Timothy T. Bushman, Tyson Grier, Michelle Canham-Chervak, Morgan K. Anderson, Bruce H. Jones. Army Institute of Public Health, Aberdeen Proving Ground, MD Abstract The Functional Movement Screen (FMSTM) is an evaluation tool intended to identify sports and exercise participants who are at higher risk of activity-related injuries. PURPOSE: To determine the predictability of injury risk using the FMSTM in an operational Army unit. METHODS: Male Soldiers aged 18-57 years completed the FMS TM (n = 2,484). Demographic data were collected by survey. Medical record data for overuse injuries six months after the FMSTM assessment were obtained from the Defense Medical Surveillance System. A cut point of ≤14 points, as is commonly reported in the literature, was used to denote high-risk for injury on the FMSTM. Risk ratios (RR) and 95% confidence intervals (95% CI) were calculated. ROC curve analyses for sensitivity, specificity, and area under the curve were calculated along with positive and negative predictive values. RESULTS: Soldiers who scored ≤14 points on the FMSTM had a significantly higher risk of overuse injury (RR (≤14 points/19-21 points) = 1.86, 95%CI 1.50-2.31) during the six-month injury surveillance period after the FMSTM assessment. However, FMSTM was only able to predict overuse injury with 37% sensitivity, 81% specificity, a positive predictive value of 43%, and a negative predictive value of 77% (area under the curve of 61%). CONCLUSION: Although Soldiers that scored poorly on the FMSTM had a higher risk of overuse injury, the sensitivity was low. Based on these findings, caution is advised when implementing this screening tool in an Army population at the cut point of ≤14 points since only 43% of those identified as “at-risk” for injury were accurately labeled; the other 57% identified as “at-risk” were ultimately not injured. As a consequence, limited prevention and treatment resources may be directed toward a considerable proportion of Soldiers who are ultimately at low-risk for injury. Additional investigations using the FMSTM to screen for injury risk in other Army populations is warranted, as well as the use of alternative cut points for optimizing injury risk prediction. Keywords: Functional Movement Screen, fitness assessments, Army, injury, injury screening

Effect of Body Mass Index and Physical Fitness on Injury Risk for Soldiers During Army Basic Combat Training

Presenter: Shamola Greene (USA)

Shamola Greene, Keith Hauret, Stephen Rossi, Bruce H. Jones. U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD Background: Research has shown that higher BMI is associated with decreased fitness and increased risk of injury, disability, and discharge. Purpose: To describe the effects of Body Mass Index (BMI) and physical fitness on injury risk for Soldier's in the U.S Army's 10 week Basic Combat Training course. Methods: Soldier demographics and Army Physical Fitness Test (APFT) performance (2-min push-ups [PU] and sit-ups [SU], timed 2-mile run [Run] and total APFT score [Score] were acquired for Soldiers who trained in Fiscal Years 2010-2012. Injury encounters were then linked to demographics and APFT performance. Gender-specific quintiles (Q) were established for body mass index (BMI: weight/height2) PU, SU, Run, and Score. Injury incidence (percent of Soldiers injured) and relative risk (RR: women: men) with 95% confidence intervals (CI) were calculated for all cells in 5x5 tables (males and females separately) with quintiles of BMI in rows (Q_1 [lowest] – Q_5 [highest]) and quintiles of PU, SU, Run or Score in columns. For the RR table for BMI x Run, the referent cell was BMI Q_3 (middle) and Run Q_1 (fastest). For the other APFT events, the referent cell was BMI Q_3 (middle) and PU/SU/Score Q_5 (highest). Results: Data on 143,938 men and 41,727 women were analyzed. For women, means ± standard deviation for BMI, PU, SU, Run and Score, respectively, 23.3 ± 2.7, 31 ± 12 repetitions, 60 ± 12 repetitions, 17.7 ± 1.8 minutes, and 226 ± 38 points, and for men means were 25.1 ± 3.7, 53 ± 14 repetitions, 63 ± 12 repetitions, 14.7 ± 1.4 minutes, and 228 ± 36 points. Injury incidence was higher for successively lower quintiles of fitness for both genders. The association of injury incidence and BMI was slightly U-shaped with men and women in the highest and lowest BMI quintiles having slightly higher incidence. In the 5x5 table with injury RRs for quintiles of BMI (Q_1 [lowest] - Q_5 [highest]) stratified by Run (Q_1 [fastest] - Q_5 [slowest]), the highest risks were for women and men with the lowest BMI and the slowest run time (BMI Q_1/Run Q_5) compared to the referent group BMI Q_3/Run Q_1 (RR women=2.56 [CI = 2.32-2.82] and RR men =3.11 [CI = 2.83-3.43]). On the other hand, women and men in the group with the highest BMIs and who ran the fastest (BMI Q_5/Run Q_1) exhibited among the lowest RRs (RR women = 1.01[CI = 0.87-1.17] and RR men = 1.23 [CI = 1.05-1.43]).Conclusion: This investigation found that women and men with the lowest BMIs and the slowest run times had the highest risk of injury, while the women and men who had the highest BMIs but ran the fastest had among the lowest risks. These findings could have important implications for screening applicants for military service

Risk Factors Associated with Medial Tibial Stress Syndrome in Runners

Presenter: Phil Newman (Australia)

Phil Newman1 Jeremy Witchalls, Gordon Waddington, Roger Adams, University of Canberra Contact person Phil Newman Abstract Background Medial Tibial Stress Syndrome (MTSS) affects 5-35% of runners. Research over the last 40 years investigating a range of interventions has not established any clearly effective management for MTSS that is better than prolonged rest. At the present time, understanding of the risk factors and potential causative factors for MTSS is inconclusive. Objectives To evaluate studies that have investigated various risk factors and their association with the development of MTSS in runners. Search methods Medical research databases were searched for relevant literature, using the term of "MTSS AND prevention OR risk OR prediction OR incidence" Results A systematic review of the literature identified 10 papers suitable for inclusion into a meta-analysis. Measures with sufficient data for meta-analysis included dichotomous and continuous variables of BMI, ankle DF ROM, navicular drop, orthotic use, foot type, previous history of MTSS, female gender, hip ROM and years of running experience. The following factors were found to have a statistically significant association with MTSS: Increased hip ER in males (SMD 0.67, 95% CI = 0.29-1.04, $p < 0.001$); Prior use of orthotics (RR 2.31, 95% CI = 1.56-3.43, $p < 0.001$); Fewer years of running experience (SMD -0.74, 95% CI = -1.26 to -0.23, $p = 0.005$); Female gender (RR 1.71, 95% CI = 1.15-2.54, $p = 0.008$); Previous History of MTSS (RR 3.74, 95% CI = 1.17-11.91, $p = 0.03$); Increased BMI (SMD 0.24, 95% CI = 0.08-0.41, $p=0.003$); Navicular Drop (SMD 0.26, 95% CI = 0.02-0.50, $p=0.03$); Navicular drop >10mm (RR 1.99, 95% CI = 1.00-3.96, $p=0.05$); Authors' conclusions Female gender, previous history of MTSS, fewer years of running experience, orthotic use, increased BMI, increased navicular drop and increased ER hip ROM in males are all significantly associated with an increased risk of developing MTSS. Future studies should analyse males and females separately as risk factors vary by gender. This data can inform both screening and countermeasures for the prevention of MTSS in runners.

Systematic Review of the Association of Fitness Components with Musculoskeletal Injury

Presenter: Dianna Purvis (USA)

Dianna L. Purvis, Peter Lisman, Sarah delaMotte, Kaitlin Murphy, and Patricia Deuster Uniformed Services University Purpose This investigation systematically reviewed associations between components of physical fitness and musculoskeletal injury (MSK-I) in athletic and military populations. Fitness components examined were: cardiorespiratory endurance, muscular endurance, muscular strength, flexibility, balance, speed, anaerobic power, and agility. Methods The authors reviewed literature identified from an online search using MEDLINE, EBSCO, EMBASE, and the Defense Technical Information Center database. Combinations of the words musculoskeletal injury, training, exercise, cardiorespiratory endurance, muscular endurance, muscular strength, flexibility, balance, speed, anaerobic power, and agility were included as search terms. Articles were included if: (1) they examined associations between physical fitness and MSK-I (acute or chronic) in an athletic or military population between 18-65 years of age, and (2) outcomes included measures of association such as odds, hazard, and/or risk ratios. Data extracted included study design, population, follow-up time, MSK-I definition, fitness component fitness test type, and reported outcomes. The quality of evidence was assessed using a modified assessment developed by Bullock et al. (2010) and graded on a scale ranging from 0 – 22. Quality scores ranged from low (≤7.6), average (>7.6 to ≤14.7), or high (>14.7). Results Of 3,335 studies identified, 58 met the inclusion criteria. Mean study quality was 18.0±1.8 and ranged from 12.0 to 21.5, with the majority of studies (55 of 58) rated as high methodologic quality. Cardiorespiratory endurance was the most frequently studied fitness component (N=48). Poor cardiorespiratory endurance was strongly associated with MSK-I in 86.4% (38 of 44) of articles reviewed. Specifically, slower run times were associated with increased MSK-I risk. Low muscular endurance was associated with increased MSK-I incidence in 55.6% (15 of 27) of reviewed articles. Poor muscular strength was associated with increased MSK-I in 77.3% (17 of 22) of the articles, though few studies (n = 8) examined this association in females. Flexibility extremes, either high or low, were associated with MSK-I in half (10 of 20) of articles reviewed. Although few studies examined the relationship between anaerobic power and MSK-I, 71% (5 of 7) found low power to be significantly associated with MSK-I incidence. Only three of the included studies examined balance and only one examined speed and incidence of MSK-I; no eligible studies looked at the association between agility and MSK-I. Conclusions Poor cardiorespiratory endurance and both low muscular endurance and strength were strongly associated with increased risk of MSK-I. Associations between MSK-I and measures of low anaerobic power, were strong but limited in number. In contrast, the association between MSK-I risk and balance, speed, and agility remain equivocal. Recommendations from this systematic review include: 1) continue to assess cardiorespiratory endurance in Warfighters throughout all Warfighter life-cycle phases, including pre-accession, to identify MSK-I risk; 2) develop improved strength and flexibility measures to standardize research results to uncover true associations with MSK-I; and 3) conduct high-quality studies to further examine the impact of balance, speed, and agility on MSK-I

Prospective Musculoskeletal Injury Rates among Different Categories of Soldiers

Presenter: Scott Shaffer (USA)

Scott W. Shaffer (1), Deydre S. Teyhen (1,2), Robert J. Butler (3), Ann-Maree Williams (4), Jennifer Prye (4), Stephen L. Goffar (1), Kyle B. Kiesel (5), Daniel Rhon (1), Phillip J. Plisky (5) 1. U.S. Army-Baylor University Doctoral Program in Physical Therapy, Ft Sam Houston, TX, 210-221-8410, Daniel.I.Rhon.mil@mail.mil, Scott.W.Shaffer.mil@mail.mil, Stephen.Goffar@gmail.com 2. Office of the Surgeon General, U.S. Army, USA, 703-681-9078, Deydre.S.Teyhen.mil@mail.mil 3. Duke University, Durham, NC, 919-681-7225, Robert.butler@duke.edu 4. Henry M. Jackson Foundation, MD, 210-482-9744, ann-maree.williams.ctr@mail.mil, Jennifer.c.prye.ctr@mail.mil 5. University of Evansville Department of Physical Therapy, Evansville, IN, 812-488-2341, kk70@evansville.edu, pp2@evansville.edu Purpose: Across the Department of Defense (DoD) there are approximately 750,000 musculoskeletal injuries (MSI) with 25 million related limited duty days on an annual basis. Although the impact of MSI in basic training populations is well documented, limited data exists regarding the incidence and type of MSI across various military unit types. The purpose of this study was to compare injury incidence rates among Rangers, Combat, Combat Service (CS), and Combat Service Support (CSS) military units. Methods: Healthy active duty Soldiers (n = 1430, 24.6±5.0 years, 26.7 ± 3.4 kg/m2) at Joint Base Lewis-McChord, WA were followed for 1-year. Injury data was collected using monthly injury surveillance surveys, comprehensive medical record reviews, and a DoD healthcare utilization database. Injuries were categorized as comprehensive (CII), overuse (OII), acute (AII) injury index and time-loss injury (TLI). Descriptive statistics, injury incidence rate per 1000 days, and relative risk (RR) were calculated. Results: Of the 1430 Soldiers, 481 (33.6%) had TLI, 222 (15.5%) sought medical care for MSI, 60 (4.2%) reported MSI but did not seek medical attention, and 667 (46.6%) were uninjured. Primary MSI complaints included foot and ankle (15.7%), low back (14.3%), and knee (12.8%). MSI were responsible for 5.9±14.4 medical encounters per injury, 21,902 days (36.3+59.7 days per Soldier) of limited duty, and medical cost of $1,752±6,293 per injury. Injury incidence rates (per 1000 days) were: 2.02 CII, 1.58 TLI, 1.48 OII, and 0.32 AII. Injury incidence rates for CII was greatest in combat units (0.87, RR: 0.43) and lowest among Rangers (0.33, RR: 0.16). Injury incidence rates for TLI ranged from 0.51 to 0.61 (RR: 0.32-0.38) for combat, CS, and CSS compared to 0.14 (RR: 0.09) for Rangers. For OII, combat units had the highest injury incidence rate 0.57 (RR: 0.38). The lowest injury incidence rate was for AII across the units (0.07-0.18, RR: 0.18-0.4). Conclusion: Injury incidence rates were universally higher than reported in athletic populations (~ 25%). The high rates of CII, OII, and TLI demonstrate the need to determine ways to both predict and prevent musculoskeletal injuries. The higher relative risk of injury in combat units should be explored further. These findings suggest that development of injury prediction models should consider the influence of unit type on injury risk. A better understanding of injuries and their impact on performance may reduce medical cost and lost duty days, as well as improve the overall health of the U.S. Military.

A Novel Dual-task and Multitask Assessment Battery Guiding Return-to-Duty in Concussed Service Members

Presenter: Laurel Smith (USA)

Laurel Smith1, Mary Vining Radomski2, Marsha Finkelstein2, Karen McCulloch3, Leslie Freeman Davidson4, Henry McMillan5, Matthew Scherer6, Margaret Weightman2 1 United States Army Research Institute of Environmental Medicine, Natick, MA 2 Courage Kenny Research Center, Allina Health, Minneapolis, MN 3 Division of Physical Therapy, Department of Allied Health Sciences, University of North Carolina, Chapel Hill, NC 4 Riverbend Therapeutics, LLC, Great Falls, VA 5 Department of Brain Injury Medicine, Womack Army Medical Center, Fort Bragg, Fayetteville, NC 6 Andrew Rader US Army Health Clinic, Joint Base Myer-Henderson Hall, Fort Myer, VA PURPOSE: The Assessment of Military Multitasking Performance (AMMP) is a battery of military-related functional dual-tasks and multitasks that target known sensorimotor, cognitive, and exertional vulnerabilities after concussion/mild traumatic brain injury (mTBI). Once validated, the AMMP is intended for use in combination with other metrics to inform duty-readiness decisions in service members following concussion. A dual task paradigm requires a Soldier to perform a physical and a cognitive task simultaneously in order to compare dual-task with single task performance. A multitask format requires completion of complex physical and cognitive activities that approximate real-world military tasks. Several test tasks challenge agility or activity tolerance. Initial validation for the AMMP involves establishing interrater reliability (IRR); and then convergent/discriminant validity by using correlations to neurocognitive and sensorimotor tests and establishing known groups validity by comparing scores on AMMP tasks between healthy control (HC) and concussed Soldiers undergoing rehabilitation in a brain injury clinic. METHODS: Using a convenience sample case-control methodology involving test construction and evaluation, a data-driven iterative process has been used to evaluate the six AMMP test tasks for interrater reliability (IRR) by 3 person rater teams comprised of physical and occupational therapists. Scoring discrepancies identified by intraclass correlation coefficients resulted in further clarifications of scoring rules and scorer training requirements. Ongoing data collection efforts continue at Fort Bragg for both HC and concussed Soldiers with a goal of 80 subjects per group. RESULTS: In addition to preliminary HC reliability testing, 34 subjects have been tested to date. Reliability findings frequently differed in HC versus concussed groups. ICCs for task completion time were 0.96-0.99 in HC and 0.77 to 0.99 in subjects with concussion. Cognitive components for each of the 3 dual-tasks, such as responding to key words in recorded radio chatter or recalling grid coordinates, demonstrated ICCs between 0.64 and 0.99. Subjects with concussion typically demonstrated greater number and range of errors than were seen in HC. CONCLUSIONS: Preliminary testing informed modifications in test structure, instruction, and scoring to enhance IRR. Development of measures that meet military stakeholder requirements for face validity and functional relevance contribute to the challenges of development of a valid AMMP battery. The consistency of scores across raters and the ability to discriminate known groups are fundamental to using the findings of the AMMP to make substantive recommendations regarding readiness to return to duty following concussion/mTBI. Funding for this work provided by MRMC W81XWH-12-2-0070.

Influence of Pain and Prior Injury on Musculoskeletal Injury Occurrence: A Prospective Review of a Large Military Cohort

Presenter: Deydre Teyhen (USA)

Deydre S. Teyhen (1,2), Scott W. Shaffer (2), Robert J. Butler (3), Stephen L. Goffar (2), Kyle B. Kiesel (4), Daniel I. Rhon (2), Phillip J. Plisky (4) 1. Office of the Surgeon General, U.S. Army, USA, 703-681-9078, Deydre.S.Teyhen.mil@mail.mil 2. U.S. Army-Baylor University Doctoral Program in Physical Therapy, Ft Sam Houston, TX, 210-221-8410, Daniel.I.Rhon.mil@mail.mil, Scott.W.Shaffer.mil@mail.mil, Stephen.Goffar@gmail.com 3. Duke University, Durham, NC, 919-681-7225, Robert.Butler@duke.edu 4. University of Evansville Department of Physical Therapy, Evansville, IN, 812-488-2341, kk70@evansville.edu, pp2@evansville.edu Purpose: Prior history of musculoskeletal injury has been found to be a predictor of future injury risk. Screening for pain with functional movement tests may be able to further identify individuals with potential for developing musculoskeletal injuries. The purpose of this study was to determine the predictive ability of prior history of injury and pain with movement tests to identify future injury in Soldiers. Methods: Baseline and follow-up data were available for 1430 healthy active duty Soldiers (24.6 ± 5.0 years, 26.7 ± 3.4 kg/m2) at Joint Base Lewis-McChord, WA. Past history of injury was established via survey to identify prior injuries, location, mechanism of injury, recurrence, and recovery status. Pain with movement was assessed during the Functional Movement Screen (FMS), Lower and Upper Quarter Y-Balance Tests (YBT-LQ, YBT-UQ), hop tests, and ankle dorsiflexion. Soldiers were followed for 1-year through self-report surveys and review of the electronic medical record. Injuries were defined using three injury indices: comprehensive (CII) and overuse (OII) injury indices, and time-loss injury (TLI). Variables with significant ($p<.05$) univariate relationships (chi-squared or t-test) were used in a logistic regression equation to determine the most parsimonious set of predictors of future injury. Results: Of the 1,430 Soldiers, 667 (46.6%) experienced at least one injury during the 1-year period; totaling 1191 injuries; averaging 1.2 ± 0.9 injuries per participant. Questions related to prior injuries were universally (100%) associated with CII, OII, and TLI. Of the 29 pain provocation tests, 71% (n=20) were associated with CII and OII, and 76% (n=22) were associated with TLI. The regression, which controlled for age and gender, identified pain with FMS pain provocation tests, hop testing, prior history of injury and recovery status from prior injury to be the most parsimonious set of variables predictive of future injury. The absence of past injuries and lack of pain with pain provocation tests correctly identified subjects whom were not injured: 72.5% for CII (Sn = 0.75, Sp=0.46), 83.4% for OII (Sn=0.71, Sp=0.41), and 87.2% for TLI (Sn=0.71, Sp=0.41). Conclusion: Musculoskeletal injuries have a negative impact on physical performance and mission readiness in the military. This study demonstrated the absences of pain with movement testing and past history of injury were associated with decrease risk of future injury. Future research should focus on developing efficient methods to determine injury risk and develop effective mitigation strategies.

Injury Prevention in Basic Military Training: The Role of Physical Training and Modulation of Physical Demands

Presenter: Thomas Wyss (Switzerland)

Thomas Wyss, Urs Mäder, and Lilian Roos Swiss Federal Institute of Sport Magglingen SFISM Non-combat injuries are a serious health problem in today's armed forces. Injury rates are related to high physical demands during daily military routines. Wyss et al. (2014) investigated this relation and found six risk factors, describing 98.8% of the variance of injury incidence rates between different basic military training (BMT) schools: high physical demands (two variables: energy expenditure, and time spent with physically demanding materials handling); decreasing development of distances covered on foot (changes in the total weekly walking, marching and running distances); large variability in weekly physical demands (variability in daily energy expenditure within one week); little time spent on sport-related physical training (strength-, aerobic fitness training, and team sports); and short night rest duration (bed time). The present study aimed to investigate the impact of adapted physical training and modulated development of distances covered on the incidence of injury in a Swiss Army BMT school. The recruits in the intervention group (n=179) reduced the distances covered on foot during the first four weeks of BMT, and performed an adapted physical training program for the first ten weeks of BMT. Adaptations in physical training program concerned quality (qualified instructors) and quantity (180 min/week). Another company in the same BMT school (n=112) served as a control group. Injury data from all recruits were registered for 21 weeks of BMT. Additionally, individual predictor variables for injuries, such as physical fitness, previous injuries, level of previous physical activity, smoking, motivation, and socioeconomic factors, were assessed. The intervention group spent more time in physical training (151 vs. 137 min/week), and it was instructed by more and better qualified personal (1.0 physical education teacher vs. 0.4 military instructor per 20 recruits). The content of physical training sessions was similar in both study groups (strength, endurance training and team sports). However, sensorimotor and balance training was performed in the intervention group only. The intervention group showed an increasing (+2.9 km/week), the control group a decreasing (-2.1 km/week) development of distances covered on foot during the first 10 weeks of BMT. The adaptations in the physical training program and the modulation of the development of distances covered on foot, had a relevant injury prevention effect. A reduced injury incidence rate of 14.3 injuries per 100 recruits per month (-33%), compared to 21.3 injuries per 100 recruits per month in the control group, was registered. Apart from these general injury risk factors, smoking, previous injuries, low fitness levels, and high performance motivation proved to be relevant individual injury risk factors. In conclusion, the intervention study confirmed the previously monitored relation between training patterns and injury incidences. As practical implication for injury prevention, high-quality physical training sessions, and well planned physically demanding military training activities are effective. Reference Wyss, et al. (2014). Impact of Training Patterns on Injury Incidences in 12 Swiss Army Basic Training Schools. Mil Med.

THEMATIC FREE COMMUNICATIONS/POSTERS – LOAD CARRIAGE

The Impact of External Load on Tactical Combat Movements – Individual Variability and Implications for Battlefield Survivability

Presenter: Daniel Billing (Australia)

Dan Billing, Andrew Hunt, Paul Tofari, Aaron Silk Land Division, Defence Science and Technology Organisation, Melbourne, Australia Corresponding author: daniel.billing@dsto.defence.gov.au Current military operations require dismounted combatants to carry heavy external loads, which are widely acknowledged to impair the ability to move tactically between points of cover (resulting in increased exposure time to the enemy). In fact, recent studies have shown a decline of between 0.6 - 1.7% per kilogram increase in external load using linear models of aggregated participant data. However, the implications of individual response to increasing load has not been closely investigated in a tactical movement construct. Purpose: To examine individual variability in response to increasing load (measured by exposure time) and consider implications for battlefield survivability by modelling the probability of being hit by enemy fire. Methods: Nineteen dismounted combatants from the Australian Defence Force (age 21.7±2.4 years, height 181.4±8.0 cm, body mass 81.0±9.0 kg) completed a break contact simulation (five 30-m sprints commencing every 44 s) and a fire and movement simulation (sixteen 6-m bounds commencing every 20 s) in each of five external load conditions (A-9.8 kg, B-14.6 kg, C-20.9 kg, D-25.6 kg, E-30.1 kg), comprising a replica weapon, chest webbing, body armour, and helmet. Prior to conducting the simulations participants also completed a range of generic physical capacity assessments. The six fastest and six slowest soldiers (determined by bound time from condition E) were parsed into sub-groups for each simulation and analysed to determine differences in exposure time and decrement in performance per kilogram increase in load. Probability of hit for the two sub-groups was modelled using exposure time for the two simulations and the assumed reaction time, shooting cadence and shooting accuracy of the adversary. Results: The fast group had a performance decline of 0.61 and 0.78% per kilogram increase in external load for the break contact and fire and movement simulation, respectively, whilst the slow group declined by 1.03 and 1.40%. In perspective, the fast group in the heaviest load carriage condition (E-30.1 kg) had an equivalent exposure time to the slow group in a load of 15.8 and 14.6 kg for the break contact and fire and movement simulations, respectively. Based on heaviest condition (E-30.1 kg), the fast group was found to have a 6% and 8% reduction in probability of hit compared to the slow group for the break contact and fire and movement simulation, respectively. There were no significant differences between sub-groups on the basis of age, height, body/fat/muscle mass, maximal aerobic capacity, and upper body power for both the break contact and fire and movement simulations. However, lower body power (vertical jump height) was significantly higher in the fast group (45.0±2.5 cm) in comparison to the slow group (39.1±4.3 cm) for the fire and movement simulation. Conclusions: Even amongst a relatively homogenous population there are large inter-individual differences in response to external load during tactical combat movements which have meaningful consequences

An Evaluation of Equations to Estimate Energy Expenditure During Soldier Load Carriage

Presenter: Angela Boynton (USA)

Angela Boynton, PhD and Ryan McQuaid U.S. Army Research Laboratory Human Research & Engineering Directorate Aberdeen Proving Ground, MD PURPOSE: Dismounted Soldiers routinely perform physically demanding tasks resulting in substantial expenditures of energy. Quantifying the amount of energy expended is of interest as it can impact individual Soldier mobility and task performance, and overall operational effectiveness. Indirect calorimetry, the "gold standard" method for quantifying energy expenditure (EE), requires the use of a face mask and other hardware to collect and evaluate oxygen and carbon dioxide levels in expired air. Although portable indirect calorimetry systems are available, they are expensive and not designed to withstand Soldier use outdoors. Additionally, the face mask prevents communication and can interfere with Soldier equipment and task performance. As an alternative to directly measuring EE, it can be estimated using existing regression equations based on anthropometric measures, task-specific variables, and activity monitor (AM) and heart rate (HR) data. However, most of these equations were developed for activities of daily living or sports activities not involving additional external loads and may not lend themselves to energy estimation during Soldier task performance. Therefore, the purpose of this study was to determine the accuracy with which these equations can estimate EE during Soldier load carriage. METHODS: Eight equations based on HR (Keytel 2005, Payne 1971), AM (Freedson 1998, Leenders 2003, Yngve 2003), or HR and AM (Crouter 2008) data, and the Pandolf equation, which includes body mass, load mass, walking speed, grade, and a terrain coefficient, were evaluated. 9 Soldiers walked on a treadmill at 1.3 m/s for 20 minutes while wearing body armor and carrying a rucksack and dummy M4 carbine, for a total load of 27.3 kg. Actual EE (Cosmed K4b2), heart rate (Polar) and activity monitor (Actigraph) data from the final minute of walking were used in this evaluation. For each subject, the appropriate data were input into the prediction equation and the difference between estimated and measured values was calculated. Average percent difference across subjects was calculated for each prediction equation. RESULTS: Of the three HR only equations evaluated, one underestimated EE by 37% and the other two overestimated by 21 and 32%. While the four AM only equations performed slightly better, they all tended to underestimate EE (10, 12, 16 and 39%). The equation combining HR and AM data produced an underestimation of EE comparable to either method on its own (38%). Finally, the Pandolf equation underestimated EE by approximately 19%. CONCLUSION: Existing prediction equations do not adequately capture the actual EE associated with Soldier load carriage. Some combination of motion, physiologic, anthropometric and task-specific information may be needed to characterize the task being performed and level of effort involved for accurate estimation of the associated EE. Further work is needed to determine if modification of existing equations or development of new Soldier task and load specific equations can improve the accuracy of EE estimations made for a variety of Soldier tasks.

Passive Exoskeleton for Backpack Carriage

Presenter: Chee Hoong Cheong (Singapore)

Chee Hoong CHEONG, Tong LEE DSO National Laboratories, Singapore Load carriage in its basic sense is to carry weight from one point to another. To do this by means of human carriage in a sustainable manner requires much research into developing an appropriate carriage device. This device can range from the commonly seen backpack systems to the more complex exoskeleton systems. In recent years, there is evident work carried out by academia and defence-related entities in the area of powered exoskeletons. For such systems, issues such as developing a light and sustainable power source, managing the bulk mass to avoid encumbering the user, sensing the motion intent of the user etc. remain difficult hurdles to cross. PURPOSE We attempted to circumvent the challenges in power sustenance, agility limitation and instant actuation control and feedback by exploring the possibility of using a fully unpowered mechanical approach to augment backpack load carriage. METHODS A mechanical exoskeleton (MEx) in-lab prototype was developed to test the concept of mechanically augmenting the carriage of a 30kg backpack. The MEx system leverages on ground reaction forces to offload the backpack weight from the user. The hip, knee and ankle joints of each MEx limb lock on ground contact to form a rigid structure to transfer the backpack weight directly to the ground. The MEx was evaluated on twenty healthy male volunteers (age, 23.7 ± 1.6 yr; height 173.1 ± 5.4cm; weight 66.3 ± 5.5kg) under the approval of DSO Institutional Ethics Review Board. Subjects performed four activities. The activities comprised walking across a walkway, ascending stairs, descending stairs and a 30-minute treadmill march. Two configurations were compared – 30kg backpack (BP) and MEx with 30kg backpack (ExoBP). The measurement for the first three activities covered motion gait capture, foot force between foot sole and footwear insole, shoulder force and surface electromyography (SEMG). For treadmill walk, SEMG, metabolic equivalent of task (MET), heart rate (HR) and rating of perceived exertion (RPE) were measured. RESULTS Foot forces and shoulder forces were reduced by up to 31% and 81% respectively with ExoBP when compared to BP. Range of motion reduced significantly in the ankle and knee joints, while trunk motion and hip joint saw significant increment when using the MEx in most activities. ExoBP resulted in higher MET scores (ExoBP=8.0 vs BP=5.2) and HR (ExoBP=159bpm vs BP=123bpm) during the treadmill march. RPE did not show any significant difference between ExoBP and BP. SEMG results showed increased muscular exertion during MEx usage. CONCLUSIONS The overall performance measure of the MEx indicated the need to further reduce the weight, and improve form factor and augmentation mechanisms. Work is underway in the design refinement and preparation for evaluation of MEx version 2.

The Force Fitness Profile: Measuring Operational and Physical Fitness for Optimal Assessment and Reporting

Presenter: Patrick Gagnon (Canada)

P.Gagnon, MSc, T.Reilly, PhD, M.Spivock, PhD. Canadian Forces Morale and Welfare Services. Directorate of Fitness. Human Performance Research and Development. Background: The Canadian Armed Forces (CAF) recently implemented the FORCE Evaluation (Fitness for Operational Requirements of CAF Employment), a field expedient fitness test designed to predict the physical capabilities of completing common military tasks. The standards on each test component are age and gender free, therefore the same for all CAF members. The military tasks represented by the FORCE Evaluation are predominantly focused on material handling involving muscular strength and endurance as well as walking with or without load carriage. Thus, the FORCE Evaluation does not require high levels of cardiorespiratory fitness (CRF) and may not address the overall physical or health-related fitness of military personnel. Purpose: The intent for developing a FORCE fitness profile was to capture in a single graph, a score representing one's operational fitness based on their performance on the FORCE test components (Y coordinate) and one's physical fitness score derived from their abdominal circumference (AC) (X coordinate) and a prediction of CRF. This profile would give an accurate visual representation of each CAF member's location on the graph, providing instant feedback on their ability to do their job and their relative risk (RR) of developing chronic diseases such as CVD, diabetes, metabolic syndrome, etc. Methods: A comprehensive literature review was conducted to validate if CRF and AC could be used as independent predictors of mortality and morbidity from chronic disease and identify age and gender cut-offs that would categorize individuals in low, moderate or higher relative risk. Data analysis from subjects with a wide range of fitness levels that performed a maximal FORCE evaluation as well as a graded exercise test (GXT) showed that the FORCE test components, when combined with age, gender and AC, were strong predictors of VO2max (CRF)(R2: 0.94, N:23). Results: Using published relative risk (RR) ratios for CRF and AC to predict mortality and morbidity from chronic diseases (Kodama et al 2009), the chosen approach was to select RR of 3.0 for the high risk and 2.0 for moderate risk categories. Age and/or gender-specific scores were attributed to CRF predictions and AC. The sum of the CRF and AC scores, weighted will determine the Physical Fitness Score (X axis). Results from over 25,000 FORCE evaluations were then used to develop age and gender-weighted scoring tables for each of the test components. The sum of those four scores represents the Operational Fitness Score (Y axis). Conclusions: The fitness profile provides a simple way to illustrate the fitness level of CAF members compared to their peers of similar age and gender and determine fitness levels for groups or the entire CAF. Results can be monitored over time and used to reward positive changes in the culture of fitness in the CAF.

The Effects of Heavy Load Carriage During the Performance of High Intensity Military Tasks

Presenter: Tunde Szivak (USA)

Tunde K. Szivak, Jesse Maladouangdock, Shawn D. Flanagan, Brett A. Comstock, David R. Hooper, David P. Looney, and William J. Kraemer Human Performance Laboratory, Department of Kinesiology, University of Connecticut, Storrs, CT 06269, USA Warfighters continue to carry heavy loads into combat and are expected to traverse the battlefield at high speeds and perform highly anaerobic tasks. This study examined the effects of heavy load carriage during the performance of a high intensity, combat relevant course. Eighteen trained men (mean ± SD: age: 21 ± 2 years; height: 172 ± 6 cm; weight: 80 ± 13 kg) volunteered for this study and were timed during the performance of a high intensity combat relevant course under two randomized experimental conditions; unloaded and loaded. During the unloaded trial subjects wore a combat uniform with boots weighing ~ 3.2 kg and during the loaded trial in addition to the combat uniform and boots, subjects wore interceptor body armor (6.94 kg-9.10 kg) and a MOLLE rucksack weighing ~ 30 kg. The combat relevant course performed consisted of 3 consecutive tasks, which began from the prone position, leading into a 30m sprint, followed by a 27 m zig-zag run, ending with a 10 m casualty drag weight ~79.4 kg and was completed 3 times with 5 min rest between cycles. An two way ANOVA with repeated measures with post-hoc tests were utilized to compare unloaded and loaded times for the three components of the course and the overall course times. When comparing the loaded trial to the unloaded trial, the loaded trial was significantly ($P \leq 0.05$) slower for the mean 30 m sprint time (8.8 ± 1.0 seconds vs. 5.9 ± 0.3 seconds), mean 27 m zig-zag run time (13.2 ± 1.0 seconds vs. 10.4 ± .6 seconds), mean 10 m casualty drag time (13.4 ± 3.8 seconds vs. 10.4 ± 2.3 seconds), and overall mean course performance time (35.3 ± 2.6 seconds vs. 26.8 ± 2.6 seconds). As hypothesized heavy load carriage significantly decreases performance of high intensity military tasks, which could negatively impact combat effectiveness and soldier survivability. Proper strength and conditioning programs for high intensity combat tasks should be performed to alleviate as much of the performance decrement as possible for repetitive explosive tasks under heavy load carriage.

Estimating Peak Vertical Ground Reaction Force During Soldier Load Carriage Using Activity Monitor Acceleration

Presenter: Jennifer Neugebauer (USA)

Jennifer M. Neugebauer and Michael LaFiandra Dismounted Warrior Branch Human Research and Engineering Directorate, U.S. Army Research Laboratory Aberdeen Proving Ground, MD 21005 Biomechanical studies of military load carriage, specifically ground reaction forces (GRFs), are commonly limited to the laboratory due to the non-portable equipment used to quantify GRFs during locomotion. Laboratory-based testing allows for repeatable, high-resolution data collection using the necessary equipment, but generally limits the type of operational relevant tasks that can be investigated. GRFs during load carriage are known to differ when compared to unloaded walking and are therefore of interest to assess differences in loading sustained by Soldiers. In order to investigate GRFs outside of the laboratory, methods to quantify peak vertical GRF (pGRFvert) of Soldiers during load carriage are needed. PURPOSE: Develop a statistically based model to estimate pGRFvert during loaded walking from ActiGraph GT3X+ activity monitor (AM) peak vertical AM acceleration (ACCvert). METHODS: 15 male Soldiers (25.4 ± 5.3 years, 85.8 ± 9.2 kg, 1.79 ± 9.3 m) wore an ActiGraph GT3X+ AM over the most lateral aspect of their right hip. Six walking trials (0.67-1.61 m/s) for each of four loads (no load, 15, 27, 46 kg) and two types of footwear (athletic shoes and combat boots) were completed (data were collected during the last 20 seconds of each 30 second trial). Average ACCvert and pGRFvert were determined using custom Labview and Matlab programs. A regression equation to predict pGRFvert initially included ACCvert, body mass, type of shoe (athletic shoe or combat boot), mass of the load carried, and the interaction of ACCvert and mass of the load carried. The significance of height, the specific AM worn, and the hardness of the footwear were also determined. Significance was defined at $p < 0.05$. A leave-one-subject-out (LOSO) approach was used to cross-validate the model. Each subject was excluded from the dataset, a unique model developed, and that model used to predict pGRFvert for the excluded subject. Root mean square error (RMSE) and average absolute percent difference (AAPD) between actual and predicted pGRFvert were determined. pGRFvert was also predicted for two novel test datasets and RMSE and AAPD calculated. RESULTS: The final equation to predict pGRFvert included ACCvert, body mass, carried load mass, and ACCvert-carried load mass interaction. Cross validation resulted in an AAPD of 4.0 ± 2.7% and an RMSE of 69.5 N for LOSO and an AAPD of 5.5 ± 3.9% and an RMSE of 78.7 N for the two test datasets. CONCLUSION: A statistically based equation was developed to predict pGRFvert from ActiGraph GT3X+ AM acceleration for Soldiers carrying military loads while walking. The low AAPD and RMSE suggest this equation provides a means to estimate pGRFvert without a force plate. Future research should determine the validity of the model to predict pGRFvert while walking over different terrains such as blacktop or packed dirt.

Predictive Equations to Estimate the Energy Expenditure of Walking at Different Speeds, Grades and Backpack Load Carrying

Presenter: Andre Siqueira Rodrigues (Belgium)

André V. Siqueira Rodrigues1,2, Jean Soares Amaral2, Luiz Antonio dos Anjos3, Flavio G. Ferreira Pinto2, Rafael CF Garcia2 1 – Conseil International du Sport Militaire; 2 – Instituto de Pesquisa da Capacitação Física do Exército; 3 –Universidade Federal Fluminense. Background: Soldiers are often required to carry loads while walking during military operations. Thus, accurate estimation of the energy expenditure (EE) of this task is an important issue for nutritional and medical purposes. Current predictive equations to estimate EE have been found to be inadequate in Brazilian samples of young individuals. Purpose: To develop predictive equations to estimate the EE of walking at different velocities, grades and carried loads. Methods: Gas exchange, heart rate (HR), accelerometry and step counts were measured in 60 male subjects while they walked on a treadmill at 24 combinations (3 minutes each) of speed (S=1.11 and 1.56m.s-1), grades (G=0, 5, 7.5, and 10%), and backpack loads (BL=0, 15, and 30kg). Resting metabolic rate and VO2max (treadmill ramp protocol) data, along with anthopometric and body composition measures, were also obtained. Regression models were used to develop predictive equations with VO2 as dependent variable and physical and physiological variables as independent variables. Results: Physical and physiological mean (SD) characteristics of the subjects were: age=21.8 (2,2)yrs; body mass (BM)=73.2 (9.6)kg; % body fat=19.5 (5.5); VO2max=50.9 (6.2)mL O2.kg-1.min-1). The developed equation with the highest R2 (0.875) and lowest SEE (0.232L.min-1) was: VO2 (L.min-1) =0.00517(HR)+0.08571(G)+ 1.04881(S)+0.01715(BL+BM)+0.00518(steps.min-1)-0.01307(BMI)+1.18407(resting VO2)-2.85528. The second best equation (R2=0.863 and SEE=0,242) was: 0.00545(HR)+0.08404(G)+ 1.24292(S)+0.01680(BL+BM)-2.57397. The inclusion of only S, G, and BL+BM in the model yielded a reasonably good equation (R2=0.840 and SEE=0.261): 0.10177(G)+1.52005(S)+ 0.02153(BL+BM)-2.68988. Conclusions: The simple model including only S, G, and BL+BM is adequate to estimate EE of walking in young soldiers of the Brazilian Army and comparable to the models that include more sophisticated physiological and accelerometry-derived measures. Supported in part by grants from CNPq (Proc. 305399/12-8) and FAPERJ (Proc. E-26/110.270/2012).

Energy Expenditure and Training Load During Military Basic Training Period

Presenter: Minna Tanskanen (Finland)

Energy expenditure and training load during military basic training period Tanskanen M (1), Jurvelin H (1), Kinnunen H (2), Kyröläinen H (1) 1) Department of Biology of Physical Activity, University of Jyväskylä, Finland 2) Department of Electrical Engineering, University of Oulu, Finland The volume and intensity of training load and energy expenditure during military basic training (BT) period is poorly known. In order to maintain and enhance aerobic performance, a certain amount of physical activity is required. On the other hand, excessive and prolonged physical activity leads to an overreaching state, which is followed by decreased physical performance and other physiological and psychological symptoms. The purpose of this study was to measure training load and energy expenditure during an 8-week military BT period using objective measurements in authentic environment. Methods: Thirty-four voluntary male conscripts (age 19.1±0.3 years) were divided into three training groups (basic, semi, pro) by their reported physical activity evaluated by international physical activity questionnaire (IPAQ) (1) prior to their military service. Maximal oxygen consumption (VO2max) and heart rate (HR) were determined by maximal treadmill test in the beginning and after four and seven weeks of BT to measure. During BT, heart rate (HR) monitors and accelerometers were used to evaluate physical activity and energy expenditure. HR data was used to calculate the training load (TRIMP, training impact) (2) for each day, week and the whole BT period. Daily rest and maximal HR was interpolated using the results of maximal treadmill test. Results: Training load of BT was remarkable and parallel with the training load of elite athletes during training and competition periods. The training groups differed ($p<0.001$-0.05) in terms of VO2max to each other (basic 36±6, semi 42±6, pro 48±6 ml/kg/min). The conscripts in the basic group were the most loaded during the study period (TRIMPbasic 12393±2989 vs. TRIMPsemi 10252±1337, $p<0.05$ and TRIMPpro 8444±2051, $p<0.01$). The intensity of different physical activities during the BT period were low or moderate (<6MET). Thus, the remarkable training load was rather due to extended duration of activity than high intensity. The average daily physical activity was 2.1±0.1 MET and did not differ between the groups. However, the pro group was more active ($p<0.01$) during leisure time compared to basic and semi (basic 2.3±0.1, semi 2.4±0.1, pro 2.6±0.2 MET) groups. Conclusion: According to this study, the optimizing of training load among the different fitness groups was not sufficient during BT. Thus, the differentiation in training loads ought to be even more pronounced. In the future, measuring the training load during military service is recommended in order to individualise the training load for each conscript. Combining of heart rate and physical activity measurements might give the best estimate of energy expenditure in field conditions. References: 1. Craig CL et al. (2003) Med Sci Sports Exerc 35:1381-1395. 2. Bannister E et al. (1991) Physiological Testing of Elite Athletes. Human Kinetics. p. 403-442.

THEMATIC FREE COMMUNICATIONS/POSTERS – FUNCTIONAL MOVEMENT SCREEN

Relationship Between Functional Movement, Core Stability and Body Stature on Conduct after Capture Training Outcomes

Presenter: Mark Carlson (Canada)

M. Carlson, A. Fuite, & S. Jaenen Canadian Forces Morale and Welfare Services; Directorate of Fitness; Human Performance Research and Development Purpose: Conduct After Capture (CAC) training is designed to simulate the psychological and physical stress of captivity. As such, candidates are placed under significant physical stress for long periods of time. Anecdotal evidence has indicated that candidates with a smaller body stature and greater flexibility and mobility have been more successful in completing CAC training. The purpose of the study was to determine if functional movement as measured by the Functional Movement Screen (FMS™), and/or core stability, and/or body stature, were related to CAC training outcomes. Methods: Participants in the study were healthy male (n=66) and female (n=3) Canadian Armed Forces members who attempted the CAC training course; underwent a comprehensive medical screening; and provided written informed consent. Prior to undertaking the CAC training course participants completed a variety of physiological measures. Height and body mass measurements were taken. Estimations of segmental lean mass (i.e. right and left arms, trunk and right and left legs) and percent body fat were obtained through bioelectrical impedance. Participants performed the FMS™ (deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, rotary stability and stability push up) and subsequent clearing tests (active impingement, flexion and extension) as well as core stability tests (flexor endurance, modified Beiring-Sorenson, and right and left lateral musculature endurance). Participant outcomes of CAC training were classified as: (i) completed training (COM) (n=49); (ii) did not complete training (DNC) (n=13); and (iii) academic failure (AF) (n=7). Participants who were removed from training due to AF were not included in the analysis. Results: Participants who COM had significantly less body mass (82.6±9.8kg) compared to those who DNC (89.7±9.9kg) ($p=0.024$). Similarly, percent body fat was significantly less for those who COM (15.4±5.1%) compared to those who DNC (21.0±8.5%). There were no significant differences between groups for flexor endurance (COM: 185.5±114.5; and DNC: 143.6±56.7s), modified Beiring-Sorenson (COM: 122.1±50.7; and DNC: 97.7±33.6s); and right (COM: 70.8±36.9; and DNC: 48.4±33.5s) and left (COM: 73.1±38.9; and DNC 51.9±36.9s) lateral musculature endurance tests. The total composite score for the FMS™ was not different between groups (COM: 16.3±2.4; and DNC: 15.3±3.8), however participants who COM displayed a significantly greater score on the hurdle step on both right and left sides (2.8±0.4) compared to those who DNC (2.3±0.6). Conclusions: Our results are in partial agreement with the previous anecdotal evidence. Specifically, participants with a smaller body stature as evidenced by body mass and percent body fat, combined with good stability and control of the hips and pelvis as indicated by the hurdle step, were associated with successful CAC training outcomes. Functional movement as measured by the FMS™, excluding the hurdle step, as well as core stability were not related to CAC training outcomes.

Functional Movement Changes With Deployment: The Combat Readiness Evaluation (CORE)

Presenter: Sarah de la Motte (USA)

Sarah de la Motte1, Peter Lisman2, Anthony Beutler1, Steven Blivin3, Francis O'Connor1, Patricia Deuster1 1Consortium for Health And Military Performance, Uniformed Services University, Bethesda, MD 2Towson University, Towson, MD 3Naval Hospital Camp Lejeune, NC The Functional Movement Screen (FMS) is 7-step, field expedient, screen for evaluating the quality of fundamental movement patterns. Scores ≤14 have been associated with increased risk of injury in athletes and Marine Officer Candidates. More importantly, low FMS scores indicate movement dysfunction, including pain with movement, inadequate flexibility and/or poor core stability, which may impede the ability to perform duty-specific tasks. The impact of pre-deployment training and eventual deployment on existing movement dysfunction is unknown. Purpose: To examine FMS score changes from pre-to-post deployment in a large Marine cohort. Methods: After informed consent, two deploying Marine Battalions (N=338) underwent the FMS three months (Pre1) and one month (Pre2) prior to deployment, and within 1 week post-deployment (Post). FMS scores from each time point were dichotomized into adequate (>14) or poor movement (≤14) groups. Also, individual change scores were calculated across the three timepoints, with negative scores indicating further functional movement decrements. Pearson Chi-square analyses were used to determine the relationship between FMS groups and functional movement changes before and after deployment. Results: Marines with compromised movement patterns (≤14) were more likely to exhibit functional declines over time: scores at Pre2 were lower than Pre1 (χ^2=55.7, p<0.0001) and scores post-deployment were lower than both Pre1 and Pre2 (Pre2-Post)(χ^2=35.6, p<0.0001) compared to those who had adequate movement at Pre1. Conclusions: Marines who began pre-deployment with compromised movement patterns were more likely to exhibit further decreases in movement ability compared to those who began pre-deployment training with adequate movement. Moreover, further functional declines after deployment were noted in those with initial compromised movement patterns. Programs to target Marines with compromised movements before deployment may be warranted to improve the overall health of deploying Marines. DISCLOSURES, CONFLICTS OF INTEREST AND SOURCE FUNDING The authors report no conflicts of interest. This work was supported by the Office of Naval Research, G181EJ. The project was approved by the Naval Hospital Camp Lejeune, Naval Medical Center Portsmouth and the Uniformed Services University of the Health Sciences Institutional Review Boards and by the Commander at Marine Corps Base Camp Lejeune (NHCL.2011.0010). The opinions or assertions contained herein are the private ones of the author(s) and are not to be construed as official or reflecting the views of the Uniformed Services University, Department of the Navy or the United States Department of Defense.

Predicting Post-Deployment Pain in US Marines

Presenter: Peter Lisman (USA)

Carl Goforth, Sarah de la Motte, Pete Lisman, Josh Kazman, Patricia Deuster, Francis O'Connor, Anthony Beutler Introduction: Musculoskeletal pain is a common complaint among returning warfighters. Over half of surveyed deployed Combat Brigade Team personnel list pain as a returning problem. Previously identified pain risk factors (RFs), to include wearing body armor and the amount of time spent on walking patrol, are not easily modifiable, thus hampering pain reduction efforts. Recent data indicate that poor movement patterns and inadequate core stability might be RFs for musculoskeletal pain in active populations. The Functional Movement Screen (FMS) is a 7-step clinical assessment tool that assesses movement patterns and pain during exercises involving core strength, balance, and stability, and has been shown to be associated future injury in US Marine Officer Candidates. Identification of these modifiable RFs might translate into training and deployment readiness programs that effectively minimize pain experience by deploying troops. Purpose: To assess the association between functional movement and pain, by using FMS scores and post-deployment Defense and Veterans Pain Rating Scale (DVPRS) scores, in Infantry Marines upon return from deployment. Methods: Marines from 10th Marine Regiment, 2nd Marine Division, Camp Lejeune, NC were consented and screened using the FMS within 1 month post-deployment (N=148). The 7-step FMS was graded on a 0-3 scale (0=pain; 3=optimal), yielding a max FMS score of 21 points.Results: Sample characteristics included mean age 23.9 ± 3.2 yrs (range 18 to 35 yrs), all-male, average weekly body armor use 33.2 ± 20.5 hrs. Average post-deployment pain severity was 1.9 ± 2.0 (max = 10) and average post-deployment FMS score = 15.3 ± 2.6 (N = 130; Range 5-21). Using independent samples t-test, mean pain severity was significantly higher for low FMS performers (FMS ≤ 14 points) compared to high FMS performers (FMS > 15 points): Low FMS: 3.1 ± 2.4 vs. Hi FMS: 1.5 ± 2.1; $t_{129} = 4.62$, $p < 0.001$. In addition, the correlation between weekly time wearing body armor and pain severity score was significant and positively related ($r = 0.24$, $p = 0.003$).Conclusions: FMS scores in US Marines returning from deployment are similar to US athletes, but vary widely. Low functional movement performers had the highest post-deployment pain severity. Similarly, those reporting greater weekly times wearing body armor had higher self-reported post-deployment pain severity. Whether "pre-habilitation" during pre-deployment training would translate to decreased post-deployment pain for the US military and Veterans Administration remains to be determined.

Comparison of Performance Between Rangers, Combat, Combat Service, and Combat Service Support Soldiers

Presenter: Dan Rhon (USA)

Daniel I. Rhon (1), Deydre S. Teyhen (1,2), Scott Shaffer (1), Robert J. Butler (3), Stephen L. Goffar (1), Kyle B. Kiesel (4), Robert E. Boyles (5), Danny McMillian (5), Jared N. Williamson (6), Phillip J. Plisky (4) 1. U.S. Army-Baylor University Doctoral Program in Physical Therapy, Ft Sam Houston, TX, 210-221-8410, Daniel.I.Rhon.mil@mail.mil, Scott.W.Shaffer.mil@mail.mil,Stephen.Goffar@gmail.com 2. Office of the Surgeon General, U.S. Army, USA, 703-681-9078, Deydre.S.Teyhen.mil@mail.mil 3. Duke University, Durham, NC, 919-681-7225, Robert.Butler@duke.edu 4. University of Evansville Department of Physical Therapy, Evansville, IN, 812-488-2341, kk70@evansville.edu, pp2@evansville.edu 5. University of Puget Sound, Tacoma, WA, 253-879-3180, dmcmillian@pugetsound.edu, bboyles@pugetsound.edu 6. Tacoma Strength: Unbroken, Tacoma, WA, 253-220-5472, jared@uprtacoma.com Purpose: Emerging evidence indicates that performance on fitness and movement tests can identify athletes at risk for injury. The purpose of this study was to establish normative data and compare performance between Soldiers based on military unit type: Rangers, Combat, Combat Service, and Combat Service Support. It was hypothesized that Soldiers in Rangers and Combat units would outperform Soldiers in Combat Service or Combat Service Support units. Methods: Service members actively participating in military and fitness training were recruited as part of a larger trial. Participants (n = 1,466) were active duty Soldiers (1.8 ± 0.1m, 82.4 ± 12.4kg, 26.7 ± 3.4kg/m2, 24.7 ± 5.0 years) at Joint Base Lewis-McChord, WA. The sample included 207 Rangers, 624 Combat, 298 Combat Service, and 301 Combat Service Support Soldiers. Participants completed the following tests: closed chain ankle dorsiflexion (DF), Functional Movement Screen (FMS), Y-Balance Test Lower Quarter (YBT-LQ), Y-Balance Test Upper Quarter (YBT-UQ), triple hop, and Army Physical Fitness Test (APFT; push-ups, sit-ups, and 2-mile run). Analysis of Variance (ANOVA, $p < 0.05$) was performed to compare the results based on military unit type (Rangers, Combat, Combat Service, and Combat Service Support). Data were collected electronically using handheld devices and were synchronized with a server computer. Data were collected in a single session lasting approximately 90 minutes. Results: Normative data for Soldier performance included 36.2 ± 7.8° DF, 14.4 ± 2.7 FMS score, 96.9 ± 8.9% limb length for YBT-LQ, 88.3 ± 9.7% limb length for YBT-UQ, 449.8 ± 88.0 cm for triple hop, 67.0 ± 14.8 push-ups, 71.4 ± 12.2 sit-ups, and 868.8 ± 121.2 seconds for 2-mile run. Rangers performed better than all other unit types on all performance and fitness measures ($p<0.05$). Combat Soldiers performed better than Combat Service and Service Support Soldiers on FMS, YBT-LQ, and APFT ($p<0.05$). Performance was equivalent between Combat Service and Service Support Soldiers performance on DF, FMS, YBT-LQ, and APFT ($p<0.05$). Conclusions: As hypothesized, Soldiers in Ranger units performed better than those in other units. The impact of musculoskeletal injury on unit readiness, retention, and disability is well documented and plagues the military in a garrison and deployed environment. A better understanding of unit-specific normative data for tests associated with physical performance and injury risk provides a foundation for future injury prediction and prevention strategies.

A Novel Return to Duty Screening Tool for Military Clinicians

Presenter: Mark Thelen (USA)

LTC Mark Thelen, LTC Shane Koppenhaver, MAJ Carrie Hoppes United States Army-Baylor University Doctoral Program in Physical Therapy United States Army Medical Department Center & School, Fort Sam Houston, TX 78234 PURPOSE: Musculoskeletal injuries represent the most costly threat to military medical readiness. Previous injury has been cited on numerous occasions as the greatest predictor of future injury. It is difficult to assess clinically when an injured service member has fully recovered, and there is no standardized procedure being utilized to assist military clinicians in making this determination. Although there are several systems aimed at predicting musculoskeletal injuries, they are equipment and time intensive and not specific to the military. Therefore, the purpose of this study was to assess the reliability of a newly proposed Return to Duty (RTD) screening tool that requires minimal training, equipment, time, is gender-neutral and can be used by any military clinician in any environment. METHODS: A cohort of 34 military service members were recruited, consented, completed demographic information, and had the RTD screening tool administered. In order to be included in the study, participants must have sustained an activity limiting injury within the preceding six months. The RTD screening tool consisted of seven events: modified overhead deep squat, modified anterior reach, modified Feagin hop test, modified trunk stability push-up, forward step down in simulated darkness, modified hip abduction, and subjective concern for injury. A maximum of two to three points per event were awarded with the maximum possible composite score being 16. To assess inter-rater reliability, two graders simultaneously scored each of the seven events and provided individual event and overall composite scores. To assess test-retest reliability, participants returned 3-7 days later for subsequent administration of the RTD screening tool. RESULTS: The mean RTD screening tool composite score was 11.3 (SD: 2.3) and 11.6 (SD: 3.0) for males and females respectively. There was no significant difference in composite scores between males and females at either time interval. The mean ICC (2,1) for inter-rater reliability was 0.88 (95% CI: 0.78,0.94). All individual events demonstrated moderate to excellent chance-corrected agreement between raters (range: k = 0.52-1.0) with the exception of the modified hip abduction event which was rated fair to poor (k = 0.26). Test-retest reliability for the composite score was 0.57 (95% CI: 0.21, 0.79). CONCLUSIONS: The RTD screening tool demonstrates an acceptable level of inter-rater reliability for both the composite score and all but one of the individual event scores. The test-retest reliability measures were lower than anticipated which is possibility related to a participant learning effect. Follow-on research should focus on measuring injury occurrence and comparing that with RTD screening tool event and composite scores in order to assess if any particular event and/or composite score demonstrates the ability to predict subsequent injury.

CONCURRENT SYMPOSIA – THURSDAY

Science to Practice: Transitioning Predictive Models into Working Applications for the Warfighter

Presenters: Samuel Cheuvront (USA), Jaques Reifman (USA), Xiaojiang Xu (USA), Beth Beidleman (USA)

Deployment of Warfighters to extreme environments such as altitude, cold and heat causes debilitating effects on their health and performance. This symposium will address the science behind the development of predictive models in each of these environmental conditions as well as the new sweat prediction equation to minimize decrements in health and performance in the Warfighter. These predictive models all serve as useful planning tools for clinicians, health-care providers, and military commanders when planning combat and humanitarian missions. The transition of these models into useful practical applications on personal computers, tablets and smart phones will be discussed.

Advances in the Physiology, Biomechanics, and Modeling of Soldier Load Carriage

Presenters: Robin Orr (Australia), Joseph F. Seay (USA), Joseph Knapik (USA), Yuval Heled (Israel), Yoram Epstein (Israel)

Loads carried by soldiers have been of operational and scientific concern since around the 18th century. Surprisingly, with technological advances, the problems have worsened rather than improved, leaving load carriage a continuing military problem. The overall weight burden on a soldier in today's military operations can exceed 50 kg and sometimes equals the soldier's body weight; loads of 30% to 75% of body weight are very common. The present session will provide up-to-date insight on a variety of aspects in regard to load carriage. Presentations will cover the physiological burden and the biomechanics of load carriage emphasizing risks that affect the individual soldier performance, as well as the team/squad performance, and current knowledge on how combinations of specific modes of physical training can substantially improve load carriage performance. The presentations will also cover physiological and biomechanical aspects of load carrying systems that may assist soldiers carrying heavy loads, and a computational model that investigates the effect of the load weight and the backpack structure on the strains and stresses that develop in the shoulder tissues with its ability to predict possible damage to the soft tissues and nerve.

Requirements for Soldiers' Physical Performance and Training in the Nordic Countries

Presenters: Heikki Kyröläinen (Finland), Mikael Mattsson (Sweden), Paul Andre Solberg (Norway), Anders Kilen (Denmark)

It is well known that good aerobic and neuromuscular performance is required for successful work in modern military and crisis management operations despite technological developments of warfare. During sustained military operations multiple stress factors such as prolonged physical activity, energy and water deficit, sleep deprivation and disturbances in mood state enhance physical and mental loading of soldiers. Therefore, physical training combined with military training, is essential for maintaining or even increasing soldiers' physical and mental capacity not only for a success in their duties but also for better recovery from strenuous activities. During this symposium, Dr. Heikki Kyröläinen (Finland) will introduce how physical training can be optimized during military basic training period and what are the requirements for soldiers' physical performance in the Finnish Defense Forces. Thereafter, Dr. Mikael Mattson (Sweden) will specify requirements for soldiers' endurance capacity in prolonged continuous work. Dr. Paul André Sohlberg (Norway) will speak about their project how they have developed and implemented of a new concept for physical training in the Norwegian Navy Special Operations Command. Finally, PhD student Anders Kilen (Denmark) will describe micro-training and its utilization during military training.

POSTER SESSION IV – PHYSICAL PERFORMANCE STANDARDS

Evaluation of USMC Fitness Tests as Predictors of Success on Combat Proxy Tasks

Presenter: Karen Kelly (USA)

Karen R. Kelly1, Jason Jameson1, Leon Pappa2 and Brian McGuire2 1 Department of Warfighter Performance, Naval Health Research Center, San Diego, CA 2 Training and Education Command, U.S. Marine Corp, Quantico VA Objective. To determine whether benchmark physical fitness tests including the Physical Fitness Test (PFT) and the Combat Fitness Test (CFT) utilized by the United States Marine Corps are valid predictors of successful completion of combat-related tasks. An additional purpose of this study was to determine which benchmark physical fitness tests are most predictive of performance on these tasks. Methods: Data was collected from three different sites within USMC Training and Education Command. All participants (409 males, M, and 379 females, F) were active-duty Marines having been recently tested on the PFT and CFT. Participants were asked to execute a total of 6 combat proxy events: pull-ups, deadlifts, clean and presses, 120mm tank loading drill, a 155mm artillery round carry, and negotiating an obstacle course wall while wearing a fighting load (~30lbs). The validity of the existing physical fitness tests, PFT and CFT—for predicting performance on a battery of combat-related tasks was assessed. To determine predictive validity, correlations were computed between components of the PFT and CFT and the individual combat tasks, as well as an overall composite combat proxy test score. Results: The clean and press was strongly associated with pull-ups (r=0.70), ammo can lift (r=0.69), 3-mile run (r=-0.53), movement to contact (800 yd sprint, r =-0.64), and maneuver under fire (r= -0.68). When taken together, upper body strength as tested via the pull-up or ammo can lift was the strongest predictor of success on combat proxy tests (r=0.67; r=0.74 respectively). Conclusions: The CFT does a better overall job than the PFT for predicting performance on the combat-related tasks. For the component CFT tasks, the ammo can lift is the best individual predictor of performance on the proxy tasks. Overall, these results suggest that the Marine Corps' PFT and CFT serve as a sound basis for making valid inferences about a Marine's physical capability to perform well in combat. Disclaimer: This work was supported by the Training and Education Command, USMC, under Work Unit No. N1235. The views expressed are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government. Approved for public release; distribution is unlimited. This research was conducted in compliance with all applicable federal regulations governing the protection of human subjects and was reviewed and approved by the Marine Corps Combat Development Command Institutional Review Board.

Development of a Job-based Physical Readiness for Operations Test

Presenter: Cara Lord (Australia)

Cara Lord1, Rod Snow1, Brad Aisbett1 1School of Exercise and Nutrition Science, Deakin University, Australia Corresponding author: clor@deakin.edu.au Introduction: The rebranding of volunteers as "workers" in the new Australian Workplace Health & Safety Act (2011) has introduced the notion of Australian employment laws to a previously unaffected population, volunteer firefighters. These changes now allow agencies to preferentially select potential employees, which may include determining whether the physical abilities of a worker correspond to those needed 'on the job'. This preferential selection of employees could presumably minimise or eliminate preventable harm to those without the required capabilities. Purpose: To develop a Physical Readiness for Operations Test based upon the job requirements of fighting wildfires in rural Australia. Methods: The development process started with assessment of the quantification of critical tanker-based firefighter job tasks, followed by a workshop attended by various expert groups including; incumbent firefighters, subject matter exerts, human movement specialist and occupational legislative experts to quantify the critical job tasks and design a representative test. Following pilot testing to compare the physiological requirements of the test to the job tasks, an agency wide survey was completed by incumbents assessing their levels of operational fidelity of the test to the job demands. Finally agency training and occupational health and safety staff reviewed the test to ensure the test could be feasibly used for the required purposes. Results: All experts with tanker-based firefighting experience rated seven critical job tasks relevance for inclusion in the development of the test, of which four were identified as criterion job tasks. An additional task was included to the criterion tasks list, provided with support of 100% of the attendees. All tests developed in the workshop were job-based tests, with a minimum of 80% agreement between all experts in attendance at the test design workshop. A high rating of physical resemblance of the PRO-T Test was reported by incumbent firefighters in the survey of PRO-T test operational fidelity. Conclusion: Inclusion of various expert groups from different domains and incumbents resulted in a robust test being developed, as judged by a large cohort of incumbent firefighter's survey responses. REFERENCES Workplace Health and Safety Act (2011). An Act relating to work health and safety, and for related purposes. Department of Education, Employment and Workplace Relations

Muscle Activity During Sustained Hand Held Mine Detector Use

Presenter: Kane Middleton (Australia)

Kane J. Middleton*- and Tim L. A. Doyle- *Centre for Human and Applied Physiology, University of Wollongong, Wollongong, Australia -Land Division, Defence Science and Technology Organisation, Melbourne, Australia Combat engineers use hand held detectors for extended periods of time. Sustained muscular contractions can have significant effects on task performance, especially fine motor skills which are critical to marksmanship. Previous research has shown that following sustained muscular contractions of the upper limb, both hand steadiness (Leyk et al., 2006) and shooting accuracy (Evans et al., 2003) deteriorate. Purpose: To measure muscle activation across a simulated route clearance using an in-service hand held detector. Methods: Six soldiers (5 male, 1 female; age 25.0 ± 3.1 years; height 173.4 ± 8.0 cm; mass 83.5 ± 10.7 kg) performed a 45 min simulated route clearance using an in-service hand held detector. Electromyographic data were collected from five muscle sites (Table 1). Mean and peak percentages of maximum voluntary contraction (%MVC) were calculated for the first and last ten seconds of the route clearance. These data were analysed using paired t-tests with significance set at an alpha level of 0.05. Effect sizes were calculated to identify functional changes according to Cohen (1988; small 0.2-0.49; medium = 0.5-0.79; large ≥ 0.8). Results: A significant increase in mean %MVC was found in the brachioradialis muscle. No other statistical changes in mean or peak %MVC were evident (Table 1). However, large effect sizes for both mean (brachioradialis, anterior deltoid and medial deltoid) and peak (brachioradialis and medial deltoid) %MVC were found. Table 1 Mean and peak %MVC changes during a simulated route clearance for five muscle sites. Data are mean (±sd). *Significantly different to Initial. Mean %MVC Effect Size (d) Peak %MVC Effect Size (d) Initial Final Initial Final Brachioradialis 9.7 (5.2) 19.2 (12.7)* 1.0 16.8 (7.6) 34.0 (20.6) 1.1 Flexor Carpi Radialis 8.4 (4.3) 10.9 (7.1) 0.4 15.5 (8.5) 19.4 (15.3) 0.3 Biceps Brachii 13.6 (7.0) 20.2 (18.2) 0.5 22.5 (10.0) 33.8 (21.7) 0.7 Anterior Deltoid 8.0 (3.9) 11.8 (4.0) 1.0 17.1 (9.7) 24.1 (11.5) 0.7 Medial Deltoid 8.4 (2.7) 12.7 (6.8) 0.8 12.4 (3.4) 18.8 (9.2) 0.9 Conclusions: The sustained use of an in-service hand held detector during a 45 min simulated route clearance significantly changed upper limb muscle activation. The mean %MVC recorded for brachioradialis almost doubled while there was a trend for all muscles measured to increase in %MVC. Given shooting performance significantly decreases after sustained upper limb muscular contraction tasks (Evans et al., 2003), fine motor skills and consequently marksmanship may be compromised immediately following extended hand held detector use. References: Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (second ed.). Lawrence Erlbaum Associates. Evans, R.K et al. (2003). Upper body fatiguing exercise and shooting performance. Mil Med, 168: 451-456. Leyk, D. et al. (2006). Recovery of hand grip strength and hand steadiness after exhausting manual stretcher carriage. Eur J Appl Physiol, 96: 593-599.

Correlation Between Anthropometric Variables and Body Fat Percentage in Military Young Adults of the Brazilian Air Force

Presenter: Pedro Palermo (Brazil)

Measure, evaluate and classify the body composition and the distribution of body fat are still a challenge within military personnel. Two of the main reasons are the correct relation between the clinical and health meanings and the physical fitness test scoring system currently used by several Armed Forces, and the use of a scientific generalized methodology per age, gender, and applicable to a multi-ethnical population. More than 10 years ago, the Brazilian Air Force (FAB) implemented the percentage of body fat (%BF) in its physical fitness test, measured via the sum of 3 skinfolds, as a meaning of evaluating and scoring the body composition of its military personnel. Methodological problems, as well as operational and logistical difficulties of the implemented system have raised the importance to develop an easier anthropometric methodology to evaluate the body composition under scientific criteria. This paper aims at investigating in which way the variables associated with the weight, height, and waist circumference (WC) of military personnel from the Brazilian Air Force (FAB) between 20 and 30 years old, evaluated by the physical fitness test in 2012, are correlated with the percentage of body fat (%BF). The researched group was composed of 986 male and 196 female from 10 Military Units of the FAB, previously selected for having strictly followed all the skinfolds measurement procedures. The body mass index (BMI), the WC, the waist-to-stature ratio (WSR) and the product waist-to-BMI (PWBMI) were the independent variables and the %BF, estimated by skinfold, as the dependent variable. Linear and multiple regressions filtered by multicollinearity to discard strong associations within dependent variables were also implemented. The most significant Pearson correlations (r) were 0,709, standard error (STE) of 3,964% for male, when associated to PWBMI; and 0,624 (STE= 4,584%) for female, when associated to BMI. The %BF regressions presented determinant coefficients (R2) of 59,6% for WC (STE=4,24%, p<0,000) and 64,2% for PWBMI (STE=3,99%, p<0,000) when considering both sex and age. The results are slightly lower in comparison with other study implemented in 48 Brazilian students of Physical Education. Conclusively, the correlations should be used cautiously when determining the %BF. This research also presented PWBMI as a potential new index for the evaluation of body composition, due to the fact that it is directly and positively associated with body fat quantity and distribution. New studies are necessary to investigate the clinical value of PWBMI, as well as the adoption of other anthropometric sites in a balanced male and female sample of Brazilian military personnel to determine a body composition index for physical fitness test purposes.

Gender Neutral to Gender Free: Physical Employment Standard Evolution in the Canadian Armed Forces

Presenter: Tara Reilly (Canada)

Tara Reilly, PhD*, Jacqueline Laframboise MSc *tara.reilly@forces.gc.ca Canadian Forces Morale and Welfare Services. Directorate of Fitness. Human Performance Research and Development. Background: More than any other issue, Physical Employment Standards (PES) have been used to argue for the exclusion of women from combat (Pinch et al 2004). The physical ability criteria for inclusion in combat units, appears to be both arbitrary and discriminatory to females by emphasizing male areas of physical competence (Pinch et al 2004). In 1989 the Gender Barrier was lifted from all Occupations within the CAF and the CF EXPRES test was developed as an annual PES for CAF personnel, based on guidelines delivered from the Canadian Human Rights Commission produced in 1978. The CF EXPRES employed predictive relationships between performance on common military tasks and the Canadian Standardized Test of Fitness (push-ups, sit-ups, grip- strength, shuttle run/or step-test). It was Gender Neutral but not Gender Free as predictions were dependent on age and gender, leading to misconceptions within the CAF about the abilities of females. Research demonstrates that the gap between maximum capabilities of males and females narrows as the task moves from a Physical Fitness style test (Push-ups) to an Occupational style test (manual material handling) (Constable & Palmer, 2000). April 2014, the CF EXPRES was replaced by the FORCE Evaluation (Fitness for Operational Requirements of CAF Employment), also predicting the physical capabilities of completing common military tasks but with no age and gender categories. Early exposure to FORCE during the familiarization year has resulted in a 90% success for females, with performance limitations linked more to anthropometry than gender (Reilly, 2014). However, during the first year of implementation we expect the success rate to improve similar to those seen in a recent 12 week training study (Laframboise, 2014). Purpose: To present how the CAF Human Performance Research Team ensures that Discrimination and Adverse Impact within PES is avoided. Methods: (1) Ensure representation of female SME in the identification of tasks. (2) Use facts rather than opinions when setting operational standards. (3) Design PES to be operational, occupational and reflective of common work activities. (4) Data collection must include females (especially when determining the physiological demands of each task). (5) Do NOT norm reference. (6) If adverse impact is detected: a. Collect more information from females; b. Conduct training studies. (7) Apply the Accommodation principle as often as possible (8) Consider other reasons for adverse impact such as anthropometry (small males). Conclusions: By following these recommendations employers can decrease the likelihood of disadvantaging select groups. This method serves as a best practice and was developed with consultation from Employment Equity, Legal Labour Law and Human Rights and Diversity. By following this process employers can capture valid physical capabilities on occupational demands and decrease the likelihood of disadvantaging select groups.

The Relationship Between Performance on Physical Employment Standards and Anthropometric Characteristics of the Canadian Armed Forces

Presenter: Tara Reilly (Canada)

Tara Reilly, PhD* Audrey Prayal-Brown, BSc Barry Stockbrugger, MSc *tara.reilly@forces.gc.ca Canadian Forces Morale and Welfare Services. Directorate of Fitness. Human Performance Research and Development. Background: The Canadian Armed Forces (CAF) recently implemented the FORCE Evaluation (Fitness for Operational Requirements of CAF Employment), designed and proven to predict the physical capabilities of completing common military tasks at a minimum occupational performance standard. Data collection during development of the test included detailed anthropometric profiles. Bilzon et al. (2002) and Lyons et al. (2005) reported evidence of relationships between Lean Body Mass (LBM) and Dead Mass (DM = fat mass + casualty mass) with casualty evacuation and load-carriage. Identifying potential limitations on these occupational tasks for groups with specific anthropometric characteristics will support accommodation and training programs. Purpose: To determine if anthropometric measurements and demographic information could predict the performance outcomes of the FORCE and/or Common Military Task Fitness Evaluation (CMTFE). It was hypothesized that LBM will be correlated with performance on tasks requiring lifting actions such as the vehicle extrication, stretcher carry, sand bag fortification (CMTFE tasks) as well as the amount of sand bags one can drag (FORCE). Methods: This was a secondary analysis of data from FORCE Evaluation development research (Phase III) (N=668); 201 female (36+/-9.2 yrs) and 467 were males (32.2+/-10.2) varying in military occupation and rank. Anthropometric measurements included a range of human dimensions acquired by manual means and through use of Bioelectrical Impedance and Segmental Analysis. Statistical analysis included correlation and linear regression analyses. A DM variable was computed for VE, SC and SBD. Results: A Pearson Correlation Coefficient equalling 0.670 or higher are reported (Taylor, 1990). As predicted, any task requiring lifting, pulling, or moving of an object was significantly correlated (R >0.67) to LBM measurements, with the greatest PCC equalling 0.78 with stretcher carry. LBM correlated with lifting actions such as sand bag drag (R=0.77), vehicle extrication (R=0.71), sand bag fortification (R=0.68), and sand bag lift (-0.67). DM demonstrated a higher correlation with task performance compared to LBM, although the difference was insignificant. When, extricating a casualty from a vehicle (86 kg: mean mass of a CAF member), no failures occurred above a LBM of 59.3 kg or greater. There were 384 males and 116 females who passed the 86kg standard. Below 59.3 kg of LBM, 54 individuals failed and 177 passed. The highest R value for the linear regression with anthropometrics alone was of 0.694, predicting stretcher carry using gender, fat mass, height, weight, age and lean leg mass. Conclusions: DM and LBM were explored throughout the analysis of this data especially when comparing any tasks that involved the movement of external loads such as casualty evacuation. Results indicate there is no conclusive minimum LBM required to perform these tasks successfully, although LBM is highly correlated with performance.

Concept for a Pre-Deployment Assessment of Basic-Military-Fitness in the German Armed Forces

Presenter: Ulrich Rohde (Germany)

Ulrich Rohde(1), Alexander Sievert(2), Dieter Leyk(1,2) Institution: (1) Central Institute of the Bundeswehr Medical Service Koblenz - Department Military Ergonomics and Exercise Physiology (2) German Sport University Cologne - Department of Physiology and Anatomy Despite technical progress, physical fitness is still a key factor for operational readiness of soldiers. Periodic monitoring of proficiency level is a prerequisite for maintenance and improvement of military fitness. In the German Armed Forces the directive "Individual Basic Skills and Physical Ability" defines military fitness as a four-level construct: (1) "Fundamental/Baseline-Fitness", (2) "Basic-Military-Fitness", (3) "Task-Fitness", and (4) "Mission-Fitness". The directive establishes the implementation of standard guidelines for regular physical performance assessments of the first two levels. Since 2010 "Fundamental/Baseline-Fitness" is assessed with the Basic-Fitness-Test once a year. It consists of three events that are carried in sports suit: (i) 11 x 10m-shuttle-run, (ii) flexed-arm-hang in the chin-up position and (iii) 1000m-run. In contrast to the annual assessment of "Fundamental/Baseline-Fitness", the monitoring of "Basic-Military-Fitness" is intended as part of deployment training. Purpose: In order to assess "Basic-Military-Fitness" the "Basic-Military-Fitness-Tool" (BMF) was developed. Methods: Identification of relevant tasks and corresponding requirements based on (1) tasks analysis during realistic deployment training of different branches (logistic services, mechanized infantry) at the Combat Maneuver Training Center, (2) interviews of subject matter experts, and (3) lessons learned. Results: Mission essential requirements were identified, that are mandatory for coping with the physical demands of deployments. The "BMF" combines four crucial military demands into one single, timed test run: (a) 125m obstacle course with changes in direction, velocity and body position (maneuver under fire), (b) 40m of dragging a 50kg load (casualty recovery), (c) 100m carrying of two 18kg jerry cans (load carrying), (d) five times repeated lifting of a boxed 24kg load to a height of 1.25m (load handling respective average sill height of military vehicles). Testing is carried out wearing field uniform (5kg), body armor (13.4kg), and helmet (1.6kg). Preliminary analyses showed that the "BMF" meets the required criteria. It is (1) easy and everywhere applicable, (2) requires few personnel and little material, and (3) yields objective and reproducible results. Conclusions: The Basic-Fitness-Test is suited to evaluate "Fundamental/Baseline-Fitness". However, it is not qualified to assess the demands of present day deployments. For this purpose the "BMF" was developed to reproduce the physical requirements of military operations on the level - "Basic-Military-Fitness" - encompassing all military services and ranks. First results indicate, that the "BMF" is a suitable method to capture relevant physiological components of mission essential tasks on a joint forces level. After completion of the evaluation, it can be applied during deployment training to identify and control individual physical performance deficiencies. Literature 1. Rohde et al.: Leistungsanforderungen bei typischen soldatischen Einsatzbelastungen. Wehrmed Mschr 2007; 51(5-6). 2. Leyk et al.: Physical Fitness and Military Fitness: Development of a Pre-Deployment Testing Concept. In: Federal Ministry of Defence (Ed.) 2011 Annual Military Scientific Research Report. Bonn 2012.

Self-Reported Physical Work Demands in the Norwegian Armed Forces

Presenter: Annett Victoria Stornæs (Norway)

Annett V. Stornæs (MSc/Kapt.), Anders Aandstad (MSc), Jon Kirknes (Major) Title Self-reported physical work demands in the Norwegian Armed Forces Background The physical requirements and tests in the Norwegian Armed Forces (NoAF) have seen little change over the last thirty years. At the same time, the occupational tasks undertaken by the NoAF have undergone major changes. The structural changes have placed new demands on the soldiering role. The survey on physical requirements and self-reported physical work demands in the NoAF is a part of the project "Revision of the Physical Test Battery in NoAF". Aim/purpose The purpose of the survey was to provide a complementary and descriptive presentation of military personnel's perceptions, opinions and attitudes about physical tests, physical requirements and physical work demands in their everyday work. Sample The initial sample consisted of 2134 military employees (no civilian), representing all different NoAF units. The response rate was 47.4 %. There were 92.8 % male and 9.8 % female respondents, which is about the same as in the population. 1/3 had operative service, 40 % were in administrative service and nearly 15 % were technical personnel. About 50% have served in an international operation. Results Half of the respondents exercised 1-2 times a week during work hours. Totally 30 % exercised 3-4 times a week in their spare time. About 70 % reported that their service was rarely endurance or strength demanding (lifting/carrying heavy loads). Still, about 50-60% of the respondents believe endurance and muscular strength is important in their service. Respondents were asked how often they conduct various physically demanding activities as part of their service. The most common activity was "lifting objects that are experienced as heavy"; 19 % were conducting this activity weekly and 29 % monthly. The statistical tests show that there were sig. differences between the different branches. More respondents from the Army state that they conduct almost all of the activities weekly or monthly compared to the other military branches. About 90 % conducted the mandatory annual physical test for officers in the period from 2009 to 2012. The majority of respondents (65 % in 2012) conducted the 3000m run. Over 80 % in the Army conducted the 3000m run (2012). The majority (72 %) is satisfied with the physical tests they can choose from and over 70 % are satisfied with the test requirements. However, over 40 % respond that strength tests should be included. The majority (90 %) agrees that all military personnel should have mandatory physical tests annually. Nearly 60 % also mean that civilian personnel should have mandatory physical tests. Men were more positive towards gender neutral minimum requirements on the physical tests, compared to woman. While many were positive towards similar minimum requirements between men and woman, the majority meant that that older personnel should have lower fitness requirements than younger personnel.

Influence of Physical Activity Weight, Smoking and Prior Injury on Performance

Presenter: Deydre Teyhen (USA)

Deydre S. Teyhen (1,2), Daniel Rhon (2), Robert. Butler (3), Scott Shaffer (2), Stephen L. Goffar (2), Danny McMillian (4), Robert Boyles (4), Kyle B. Kiesel (5), Phillip J. Plisky (5) 1. Office of the Surgeon General, U.S. Army, USA, 703-681-9078, Deydre.s.teyhen.mil@mail.mil 2. U.S. Army-Baylor University Doctoral Program in Physical Therapy, Ft Sam Houston, TX, 210-221-8410, Daniel.I.Rhon.mil@mail.mil, Scott.W.Shaffer.mil@mail.mil,Stephen.Goffar@gmail.com 3. Doctor Division of Physical Therapy, Duke University, Durham, NC, 919-681-7225 robert.butler@duke.edu 4. University of Puget Sound, Tacoma, WA, 253-879-3180, dmcmillian@pugetsound.edu, bboyles@pugetsound.edu 5. University of Evansville Department of Physical Therapy, Evansville, IN, 812-488-2341, kk70@evansville.edu, pp2@evansville.edu Purpose: Inactivity, overweight, smoking, and prior history of injury have been identified as health and injury risk factors. However, few studies have assessed the impact of these risk factors on physical performance. The purpose of this study was to determine if the number of health and injury risk factors negatively impacted physical performance. Methods: Participants (n=1466, 86 female) were healthy active duty service members (mean age 24.7 ± 5.0 years; 26.7 ± 3.4 kg/m2) at Joint Base Lewis McChord, WA. Participants were categorized based on the number of risk factors they possessed. Physical performance measures included the Army Physical Fitness Test (APFT; 2-mile run time, number of push-ups and sit-ups completed in 2 minutes), triple cross-over hop test for distance, Functional Movement Screen (FMS), and Lower and Upper Quarter Y-Balance tests (YBT-LQ, YBT-UQ). The relationship between the number of risk factors and physical performance was calculated utilizing ANCOVA with age and gender as covariates ($p < 0.05$). Results: Those with no risk factors (27.9% males, 34.9% females) exhibited the best performance on all measures. Physical performance decreased by 3.0%, 6.2% and 9.6% based on having 1, 2, or 3-4 risk factors present. Specific performance for those with 3 or 4 risk factors included decrements of: 8.6% 2-mile run, 12.0% sit-ups, 10.6% push-ups, 8.7% triple cross-over hop, 14.4% FMS, 3.2% YBT-LQ, and 5.2% YBT-UQ. On the APFT, only 6.5% of those with 0 or 1 risk factor scored below 220 points while 15.2% of those with 2 to 4 risk factors scored below this threshold. Participants with 0 to 1 risk factor accounted for 51% of those scoring above 270 points as compared to those with 2 to 4 risk factors accounting for 29%. Conclusion: Although prior research has demonstrated the association between these risk factors with future illness and injury, this is the first study to describe their relationship with physical performance. The presence of a single risk factor was associated with decrements in physical performance and as risk factors increased, performance decreased. Understanding how risk factors contribute to decreased physical performance may improve compliance of prevention programs in occupational settings. Particularly in settings involving a young and relatively healthy work force who are likely more concerned about immediate performance measures over lifelong health and wellness. Understanding the influence of these risk factors on performance may encourage military leaders to apply resources toward their mitigation.

POSTER SESSION IV – TRAINING/WOMEN IN MILITARY

Correlation Between Lower Extremity Power and Dynamic Balance with Jump Landing Ground Forces in Basic Airborne Course Trainees

Presenter: Kaizhen Chen (Singapore)

Kaizhen CHEN1, Tong LEE1, Chee Hoong CHEONG1, Qing Xiang YEE1, Carolyn Jiaming FU1, MAJ(Dr) Alexander Gorny2, MAJ(Dr) Junren ZHANG2 DSO National Laboratories, Singapore1 HQ Army Medical Services, Singapore Armed Forces 2 PURPOSE Basic Airborne Course (BAC) trainees undergo about 2 weeks of ground training, part of which consists of how to properly execute a parachute land fall (PLF). The PLF is honed via different ground training stations to simulate different conditions during live descent. Given the relatively high frequency of training jumps and the high impact forces associated with each jump, there is much interest in exploring if lower extremity muscle power and dynamic balance contribute toward effective attenuation of ground reaction forces (GRF) during landing. METHODS Lower extremity power was measured by a vertical jump test administered to 125 trainees (Age 19.0 + 1.1years; Height 174.0 + 5.8cm; Mass 69.3 + 7.4kg) from a selected BAC batch using a Yardstick Vertical Jump Tester (Swift Performance Equipment, New South Wales, Australia). Trainees performed 3 countermovement jumps, starting from a squat position immediately followed by rapid extension of the legs as powerfully as possible. The highest jump height, together with the trainee's body mass, was used to compute lower limb power required to perform the jump. Dynamic balance was assessed using the Lower Quarter Y-balance test (Functional Movement Systems, VA, USA) for 125 trainees (Age 20.4 + 0.8years; Height 172.9 + 4.9cm; Mass 68.7 + 6.3kg) in the subsequent BAC. While maintaining single leg stance, each trainee pushed a reach indicator using his free foot in the anterior, posteromedial, and posterolateral directions relative to the stance foot. 3 trials per direction were performed. The maximal reach distance was measured at the point reached by the most distal part of the free foot. Composite reach distance was computed by averaging reach in all three directions for each leg, and normalized by lower limb length. Landing GRF were recorded at the Mass Landing Trainer (MLT) for trainees from both batches during course evaluation day. Trainees performed their PLF after running up and dropping off a 4-ft tall ramp. Landing impact forces were measured using embedded force platforms (FP9090-15-4000, Bertec Corporation, OH, USA). RESULTS No significant correlation was found between either maximum vertical jump power or jump height and maximum GRF when executing a PLF from the MLT. Similarly, no significant correlation was found between bilateral Y-balance composite reach distances and maximum GRF when landing from the MLT. CONCLUSIONS The lack of significant correlations between either lower extremity power or dynamic balance with GRF implies that technique, as opposed to inherent strength and balance attributes, may have played a more important role in attenuating ground forces during landing, or that the functional tests used were not suitable representations of force attenuation mechanisms. Future work will include profiling kinematics of the PLF using motion capture systems to elucidate how different landing techniques affect impact forces.

Effects of Sixteen-Week Basic Military Training of Officer Candidates (EFK1) in the Austrian Armed Forces on Their Physical and Military Performance

Presenter: Robert Enne (Austria)

Th. Kollnberger1, R. Enne2, P. Stuparits3 Austrian Armed Forces Sports Center1 and Institute of Performance Medicine2 University of Vienna, Centre for Sport Science and University Sports, Department of Training Science3 Purpose The main purpose of this study is the evaluation of standardized training modules on general basic motor skills, body constitution and basic military skills among Austrian Armed Forces officer candidates. The energy balance was also determined in order to better assess the physical total load and the injury rates during the training. Methods 90 officer candidates (age=18.9 ±1yr; height=178.7 ±6.2cm; mass=73.4 ±8.1kg) were divided into an intervention group (IG; n= 43) and a normal group (NG; n=47). Anthropometric parameters (BMI, body fat, WHR), maximum oxygen uptake (VO2max), maximal strength, muscular endurance and balance skills were evaluated before training (pre-test), after the training phase 1 (post-test 1) and after the training phase 2 (post-test 2). Furthermore, the total energy expenditure (TEE) and distance covered on food were measured with body-fixed sensors while the energy intake (EI) was assessed by analyzing 7-day weighing records using nutritional calculation software. Data were analyzed using an analysis of variance with repeated measures and one way ANOVA ($p \leq 0.05$). The IG performed a specific supervised training program including progressive resistance training, high intensity endurance training and balance training two to three times a week. NG sports related training mainly consists of resistance, endurance and stretching training, combined in the same training session. Results Significant changes in the anthropometric parameters in IG and NG (fat -15.2%; -9.2%). IG showed statistical significant improvements concerning the VO2max (4.4%), maximum strength (7.2%), core stability (14%), balance (25%) and concerning the basic military skills (15.6%). On the contrary, statistical significant decreases of the VO2max (7.7%) and muscular endurance (16.7%) as well as no improvements in basic military skills were observed in the NG. The analysis of TEE showed values of 19.1 MJ/d in IG and 18.4 MJ/d in NG leading to a negative energy balance in both groups. The average distance covered was 12.3 km/d in IG and 11.3 km/d in NG. During the first 12 weeks of the EFK1 31.1% (n=90) visited the medical care centre at least once, returned with medical restrictions. The injury incident rate was 14.4 per 100 recruits per month. Conclusion Despite the high total physical load the specific supervised training regime seem to be effective in improving the general physical performance as well as the basic military skills. Due to the stagnation of the most sports-related physical abilities, military-related physical skills, and a significant decrease in endurance performance, the combined training of NG must be called into question. The high injury rate, especially in the first three weeks can be explained by the high non-alternating physical load during basic training. In principle, therefore, with the start of military training, a progressive increase in physical load for the entire training period is recommended.

Effect of Physical Fitness on the Risks of Training-Related Injury for Women and Men in Army Basic Training

Presenter: Stephen Rossi (USA)

Effect of Physical Fitness on the Risks of Training-related Injury for Women and Men in Army Basic Training Stephen Rossi, MPH; Keith Hauret, MSPH, MPT, and Dr. Bruce Jones, MD, MPH Army Institute of Public Health, Aberdeen Proving Ground, MD 03/28/2014 The 10-week Army basic training (BT) course includes a high volume of weight-bearing activity that increases risk for training-related injuries. These injuries limit the ability to train and increase risk for attrition. The relative risk for women compared to men during BT has ranged from 1.6 to 2.7 times higher for women. Purpose: This study evaluated the association of gender and training-related injury when controlling for physical fitness with a large database. Methods: Demographics, training-related injuries, and performance data on the first 2-mile run test (1st week of BT) were linked and analyzed for 156,114 men and 27,132 women. The 2-mile run time was used as an indicator of physical fitness. Quintiles of 2-mile run time (Q1 [fastest] –> Q5 [slowest]) were developed for women and men, combined. Relative risk (RR; w:m) and 95% confidence intervals (CI) were used to compare injury risk of women compared men. Results: Overall, 39.8% of women and 19.5% of men had a training-related injury. The crude RR (w:m) for injury was 2.05 (CI: 2.0-2.1). The overall adjusted Maental-Haenszel RR (w:m) injury when controlling for run time was 1.5 (CI: 1.4-1.5). For men, the percent injured increased in a step-wise manner from Q1 (14.2%) to Q5 (30.3%). For women, the graph of percent injured by quintile was a J-shaped curve as the percentage of injured women decreased from Q1 (33.5) to Q3 (28.7%), then increased in Q4 (33.0%) and Q5 (44.2%). The RR (w:m) of injury was highest for Q1 (RR: 2.36; CI: 2.1-2.7) and decreased for each successively slower quintile of run time (Q5 RR: 1.46; CI: 1.4-1.5). Conclusion: This large population study confirmed the findings from previous, but smaller, studies that showed that when men and women with similar run times are compared, the risk for a training-related injury becomes more similar (Crude RR: 2.05; CI: 2.0-2.1 compared to adjust RR: 1.5; CI: 1.4-1.5) for women compared to men.

Changes in Physical Demands for Deployed Female Soldiers

Presenter: Tanja Roy (USA)

Roy TR1,2, Piva S2, Christiansen BC3, Lesher J4, Doyle PM4, Waring R5, Sharp M1 1) United States Army Research Institute of Environmental Medicine, Natick, MA 2) University of Pittsburgh, Pittsburgh, PA 3) 1st Brigade Combat Team (BCT), 101st Airborne Division, Fort Campbell, TN 4) 173rd Airborne BCT, Bamburg, Germany 5) 2nd BCT, 10th Mountain Division, Fort Drum, NY Background Over two million service members (Army, Navy, Marines, and Air Force) have deployed in the last ten years for 6-15 months with 40% of service members deploying more than once.1 This increased operational tempo has resulted in an unknown change in physical demands on the soldier which in turn can affect the risk of injury. In fact, musculoskeletal injuries account for at least twice as many medical evacuations as combat injuries. They are also the leading cause of ambulatory medical visits, both in the U.S. and while deployed to combat zones. The purpose of this prospective cohort study was to investigate occupational and physical demands in deployed female soldiers. Methods Female participants were recruited from three BCTs deploying during 2012. They underwent performance testing and completed a demographic and occupational demand survey prior to deployment. Occupational demands included time spent wearing body armor, wearing a back pack, sitting, standing, walking, wearing average loads, and wearing the heaviest load. Additional information was gathered on the average miles walked, average load worn, heaviest load worn, days of heavy lifting, average weight lifted, and distance object carried. Upon completion of the deployment, soldiers again filled out the survey. Results There were 160 female Soldiers. The average Soldier was 25.8 years old and a specialist. The average Army Physical Fitness Test prior to deployment was 263 with Soldiers completing an average of 42 push-ups, 70 sit-ups, and a run time of 16 minutes and 23 seconds. They completed the Illinois agility test in 21.5 seconds and completed 143.7 steps on the Loaded Step Test. The average Y Balance difference between limbs was 3.1 cm and the average Y Balance composite score was 101.0cm. During deployment there was a significant increase in the following occupational tasks (before deployment – during deployment): 0.51 to 1.94 hours/day wearing body armor ($p<0.001$), 4.2 to 6.6 hours spent sitting ($p<0.001$), 1.9 to 2.9 hours/day wearing average load ($p=0.04$), 33.7 to 45.9 lbs for the heaviest load ($p<0.001$), 2.0 to 3.3 hours/day wearing the heaviest load ($p=0.002$), and 0.1 to 3.9 times lifting objects/day ($p=0.004$). There was a significant decrease in the following: weight 148.2 to 139.4 lbs ($p<0.001$) and BMI 24.9 to 23.6 m/kg2 ($p<0.001$). Conclusions Deploying female Soldiers wear body armor longer, sit longer, wear equipment longer, wear heavier loads for longer time, and lift objects more frequently. They also lose weight and therefore body mass index during deployment.

Developing Functionally-Adaptive and Integrated Training to Improve Fitness and Cognition for Battlefield Airmen

Presenter: Adam Strang (USA)

Adam J. Strang(1), Edward Downs(2), Edward Eveland(3), Mark Derriso(3), and Erica Johnson(3) Affiliations: (1)Ball Aerospace and Technologies Corporation, Fairborn, OH; (2)PROTERF, LLC, Miami, FL; (3)Air Force Research Laboratory, Wright-Patterson AFB, OH Abstract: Battlefield Airmen are elite combat warriors who represent special operations personnel (e.g., combat controllers, pararescumen) of the United States Air Force. These airmen must travel, often on foot and carrying up to 100 pounds of equipment, to mission sites while being confronted with taxing and unpredictable physical and cognitive demands. Because of these demands, high levels of physical fitness and cognitive ability are mandatory prerequisites for Battlefield Airmen, although the truly critical skill is the ability to rapidly and functionally adapt their physical and cognitive behaviors to meet dynamic mission demands. The goal of the current research is to develop and test a novel training program for Battlefield Airmen that aims to instill the skills of rapid and functional adaptation by purposefully exposing trainees to variable and uncertain physical and cognitive demands as a focal component of their training. This attempt follows the rationale of contemporary functional training programs, which seek to improve job performance by mimicking, and sometimes accentuating, realistic job demands through purposeful exercise. To develop such a program for Battlefield Airmen, researchers at the Air Force Research Laboratory (AFRL) teamed with professional fitness trainer Ed Downs to adapt a functional strength and agility-based physical training program (PROTERF®) that has been successfully used to improve the performance of professional sports athletes. In our adaptation, emphasis is placed on the integration of physical and cognitive exercise, with specific attention devoted to improving a subset of functional fitness (e.g., aerobic capacity/stamina, anaerobic strength, balance) and cognitive skills (e.g., spatial navigation, reaction time, rapid decision-making) that have been identified in previous research as critical for Battlefield Airmen. Initial testing and evaluation of this training program is being conducted using a controlled laboratory experiment that employs the latest in physical fitness (e.g., VO2, isokinetic strength) and cognitive (e.g., cognition test battery, neurophysiological monitoring) assessments. Here, we introduce the details of this novel training program, present some of our preliminary laboratory findings, and discuss plans for future refinement and implementation into existing Air Force training platforms.

Perceptions and Attitudes of Female Soldiers Toward Soldier's Physical Performance, Physical Fitness Tests and Physical Fitness Requirements

Presenter: Jani Vaara (Finland)

Jani Vaara1, Jarmo Viskari2, Matti Santtila2 1 National Defence University, Finland 2 Personnel Division of Defence Command, Finland Military occupation set special demands for physical performance of the soldiers. Today, the physical fitness tests and requirements are similar to both genders in the Finnish Defence Forces (FDF). However, there is limited information concerning attitudes of the female soldiers` toward soldier`s physical performance, fitness tests and requirements. Purpose: to investigate how physical fitness level, body composition, military rank and age are associated with the attitudes of the female soldiers in FDF. A survey was conducted for female soldiers. 362 voluntary female soldiers participated in the study (68 % conscripts, 2 % cadets, 30 % officers and NCO's). Response rate was 48 % among conscripts, 100 % among cadets and 39 % among officers and NCO`s. Results: 96% responded that soldiers must have a good physical condition. 76 % answered that the general physical fitness requirements in the FDF are not too demanding. 57 % replied that there should be different physical fitness standards for male and female soldiers. 48 % reported that it is inequal to have same standards of the physical fitness for both genders. 55 % believed that female soldiers could perform their military service or operational tasks if fitness requirements would be lower for females. 42 % felt that if fitness requirements would be lower for females this would cause lack of appreciation or mistreatment by their male colleagues. 12 % of the females had experienced bullying, 23 % occasional and 1 % continuous discrimination about their physical fitness. Female with lower fitness, over 35 years old and overweight felt more often that the requirements of fitness were too hard to achieve than their counterparts ($p<0.05$). NCO's experienced more often that physical fitness requirements were too hard to achieve than other ranks ($p<0.05$). Cadets, 26-35 years old and soldiers who run over 2600 m in 12 min running test felt more often that the fitness requirements should be similar to both genders than their counterparts ($p<0.05$). They also reported more often that lower fitness standards for the female soldiers would lead to lack of respect and appreciation from their male colleagues ($p<0.05$). Overweight and soldiers who run under 2200 m in 12 min running test had more often experienced bullying about their physical fitness ($p<0.05$). Overweight women had more often experienced discrimination against their physical fitness ($p<0.05$). Conclusions: Most female soldiers consider current physical fitness tests and requirements in the FDF appropriate. However, a polarized distribution of attitudes towards fitness tests among female soldiers was observed. Higher physical fitness level, normal body weight and younger age were associated with more positive attitudes toward physical fitness tests and requirements. There may be a need for the better communication about the background of the fitness requirements in FDF and for new initiatives to get more capable females to military occupation.

THEMATIC FREE COMMUNICATIONS/POSTERS – PHYSICAL PERFORMANCE STANDARDS

A Systematic Review and Meta-Analyses of Correlations Between Performance of Military-Relevant Tasks and Physical Fitness Tests

Presenter: Veronique Hauschild (USA)

Veronique Hauschild, MAJ David DeGroot, Shane Hall, Karen Deaver, Keith Hauret, Tyson Grier, Bruce Jones U.S Army Public Health Command (USAPHC) Purpose: To help evaluate the Army Physical Fitness Test (APFT) and ensure a future test is associated with Soldiers' performance of common physical job requirements, the USAPHC applied a Systematic Review (SR) methodology to identify and synthesize published correlations between military task performance and physical fitness tests. Methods: A preliminary step to our SR was to identify key military-relevant tasks and physical fitness components of interest. Starting with the Army's Warrior Tasks and Battle Drills (WTBDs), twelve task categories were identified, including some tasks performed by both military and civilian occupations (e.g., firefighters, police, and athletes). Physical fitness tests were sorted into four physical fitness groups: cardiorespiratory endurance (e.g., aerobic fitness), muscle strength, muscle endurance, and flexibility. Tests of muscular strength and muscular endurance were further subcategorized into Upper and Lower Body, Core, or Whole Body regions. Physical tests included the APFT events (2-mile run, sit ups, push-ups) as well as other equipment and non-equipment physical fitness tests (e.g., jump tests, squats, sprints, pull-ups, grip tests, arm lifts, curls, and various extension machine tests). To synthesize the data, a series of meta-analyses provided pooled correlation coefficients for the twelve tasks and eleven physical fitness test groups. Results: Flexibility tests were the least frequently identified, while upper body strength tests were most frequently identified in studies that met our inclusion criteria. Correlations with aerobic tests were fairly well studied, with a few notable gaps (e.g., the Loaded March task). Pooled r coefficients for specific physical tests (e.g., run tests, push-ups, sit-ups, grip tests, and vertical and broad jump tests) were also calculated. Of the physical fitness component groups evaluated, aerobic capacity is most strongly correlated across the greatest number of military tasks (highest $r = 0.80$, average r for all tasks = 0.53, average r for the top 5 tasks = 0.68, r value range = 0.30 – 0.80). Of next importance, muscular strength and endurance both have strong correlations with lifting, lowering, stretcher carry and crawl (average for top 5 tasks = $r > 0.50$). Lower body strength and endurance tests (average top 5 task $r = 0.63$ and $r = 0.58$) are of similar strength to correlations for top correlations with upper body endurance (average top 5 task $r = 0.57$). Core endurance, and sit-ups specifically, are weakly correlated with most tasks (average r for all tasks = 0.33; for top 5 tasks $r = 0.38$). Conclusions: A test of aerobic capacity is fundamental for assessing Soldiers' basic physical capacity to conduct critical tasks, while sit-ups do not appear to be an important test. Muscle strength and endurance are also critical physical components. Since the current APFT does not include a measure of muscle strength or power, consideration should be given to fill this gap in future testing requirements.

Predicting Relative and Absolute Maximal Oxygen Uptake from the 3000 Meter Run

Presenter: Anders Aandstad (Norway)

Anders Aandstad The Norwegian Defence University College, department of Norwegian School of Sport Sciences Aerobic capacity (maximal oxygen uptake; VO2max) is a key component of the term physical fitness within military personnel, since all prolonged activity with relatively high intensity depends primarily on the aerobic energy system. Since direct measurement of VO2max is usually not feasible to conduct during mass-testing of soldiers, distance runs are typically carried out as an indirect measure of aerobic fitness. In Norway, the 3000 m run is the primary endurance test for all military personnel. This test correlates rather well with relative VO2max (mL/kg/min), but few equations are available to predict relative VO2max from the 3000 m run. However, during military activities where moderate-heavy external loads are carried, the absolute VO2max (L/min) is usually a more relevant measure. Absolute VO2max could be estimated from a backpack run, but such tests are somewhat more strenuous, complex and might increase the risk of injuries compared to unloaded distance runs. Thus, a simple way of predicting absolute VO2max from unloaded distance run seems appealing. Purpose: To generate prediction equations for absolute and relative VO2max from the 3000 m run, and to investigate the validity of these equations in predicting directly measured VO2max. Methods: Data were compiled from several research projects where both 3000 m run and direct VO2max were measured. A total of 539 subjects (including 66 women) age 23 ± 4 years were included in the database. 14 subjects were civilian sport students; the rest were military personnel (cadets, recruits, reservists and professional soldiers). The 3000 meter run took place on flat courses, with subjects running in sports clothing without external loads. VO2max was measured directly with an automatic online system during incremental maximal treadmill running. The mean number of days between the two tests were 14 ± 8 days (range; 0-34 days). A stepwise linear regression was used to generate the prediction equations. Statistics are presented as Pearson correlation (r), coefficient of determination (R2) and standard error of the estimate (SEE). Results: Mean (± SD) directly measured VO2max were 4170 ± 714 mL/min or 54.2 ± 6.2 mL/min/kg. Mean running time during the 3000 m run were 757 ± 102 seconds (or 12:37 ± 01:42 minutes). The regression analysis showed that 3000 m run time in seconds (3000m), bodyweight in kg (BW), gender (men=0, women=1) and age in years (age) contributed significantly in predicting absolute and relative VO2max: VO2max (mL/min) = 3374 + 47.1(BW) – 3.26(3000m) – 341(gender) – 13.9(age), with r = 0.93, R2= 0.87 and SEE = 263 mL/min; VO2max (mL/kg/min) = 95.1 – 0.040(3000m) – 5.9(gender) – 0.080(BW) – 0.165(age), with r = 0.85, R2 = 0.72 and SEE = 3.3 mL/kg/min. Conclusions: Both absolute and relative VO2max can be predicted from the presented equations based on 3000 m run time, body weight, age and gender.

US Air Force Development of Tier 2 Occupationally-Specific, Operationally-Relevant Physical Tests and Standards: Physical Demand Analysis Part 1

Presenter: Neal Baumgartner (USA)

Neal Baumgartner, Arthur T. Coppage, Virginia G. Fausch, Erin L. Fager, Matthew F. Gruse, Jessica A. Neff, Alaina D. Dooley, Kimberly N. Hale INSTITUTIONS: USAF Fitness Testing and Standards Unit, and AETC Studies and Analysis Squadron, Randolph Air Force Base, TX. BACKGROUND: As early as 1998 US Air Force (AF) exercise physiologists recommended a “Two-Tier” health and performance approach to development of science-based criterion AF physical fitness (PF) standards. The AF officially implemented Tier 1 health and general fitness tests and standards in July 2010 with aerobic and body composition component standards established on professionally recognized health science criteria. Scores reflect degrees of health and general fitness, but do not necessarily reflect military task achievement for military occupations, i.e., AF specialty codes (AFSCs). We are currently developing Tier 2 occupationally-specific, operationally-relevant PF tests and standards for AF Battlefield Airmen (BA). PURPOSE: Conduct physical demand analysis, the first major step in this multi-step study; specifically, define and delineate BA duty tasks that are both physically demanding and critical to mission success, i.e., Critical Physical Tasks (CPTs), for use in next phase physical task simulations. METHODS: Duty task listings were compiled from Occupational Analysis Reports and Career Field Education and Training Plans for Combat Control (CCT), Pararescue (PJ), Special Operations Weather (SOW), Tactical Air Control Party (TACP), Special Tactics Officer (STO), Combat Rescue Officer (CRO), and Special Operations Weather Officer (SOWO). BA subject matter experts (SMEs) assisted in elimination of non-physical tasks. Physically demanding tasks were further delineated by three BA SME focus groups (FG) per AFSC, each FG consisted of three to eight operationally experienced senior NCOs and officers. Per operational missions conducted over the past ten years, FG members objectively scored each physical task for frequency, duration, intensity (physical), and importance (critical to mission success). Finally, FGs achieved consensus on task scores, via a priori criteria. RESULTS: Duty tasks were initially reduced to physical tasks (CCT/STO 556 to 71, PJ/CRO 981 to 161, SOW/SOWO 586 to 91, and TACP 415 to 79). FGs further reduced tasks, per a priori criteria, composite score ≥ 3.5 points on a 5.0 point Likert scale (composite = 0.10 repetition + 0.25 duration + 0.25 intensity + 0.40 importance), to draft CPTs (CCT/STO 71 to 40, PJ/CRO 161 to 50, SOW/SOWO 91 to 50, and TACP 79 to 44). Composite scores for draft CPTs were consistent across AFSCs (mean ± SD) CCT/STO 3.8 ± 0.3, PJ/CRO 3.7 ± 0.3, SOW/SOWO 3.8 ± 0.2, TACP 3.7 ± 0.3. Draft CPTs were ranked by composite scores and grouped by operational task in preparation for broader scoring across entire BA career fields. CONCLUSIONS: Multi-phased SME FGs with objective scoring proved efficacious for performing a salient portion of a physical demand analysis on military occupations, specifically AF BA. Further assessment of SME FG-produced draft CPTs will confirm final CPTs essential for conducting follow-on physical task simulations.

A Strategy for Developing Performance Standards in a Recruit Screening Test

Presenter: John Sampson (Australia)

John A. Sampson, Hugh H.K. Fullagar, Herbert Groeller and Nigel A.S. Taylor Centre for Human and Applied Physiology, School of Medicine, University of Wollongong, Australia Predictive screening tools for firefighters were developed during a three-stage process. Firstly, content-valid tasks were identified, secondly the physical and physiological demands of those tasks were determined, and thirdly, criterion tasks were identified for use in a screening test. In the fourth stage of the process presented herein, the screening test was developed, trialled and assessed. The criterion tasks were first performed in isolation by 14 civilians. This involved task replications of four criterion tasks (hazmat, bushfire, ventilation fan carry and operating hydraulic tools). To determine the performance speed (walking, or stepping cadence) required to best replicate the oxygen cost of some tasks, trials were performed at maximal speed, and at 30% and 60% of that speed. The metabolic demand of each trial was recorded. The four tasks which best represented the associated metabolic demand were incorporated into a test circuit with preliminary performance times trialled on 148 operational firefighters. In addition, the maximal performance speed for two critical tasks (fire-attack and fire-fighter rescue) performed following these four tasks in the proposed screening circuit was assessed within this group. The metabolic demand observed during isolated trials was distributed around the strain observed when these tasks were performed in the field by operational firefighters. Therefore, interpolation permitted determination of equivalent task intensities for three of the four tasks. These were: a 6-min, 330-m hose drag, a 3-min, 195-m unilateral load carriage task (26 kg), and a 3-min, 36-step load carriage activity (17.5 kg). Construct validity was thus established by matching the oxygen demand of the simulated firefighting tasks to these replicated activities. The metabolic demand observed during the strength-based task (operating hydraulic tools) did not match any task replication. However, a replication of hydraulic tool use was achieved by incorporating an isometric assessment performed for a fixed time (3 min). A test performance standard (≤15 min) was trialled for the performance of these tasks in a screening circuit. Of the 148 firefighters who performed the screening test, 91% were able to complete these four tasks in 15 min or less. The maximal fire-attack and fire-fighter rescue were completed in 1 min 45 s (range: 0 min 51 s – 3 min 17 s). Accordingly, the recommended performance standard (time) for this screening test was set at 17 min.

Performance on a Physical Employment Standard Assessment is Significantly Improved with Familiarisation

Presenter: Catriona Burdon (Australia)

Catriona Burdon, Kyoko Hiraiwa, Joonhee Park, John Sampson Centre of Human and Applied Physiology, School of Medicine, Faculty of Science, Medicine and Health, University of Wollongong, Australia The hypothesis that familiarisation with a loaded, self-paced recruitment test might decrease false negatives was assessed with untrained civilians who completed a firefighter recruit test. Twenty two (15 males, 7 females) healthy civilians (21.5 SD: 4.8 y, 71.8 SD: 10.8 kg, 175.1 SD: 8.3 cm) completed a firefighter recruit assessment circuit on three occasions, separated by a minimum of 24 hours. The test comprised of six loaded tasks; (i) a 26 kg single-handed load carry (195 m); (ii) 36 vertical steps with a 17.5 kg single-handed load carry; (iii) three × 40-s static holds (19.5 kg) with 20-s rest between holds; iv) a 27-kg hose drag (300 m); (v) a 27-kg hose drag with a 1.5-m height restriction (30 m); and (vi) a simulated 100-kg firefighter rescue with a 1.25-m height restriction (10 m). The protocol required participants to rest (seated) prior to completing tasks five and six if tasks one-four were completed <15 min. Participants were instructed to complete the course as fast as possible without running on each occasion while wearing firefighter personal protective equipment (21.5 kg). Participants were instructed on the correct technique and allowed to practise each task. Participants were excluded if they did not complete the entire test on the first visit. Task duration (s) and heart rate (b.min-1) were recorded for each task. Data were assessed using a one-way repeated measures ANOVA (mean ± 95% confidence intervals). Performance time improved with each visit (visit 1: 808 ± 78 s, visit 2: 698 ± 43 s, visit 3: 684 ± 48), but only the difference between visit one and two was significant (12.0 %, P <0.05). Improvements between visit one and two were observed with (i) 26 kg load carry (140 ± 15 s vs. 122 ± 13 s, 12.1 %, P <0.05); (ii) 36 vertical steps (78 ± 7 s vs. 69 ± 5 s, 10.4 %, P <0.05); and (iv) 27 kg hose drag (279 ± 31 s vs. 242 ± 18 s, 10.4 %, P <0.05). Performance on the two height-restricted tasks did not improve between visits (P>0.05). No significant difference in average or peak heart rate were observed during the circuit, however peak heart rate occurred earlier in 17 participants on the second trial (585 ± 106 vs. 416 ± 101 s; P <0.05). For this test battery, 91% of participants improved overall performance on the second trial. Therefore, it is recommended that two, but not three, tests should be used for recruit selection. The benefit here is that legally defensible physical employment assessments can be implemented with fewer candidates being turned away.

Developing Physical Employment Standards for Combat Controllers: A Trade with Two Specialties

Presenter: Joanne Caldwell Odgers (Australia)

Joanne N. Caldwell*, Tim L.A. Doyle- and Benjamin Beck- *Centre for Human and Applied Physiology, University of Wollongong, Australia -Land Division, Defence Science and Technology Organisation, Melbourne, Australia Corresponding author: jo_caldwell@uow.edu.au Purpose: Defining critical tasks for military occupations is essential for setting safe and non-discriminatory employment standards. However, this becomes difficult when individuals are not only required to perform work specific to their trade, but must work in support of other trades. Specifically, Combat Controllers, who integrate air power with land-based military activities, are unique as they not only perform trade-specific technical tasks; they are also required to work alongside Special Forces in tactical environments. Currently, it is unknown which of these roles (technical versus tactical) has the highest physical demand. Therefore, the aim of this study was to determine the physical requirements of the technical and tactical activities performed by Combat Controllers. Methods: Eight physically demanding tasks were ranked from highest to lowest on the basis of physiological demand. This was achieved using both descriptive parameters (mass, height of lift, task duration, distance covered) and physiological data (heart rate and oxygen consumption). Of these eight tasks, four were classified as technical activities. The four tactical tasks were characterised during a simulated full mission profile (infiltration over open terrain, fire and movement activity, and a casualty drag and stretcher carry), since this represented a realistic operational scenario. The technical tasks (soil quality analysis, setting up a landing zone, lift and carry equipment [distance 40 m] and individually load equipment onto a vehicle [height 0.8 m]) were completed in isolation. Data collection on all tasks involved six experienced Combat Controllers (30 y [SD 2.8]; 81.3 kg [SD 7.1]; 1.75 m [SD 0.04]). Results: The average duration of the tactical task simulation was 75.8 (±0.1) min. This task imposed significant metabolic demands requiring an average oxygen consumption of 2.2 (±0.2) L.min-1 and heart rate of 127 (±14.5) beats.min-1 across the duration of the simulation. However, the greatest oxygen cost (4.7 L.min-1 [±0.6]) and heart rates (178 beats. min-1 [±16.7]) were observed during the infiltration phase. In comparison, the soil quality analysis task (highest metabolic demand of the technical tasks) was performed for 75.5 min, but its average and peak oxygen costs were 1.3 L.min-1 (±0.1) and 3.4 L.min-1 (±0.3), respectively. Conclusion: For Combat Controllers, the greatest physical demand was encountered during the performance of tactical tasks undertaken to support Special Forces personnel. Accordingly, the establishment of physical employment standards for Combat Controllers must emphasise those tactical tasks.

Epidemiological Insights from the "Activate Inactive Individuals" Survey: Differences Between Non-Athletes and Moderately Active Persons Aged 35-49 Years and 50-64 Years

Presenter: Dieter Leyk (Germany)

Dieter Leyk(1,2), Nadine Hartmann(1), Matthias Krapik (1), Philipp Preuss (2), Alexander Sievert(2), Alexander Witzki(1) (1)Central Institute of the Bundeswehr Medical Service Koblenz (2)German Sport University Cologne - Department of Physiology and Anatomy Negative effects of sedentary lifestyles affect all age groups in modern societies. Identifying motives and barriers for exercise in the heterogeneous groups of non-athletes and only moderately active persons is essential for effective countermeasures. "Activate Inactive Individuals" (ACTI-Iv) surveys the central question how individuals can be motivated to establish active and healthy lifestyles. Primary targets are women and men of all ages and walks of life with different physical activity levels. Purpose: Aim of the analyses is comparing non-athletes to moderately active persons from two middle-aged groups (35-49 vs. 50-64) in respect to weight/BMI, motives/barriers for exercise. Results of 1840 individuals are intended as bases for future research on improving the compliance to physical activity requirements in the Bundeswehr. Methods: ACTI-Iv is an online (http://ww2.unipark.de/uc/acti-iv/) or pen/paper survey (currently German only). Age groups reflect life stages when (1) persons are primarily focused on career and/or family-life versus (2) individuals are still active in their jobs/functions, but already experience physical fitness deterioration. Fitness groups (non-athletes (NA) / moderately active persons (MAP)) were based on exercise frequency. 874 non-athletes (35-49yrs = 407) never/seldom exercised, 966 moderately active persons (35-49yrs) = 467) exercised 1-3times/week. Results: NA and MAP significantly differ in reported body weight (women: NA=75.8±17.6kg, MAP=70.8±13.9kg; men: NA=92.3±15.9kg, MAP=88.7±12.4kg) and BMI (women: NA=27.3±6.3, MAP=25.3±4.5; men: NA=28.5±4.5, MAP=27.2±3.3). Main barriers for both groups are lack of time (NA: 31.5%, MAP: 38.3%) and health-reasons (NA: 22.0%, MAP: 23.0%). "No fun in sports" is cited by triple the number of non-athletes (NA: 10.4%, MAP: 3.3%). All other barriers account for 19.7%, resp. 10.0% of responses. Compared to the younger non-athletes significantly more 50-64-year-old-inactive subjects rate their daily activity "insufficient" (12.9%). Other barriers, i.e. "health-reasons", "sports are no fun", and missing social support are also increased. In contrast, "lack of time" is significantly less reported (38.1% vs 25.9%) by older non-athletes. Health and physical fitness are the most frequent motives to exercise for both activity groups. The most distinct differences between non-athletes and moderate active persons were enjoyment of sports (delta:-20%), physical fitness (delta:-15%), and stress reduction (delta:-14%). The motives "enjoyment of sports" and "stress reduction" were more frequently reported by the younger age group. Conclusions: The differences in barriers and motives to exercise clearly indicate the importance of using tailored approaches in helping people establish active and healthy lifestyles. Distinctions between non-athletes and minimally active persons are to be expected (e.g. "fun in sports"). However, middle-aged persons are frequently treated as a homogeneous group. Results show that very simplistic age-based differentiations already reveal relevant differences and underline the requirement for individualized approaches to support participation in health and fitness offers. Future analyses will be aimed at identifying specific target groups.

Adapting the International Classification of Functioning (ICF-10) to Categorize Physical Demands of Canadian Armed Forces Occupations

Presenter: Daniel Theoret (Canada)

Daniel Théoret MSc, Kara Lee Casselman BSc, Paige Mattie MHK, Sarah Saucier BSc, Sylvie Fortier MSc. Canadian Forces Morale and Welfare Services, Human Performance Research and Development. Corresponding author: daniel.theoret@forces.gc.ca BACKGROUND Occupational Fitness Standards (OFS) are a part of the medical standards for each Canadian Armed Forces (CAF) occupation. They consist of a list of essential tasks that a member must be able to perform in order to remain in that occupation. A recent review of all CAF occupations has been completed, with extensive data characterizing their respective physical demands. This information must now be included into a classification system that would effectively present this volume of detailed information to end users (health care professionals, career managers, etc). PURPOSE To identify a classification system for the occupation-specific information obtained through the OFS review process allowing the data to be integrated into an interactive tool. A classification system was sought that would satisfy four requirements; a) use language that is familiar to the end-user, b) capture the full spectrum of physical demands information c) allow comparisons at every level of physical requirements in the CAF d) allow a simple rating system by which a health care professionals could compare the member's level of function to the specific demands of their occupation. METHODS A review of existing literature was performed and resulted in the decision to adapt the (ICF-10) published by the World Health Organization (WHO). Chapter 4 of this publication focuses on Mobility and was used as a guiding framework in developing physical categories to represent the demands of military occupations. Minor revisions to the categories described for Mobility were made to accommodate the unique demands of military tasks and a scaling system was created to provide added sensitivity to the data. RESULTS The following six categories were adopted from the ICF-10 to characterize the physical demands of military occupations: 1) Changing/maintaining body positions, 2) Lifting and carrying objects, 3) Fine hand use 4) Hand arm use, 5) Moving around and 6) Walking. For each of these categories, a 5-point scaling system was established, ranging from "no impairment" to "complete impairment" to allow for an accurate descriptions of both task/occupational demands and military member level of function. CONCLUSIONS The ICF-10 appears to be an effective guiding framework for classifying occupation-specific physical demands into discrete categories. These categories, in combination with their respective rating scales will be integrated into an interactive tool to facilitate comparison of occupational demands to a members' level of function. The limitations to using this type of category system includes the loss of some level of detail on the specific demands data. This has, however, been accepted by our military health care professionals in exchange for the ability to objectively assess a military member's level of function against the demands of their occupations, and all levels of suitability standards in the CAF.

THEMATIC FREE COMMUNICATIONS/POSTERS – INJURY II

Self-Reported Physical Activity and Musculoskeletal Injury in Female Active Duty and National Guard/Reserve Soldiers: Preliminary Findings from the Comprehensive Soldier and Family Fitness Global Assessment Tool 2.0

Presenter: Sarah de la Motte (USA)

Sarah J. de la Motte, PhD, MPH, ATC1, Elizabeth M. S. Bramhall, BS1, Josh B. Kazman, MS1, Dianna L. Purvis, PhD1, and Patricia A. Deuster, PhD, MPH1 1Consortium for Health and Military Performance (CHAMP) Department of Military & Emergency Medicine Uniformed Services University of the Health Sciences Bethesda, MD 20814 Objective Recent studies show that women in military service have lower fitness levels and are more likely than men to suffer musculoskeletal injuries (MSI) during sports and military training. However, differences in Active Duty (AD) and National Guard or Reserve (NG/R) female Soldiers have not been investigated. The Comprehensive Soldier and Family Fitness Global Assessment Tool (GAT) is an online survey that assesses physical activity, lifestyle behaviors, and MSI in non-deployed military personnel. The objective of this study was to examine differences in self-reported physical activity, Army Physical Fitness Test (APFT) pass rates and recent MSI history in AD and NG/R female Soldiers. Methods Participants included 1,322 AD and 1,033 NG/R female Soldiers who completed the GAT 2.0 over a two-week period in July 2012. APFT data was available for 605 AD and 582 NG/R female Soldiers. Independent t-tests were conducted for continuous variables. Pearson chi-squared tests for independence were used to examine associations between service component, APFT pass rates, self-reported physical activity variables and recent MSI. Results Age and body mass index did not differ between AD and NG/R female Soldiers. Mean APFT scores were significantly higher in AD female Soldiers (t1185=-11.5, P<0.001; 249.2 v. 219.9). Pearson chi-squared tests revealed that compared to NG/R, AD females were 3.2 times more likely to pass their most recent APFT (χ^2=37.0, P<0.001; OR=3.2, 95%CI 2.1, 4.6), 5 times more likely to report performing standard Army Physical Readiness Training (PRT) ≥ 3x per week (χ^2=309.8, P<0.001; OR=4.9, 95%CI 4.1-5.8), 2 times more likely to report meeting physical activity guidelines (at least 30 minutes, ≥ 5x per week) (χ^2=54.9, P<0.001; OR=2.0, 95%CI 1.7, 2.4), and 30% more likely to report performing strength training activities ≥2x per week (χ^2=7.2, P=0.004; OR=1.3, 95%CI 1.1, 1.5). Compared to AD females, NG/R females reported sustaining MSIs 2.4 times more frequently (χ^2=107.1, P<0.001; OR=2.4, 95%CI 2, 2.7), although they were less likely to seek medical care for the MSI (χ^2=82.4, P<0.001; OR=0.3, 95%CI 0.2, 0.4). Conclusion APFT pass rates, self-reported physical activity patterns and MSI histories differ significantly between AD and NG/R female Soldiers. Overall, NG/R female Soldiers were less likely to pass their most recent APFT, and less likely to report meeting PRT and physical activity guidelines. However, NG/R female Soldiers were more likely to report having a recent MSI, as well as being less likely to report seeking medical care for their MSI. Future studies should examine the relationship between lifestyle risk factors for MSI and service component. Importantly, barriers to NG/R females' seeking medical treatment need to be determined.

Evaluations of Physical Training Programs in an Infantry Division

Presenter: David DeGroot (USA)

Tyson Grier, Michelle Canham-Chervak, Tim Bushman, Morgan Anderson, Bruce H Jones. United States Army Institute of Public Health, Aberdeen Proving Ground, MD Soldiers must maintain high levels of physical fitness to endure demanding tasks, harsh deployment environments and military occupational specialty (MOS) requirements. In an effort to meet or exceed these mission specific requirements, commanders are developing, modifying, or implementing exercise programs to optimize physical readiness and decrease injury incidence. Purpose: To evaluate and compare three physical training programs implemented within the same division and assess their effects on injury and fitness. Methods: Demographics, physical fitness, injury, and physical training activities were obtained from surveys administered to Soldiers before and 6-12 months after implementation of a new physical training program. Three physical training programs were implemented in three Brigades, the Iron Horse Performance Optimization Program (IHPO) (Army Physical Readiness Training (APRT)), the Tactical Athlete Program (TAP) (APRT with an added Olympic weight training component), and the Mountain Athlete Warrior Program (MAW) (an extreme conditioning program based on the fundamentals of Cross-fit and power/Olympic weight training). The IHPO and TAP also included a musculoskeletal action team (MAT) lead by a brigade physical therapist and athletic training staff. The IHPO MAT was located at the hospital, whereas the TAP MAT was unit based. Medical records captured injury related encounters before and after implementation of the training programs. For MAW, self-reported injury data was used due to incomplete electronic medical record data. Results: There were 1250 Soldiers from IHPO, 602 Soldiers from TAP, and 626 Soldiers from MAW who completed both the initial and follow-up surveys. Injury rates remained similar before and after the implementation of IHPO and MAW (56 vs 57 (p=0.72) and 39 vs 39 (p=0.99) Soldiers per 1000 Soldiers per month, respectively). For TAP injury rates marginally decreased after 6 months of implementation (65 vs 55 Soldiers per 1000 Soldiers per month, p=0.07). However during the 2nd six months of TAP, leadership was deployed and injuries returned to previous levels (65 vs 69 Soldiers per 1000 Soldiers per month, p=0.42). The average number of limited duty days (LDD) per 100 Soldiers per month increased after the implementation of the new exercise programs for IHPO by 24% (71 to 88 days) and TAP by 100% (66 to 132 days). For MAW the average number of LDD's per 100 Soldiers per month decreased by 43% (87 to 49 days). For all three programs there was an increase in cross-training, resistance, and agility training. Total Army Physical Fitness Test Scores were similar after implementation of all 3 programs, ranging from 252-255 points. Conclusions: After implementation the IHPO, TAP, and MAW injury rates remained similar or marginally decreased. LDD's increased for the IHPO and TAP which had MAT's, whereas LDD's decreased for MAW which had no MAT. Cross-training, resistance and agility training increased for all three programs and all three programs resulted in similar levels of fitness as measured by final APFT scores.

Sports Injuries Among US Army Soldiers Deployed to Operations Iraq, New Dawn, and Enduring Freedom, 2001-2012

Presenter: Keith Hauret (USA)

Keith G. Hauret, Bonnie Taylor, Avni Patel, Geeta Kersellius, Jonathan Comer, and Bruce H. Jones Injury Prevention Program, U.S. Army Public Health Command, Aberdeen Proving Ground, MD Participation in sports and exercise is a major part of a Soldier's life and a major cause of serious, nonfatal injuries in the military. In 2006, sports were the 3rd leading cause of non-battle injury (NBI) hospitalizations for the United States (U.S.) military, comprising 13% of injury hospitalizations. Between 1989 and 1994 (Lauder et al., 2000), basketball (23%), football (22%), softball (8%), and physical training (6%) were the leading sports activities resulting in injury hospitalizations. Sports were also a leading cause of hospitalizations during the Persian Gulf War (Aug 1990 – June 1991) for which the three leading causes of injury hospitalizations were motor vehicle crashes (19%), falls (19%), and sports (18%). These injuries result in outpatient visits, inpatient hospitalizations, and medical air evacuations, as well as substantial lost duty days and decreased military readiness. Purpose: Determine the incidence of sports and exercise-related (SER) injuries requiring medical air evacuation of US Soldiers deployed for Operations Iraqi Freedom/New Dawn (Iraq: 2003-2011) and Enduring Freedom (Afghanistan: 2001-2012) and describe the injury types and anatomical locations of injury. Methods: Air evacuation records were reviewed for Soldiers medically air evacuated from Iraq or Afghanistan for SER injuries (October 2001–December 2012). Narrative case history and diagnosis codes were used to determine rates of SER injuries, types of injury, and anatomical location of injury. Results: Overall, 21,982 Soldiers were air evacuated for non-battle injuries (NBIs) from 2001 to 2012. For injuries with an identifiable cause (n=15,436), sports and exercise were the leading cause comprising 23% of NBIs (n=3,564). Seventy-six percent of SER injuries were caused by four activities: basketball (24%), physical training (19%), weight-lifting (17%), and American football (16%). The leading injury types for these four activities were sprain/strains (29%), fractures (22%), and dislocations (16%). Knee (26%), ankle/foot (15%), wrist/hand (14%), and shoulder (14%) were the leading anatomical locations of injury for these four activities. Conclusion: Even in a dangerous combat environment, sports and exercise are important causes of nonfatal injuries. These injuries, many of which are preventable, negatively impact Soldier work performance and unit readiness during deployments. Identifying or developing and evaluating prevention strategies targeted to prevent these SER injuries should be a high priority for Army leaders.

Prevalence of Low Back Disorders Among Military Pilots in the Finnish Air Force with 5 Years of Follow-Up

Presenter: Tuomas Honkanen (Finland)

Honkanen T[1], Mäntysaari MJ[1], Häkkinen A[2], Kyröläinen H[3], Avela J[3], Leino TK4 [1]Aero Medical Centre, Centre for Military Medicine, Helsinki, Finland [2]Department of Health Sciences, University of Jyväskylä, Finland [3]Department of Biology of Physical Activity, University of Jyväskylä, Finland 4Air Force Command, Tikkakoski, Finland Empirical evidence and long term studies suggest that flying in a high performance aircraft has an adverse effect on both the cervical and lumbar spine. Although it is known that military pilots often suffer from low back pain (LBP), only a few studies have been published regarding the prevention or relief of LBP. In order to improve the prevention of LBP, the Finnish Air Force (FINAF) introduced physical therapist's (PT) examination and counselling as a part of the pilots' annual mandatory aeromedical examination six years ago. This study presents data about prevalence of LBP among FINAF pilots before the PT's consultations started and compares it to the LBP prevalence 5 years later. Methods: The cohort consisted of 105 pilots who participated in their annual aeromedical examination in the Aeromedical Centre (AeMC). Each pilot underwent a physiotherapist's test and guidance session. The mean age of the pilots at the beginning of the 5-year follow-up study varied from 25 to 43, and 69% of them were flying high performance aircrafts (HPA) and 31 % other fixed wing carriers (FWC). At the end of the study, 62% of the pilots were flying HPA and 38% FWC. Each FINAF pilot fills in a pain and disability questionnaire annually as a part of their aeromedical examination and data on musculoskeletal symptoms was collected from the database of AeMC. A nonparametric McNemar-test was used to statistically compare the two repeated measures. Results: There was no drop out due to musculoskeletal disorders or any medical reasons among the group, and each aviator remained fit to fly. The prevalence of LBP decreased from 71% at the beginning to 59% after five years of follow up ($p=0.04$). The prevalence of flight-induced LBP decreased from 31% to 16% ($p=0.01$) and LBP related to leisure-time sports from 31% to 19% ($p=0.02$) in five years. LBP in other physically demanding tasks decreased from 9% to 5% and LBP while sitting (desk job) increased from 19% to 21% but these findings were not statistically significant. The HPA pilots experienced statistically significantly more LBP than FWC pilots both at baseline and follow up. Discussion: The present results show that LBP among FINAF pilots has decreased in the last five years, However, it should be emphasized that LBP is still a common problem among pilots and the promotion of occupational health is essential. Thus more research should be done to clarify the cause of pain among pilots who have severe LBP, which compromises fitness to fly.

Comparison of Injury Incidence Between the Legacy T-10 and New T-11 Parachute System During Military Airborne Training

Presenter: Joseph Knapik (USA)

Joseph J Knapik, Ryan Steelman, Kyle Hoedebecke, Kevin Klug, Kevin Collier, Tyson Grier, Bruce H Jones Parachuting injuries are the 6th leading cause of hospitalizations in the United States (US) Department of Defense active duty Soldiers. Since 1952, the T-10 parachute served as the main US Army parachute for mass tactical operations. It is rated for a maximal load of 160 kg (Soldier and equipment). However, since 1952, the average weight of the US Soldier and the equipment carried has increased. In parachute operations in Iraq and Afghanistan (2001-2003) average loads were 148 to 172 kg. The need for a new parachute system to accommodate the greater Soldier loads was recognized in 1994 and work between this time and 2010 lead to the development and implementation of the T-11 Advanced Tactical Parachute System (ATPS). The purpose of this investigation was to compare injury rates between the legacy T-10 parachute system and the newer T-11 ATPS, while controlling for other factors known to influence injury rates during airborne operations. Over a 3.5 year period, data were systematically collected on jump operations performed by military units at Fort Bragg, North Carolina in the US. Data on injured jumpers were collected on the drop zone and followed up with medical records. Operational data were collected from standard reports and included parachute type, time of day, type of jump (administrative/non-tactical or combat loaded), aircraft, aircraft exit door (right, left, tailgate), jump order (order in which the Soldiers exited the aircraft), Soldier's rank, drop zone, and entanglements. Temperature, humidity, heat index, and wind speed were obtained on the drop zone using a Kestrel® Model 4500 pocket weather tracker. There were a total of 131,747 jumps (T-10 n=106,402, T-11 n=25,345) resulting in 1,101 injured Soldiers for a crude incidence of 8.4 injuries/1,000 jumps. Most injuries (88%) with a known injury mechanism were associated with ground impact. In univariate analysis, risk of injury was 9.1 injuries/1,000 jumps with the T-10 and 5.2 injuries/1,000 jumps with the T-11 (odds ratio (T-10/T-11)=1.72, 95% confidence interval (95%CI)=1.45-2.08, $p<0.01$). Other factors that independently increased injury risk included night jumps, combat loads, higher wind speeds, higher temperatures, certain aircraft, and entanglements. After controlling for these factors in a multivariate analysis, injury risk was still higher for the T-10 parachute when compared to the T-11 (odds ratio (T-10D/T-11)=1.56, 95%CI=1.28-1.89, $p<0.01$). For virtually all strata of the independent risk factors, the T-11 had a lower injury rate than the T-10. One exception was the few cases of entanglements (n=36). Entanglement incidence was higher with the T-11 (0.51 vs. 0.22 entanglements/1,000 jumps, risk ratio=2.37, 95%CI=1.20-4.69, $p<0.01$) and when an entanglement occurred, injury risk tended to be higher with the T-11 (0.69 vs. 0.39 injuries/entanglement, risk ratio=1.77, 95%CI=0.95-3.31, $p=0.08$). Compared to the T-10, the T-11 parachute had a lower injury incidence under virtually all the operational conditions examined here, except in the very rare case of an entanglement.

Musculoskeletal Pain and Limitations in Work-Ability in Swedish Armed Forces Marines: A Population-Based Survey of Prevalence and Associated Risk Factors

Presenter: Andreas Monnier (Sweden)

Andreas Monnier 1,2,Helena Larsson 1,2,Mats Djupsjöbacka 3,Lars-Åke Brodin 4, Björn O. Äng 1 1 Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Sweden 2 Swedish Armed Forces 3 Department of Occupational and Public Health Sciences, University of Gävle, Sweden 4 School of Technology and Health, KTH Royal Institute of Technology, Sweden Background: There is recognition that musculoskeletal pain is a significant problem in the elite soldier community. Even so, the prevalence of such pain experiences and its affect on work ability in Swedish armed forces (SAF) marines is presently unknown. Together with the lack of knowledge of which factors that may be associated with musculoskeletal pain limiting work-ability, this reduces the possibilities for evidence-based preventive actions for SAF marines. Purpose: To estimate the prevalence of self-rated musculoskeletal pain and pain limiting work ability in SAF marines. A second aim was to investigate potential associated risk factors for limited work ability due to pain in these types of military personnel. Methods: This study used a cross-sectional approach on a population of active duty SAF marines. Self-completed and structured questioners were administrated to 272 marines. The questionnaires addressed musculoskeletal pain and its affect on work ability, individual and health-related (mental and physical) variables as well as work-environment and work-exposures from a military as well as a civilian perspective. Potential associated risk factors for reduced work ability due to pain in the back (lower/upper back) and lower extremity were analyzed with multiple logistic regressions. Results: Fifty percent of the marines had experienced pain that limited their work ability at least ones during the previous six months. Musculoskeletal pain was most common in the lower extremity, at 51%, and back, at 46%. These were also the regions with highest prevalence of pain limiting work ability, at 29% and 20% respectively. Age >27 yr (OR 3.22, 95% CI 1.08 – 9.63), physical training 1 day/wk or less (OR 4.96, 95% CI 1.71 – 14.40) and computer work in average 1/4 of the work day (OR 3.35, 95% CI 1.14 – 9.86) were independently associated with reduction in work ability due to back pain. No variable emerged as independently associated with lower extremity pain limiting work ability. Conclusions: This study shows that musculoskeletal pain was to a significant extent related to limitation in work ability. Older age and exercise habits with relative few training days per week were independently associated with limited work ability due to back pain. This suggests that older and inactive marines might be suitable candidates for further investigation and possible preventive actions. The association between older age and limited work ability due to back pain could however be related to duration of exposure and needs therefore to be further explored. Prospective studies are also needed to determine the direction of the association of low frequency of physical training and occupational computer tasks with limited work ability due to back pain.

Incidence and Causative Factors of Lower Limb Injuries in the NZ Army

Presenter: Jacques Rousseau (New Zealand)

Rousseau J. 1, Morton H. 2, Lark SD. 2, Dunn A. 1. 1: Army Health Services, New Zealand Defence Force, 2: School of Sport & Exercise, Massey University (NZ) Introduction A snapshot of during one year of army injuries has shown musculoskeletal injuries are the highest (Davidson et al., 2008) with lower limb injury rates in the army being consistently high. This has implications on the overall costs of injuries to the army: loss of manpower, training time, and duty time, non-deployability, and an increase in medical costs and at times can lead to service discharge (Piasis et al., 2008). Methods Eight years of injury data was extracted through the New Zealand Defence Force Accredited Employer Programme (AEP) where all work place injuries requiring medical attention are captured (n=2401). Causative factors are derived from the narrative given on the AEP form completed by the soldier. Narratives were filtered using Microsoft© Excell 2010 to uncover the injury and contributing activity, e.g. “Sports session, volleyball, landed unevenly on (R) foot, rolled ankle outwards”. Frequency data and Chi square analysis was carried out on injury site by activity. Results Analysis shows 43% of all NZ Army soldiers are injured annually. Lower limb injuries account for a significant proportion (42%) and this rate has remained static over the last 8 years. Of all the lower limb injury sites, the ankle has the highest injury rate at 37%, with most of these occurring during military training (i.e., PT, battle drill and pack march) and sport (i.e., indoor court sport, contact sports, running). Overall lower limb injuries remain the highest proportion of all injuries sustained in the NZ Army, while running was the most common activity causing ankle injuries. Discussion Regardless of many interventions over the years (i.e., change of boots, introducing orthotics, change in training practices) the statistics for lower limb and ankle injuries remains a consistently high proportion of all injuries sustained. Speculation that wearing boots with high shafts to provide support and stability to the ankle joint (Bohm & Hosl, 2010) may actually be weakening, fatiguing, altering muscle activation patterns or reducing range of motion. Therefore, when not wearing the boot the ankle is vulnerable to injury. The precise aetiology has yet to be elucidated during a series of studies to determine any changes in muscle activation, flexibility, or strength of the ankle joint through boot wearing. The results are expected to help determine future policy of footwear in the army with a view to decrease lower limb and ankle injuries. References Bohm, H., & Hosl, M. (2010). Journal of Biomechanics, 43, 2467-2472. Davidson, P. L., Wilson, B. D., & McBride. D. (2008). Lower limb injuries in New Zealand Defence Force personnel: descriptive epidemiology. Australian and New Zealand Journal of Public Health. 32(2), 167-173. Piasis, P., Hanley, K., & Bissas. (2008). International review of the armed forces medical services, 84(2), 19-24

THEMATIC FREE COMMUNICATIONS/POSTERS – TRAINING

How Effective is Basic Military Training in Developing the Physical Performance Attributes Necessary for Military Service?

Presenter: Herbert Groeller (Australia)

Simon D. Burley1, Peter Orchard1, Denise M. Linnane2, John A. Sampson1, Greg L. Castairs2, Dan C. Billing2, Jace R. Drain2 and Herbert Groeller1. 1 Centre for Human and Applied Physiology, School of Medicine, University of Wollongong, Australia. 2Land Division, Defence Science and Technology Organisation, Australia To meet the burden of physically demanding duties encountered routinely during military service, recruits are required to complete a basic military training regimen. However, the utility of such training regimen to elicit clear gains in recruit strength and endurance relevant to military duties has been shown to be limited. Therefore, the purpose of this investigation was to determine if a Australian Defence Force 12-week basic military training regimen could elicit meaningful gains in military specific physical performance. One hundred and twenty eight (122M, 6F) recruits, aged 21.5 SD4.0 y, stature 177.7 SD6.9 cm, mass 77.8 SD11.6 kg were assessed at three time points, Wk1, 8 and 12, in the performance of; i) tasks relevant to military duties; lifting strength (1RM box lift), local muscle endurance (jerry can carry) and cardiovascular endurance (3.2 km-22 kg load carriage) or, ii) pre-existing generic assessments of military fitness; estimated maximal oxygen consumption (20 m shuttle run), upper-body (2-min push-ups) and trunk (2-min sit-ups) endurance. In addition a sub-sample of recruits (n = 40) were randomly selected and assessed for upper-body strength (1RM bench press), leg power (vertical jump), 30-sec high-intensity work capacity (cycle ergometer) and peak oxygen consumption (treadmill). Data for Wk 1 and 12 are presented as mean ± 95% confidence or otherwise stated standard deviation (SD), statistical significance set at P<0.05. A significant ~11% improvement in lifting strength (Wk1, 40.3 ±1.7; Wk12, 45.1 ±1.7 kg), local muscle endurance (Wk1, 635 ±48.8; Wk12, 699.6 ±47.4 m) and cardiovascular endurance (Wk1, 1243 ±26; Wk12, 1123 ±21 s) after the 12-week regimen was observed. Upper-body (Wk1, 41.1 ±2.1; Wk12, 47.0 ±1.8) and trunk (Wk1, 93.4 ±2.6; Wk12, 99.8 ±0.3) endurance increased by 14% and 7% respectively. In contrast, no significant change in upper-body strength, leg power or high-intensity work capacity was observed in the recruits. However, while estimated maximal oxygen consumption (Wk1, 44.1 ±0.9; Wk12, 48.0 ±0.8 mL•kg-1•min-1) increased by 9%, peak oxygen consumption was maintained throughout the regimen. After 12 weeks of basic military training, a modest improvement in military-related physical performance was obtained in recruits. In contrast, physiological measures of performance, irrespective of the physical attribute remained similar throughout the regimen. Our findings suggest, the origin of the military specific and generic assessment performance gains may be due in part, to increased familiarisation with the tasks. The results of this investigation will inform future research that will explore the manipulation of basic military training to improve upon functional outcomes for recruits.

The Effect of an Eight Week Military Training Program on Fine Motor and Cognitive Function

Presenter: John Paul Hickey (Ireland)

JP Hickey, D O'Brien, B Donne Institutions JP Hickey: Medical Officer, Irish Defence Forces, Army Medical Corps D O'Brien: Clinical Psychologist, Irish Defence Forces, Army Medical Corps B Donne: Dept of Physiology, University of Dublin, Trinity College Corresponding author Name: JP Hickey Address: 21 Parnell Road, Dublin 12, Ireland. Tel: +353 87 6982333 Email: hickeyjohnpaul@gmail.com Abstract Purpose This study was designed to assess the effects of eight weeks of military training on aerobic fitness indices, military skills and neuropsychological function. Methods Thirty five (n=35) male Irish Defence Forces personnel, divided into training (n=20) and control (n=15) subgroups, completed tests of military aptitude (Kim's games, judging distance, fire order, map reading, weapon assembly) and neuropsychological function (Symbol digit modalities test (SDMT), Trail making test, Stroop test and grooved pegboard test) pre- and post-intervention. The repeated measures study design sought to account for any learning effect. Participants also completed a 10km route march, a two mile run and three by 20m shuttle run tests at both time points to quantify changes in fitness variables. Results The training sub-group significantly (P<0.001) improved mean 20m shuttle-run distance and consequently estimated VO2 max pre- to post-intervention (49.8±1.0 vs. 52.4±0.9 mL.kg-1.min-1). Two mile run time was not significantly improved. Mean %HRmax during the 10km route march was significantly higher in both training (P<0.001) and control (P<0.01) sub-groups post-intervention (71±1 and 83±1%) compared to pre-intervention (65±1 and 77±1%). However, the training sub-group conducted the route march at a significantly faster speed on the second occasion. Military training significantly improved performance in 3 of 18 neuropsychological test components and 2 of 12 military skills test components. Training significantly improved ability to estimate both short (error; 36±6 vs. 12±1%) and intermediate (error; 72±12 vs. 11±3%) distances post-intervention. The training sub-group significantly (P<0.01) improved SDMT score and mean Trail 1 time pre- to post-intervention (58.0±2.8 vs. 69.5±3.4; 18.1±0.8 vs. 14.4±0.8s, respectively). In Part 3 of the Stroop test, time mediated a significant (P<0.05) and selective improvement in the training sub-group (51.3±3.2 vs. 63.8±5.4). Conclusions In conclusion, aerobic fitness and some neuropsychological and military skills tests improved following 8 weeks of military training.

Non-Mechanical Factors That Influence the Adaptation of Bone to Short-Term Military Training

Presenter: Rachel Izard (England)

Izard, RM1., Greeves, JP1., Ball, G2., Sale, C3., Negus, CH4., Fraser, WD5. 1 HQ Army Recruiting and Training Division, Upavon, Wiltshire, UK. 2 The van Geest Cancer Research Center, Nottingham Trent University, UK. 3 Biomedical, Life and Health Sciences Research Centre, Nottingham Trent University, UK. 4 L-3 ATI, San Diego, CA, USA 5 Norwich Medical School, University of East Anglia, UK. INTRODUCTION: Arduous military training has been shown to elicit an oesteogenic effect, increasing mineralisation and periosteal expansion of the tibia over a 10 week period (1). It is unknown whether lifestyle factors (alcohol intake, physical fitness, smoking) and micronutrient status (calcium and vitamin D) influence the anabolic response of bone to weight bearing exercise. AIM: To explore the inter-relationship among anthropometry, lifestyle factors and micronutrient status as they relate to changes in bone and muscle during military training. METHODS: Participants were male (n=82) recruits undertaking British Army basic Infantry training. Whole bone cross-section density, geometry and estimated strength at the 4, 14, 38 and 66% of the tibial length were determined by pQCT at Baseline (week 1) and End (week 10) of training. Anthropometric data and aerobic fitness were also determined. Biochemical markers of bone turnover (P1NP, OC, CTX, ufPYD and ufDPD); sclerostin; vitamin D status (total 25(OH)D); and, markers of calcium metabolism were obtained at Baseline, Mid (week 5) and End of training. Lifestyle variables including smoking and alcohol intake were collected at Baseline using a validated lifestyle questionnaire. Data were analysed using an Artificial Neural Network (ANN) based inference approach and variables were entered into the model as: Baseline value; delta change; or sum of the change, dependent upon frequency of measurement. RESULTS: Smoking attenuated changes in mineralisation (trabecular and cortical density), geometry (total area, cortical thickness, bone width and periosteal perimeter) and bone strength (compressive, torsional and bending) at all measured sites. Smoking also suppressed the changes in biochemical markers of bone formation (OC) and resorption (CTX), and attenuated changes in muscle density and area. Smaller increases in muscle area were also associated with lower 25(OH)D. No other associations between 25(OH)D and changes in bone were shown. CONCLUSIONS: Smoking impaired tibial adaptations, including attenuated improvements in bone density and geometry at all measured sites during military training, possibly through suppression of bone turnover (both formation and resorption). This finding suggests that the oesteogenic benefits of exercise are not experienced by those who smoke. In spite of sub-optimal total 25(OH)D (<50nmol/L) in participants (Baseline: 18%, End: 70%), total 25(OH)D concentrations were only associated with changes in muscle density and area. We have identified specific lifestyle and micronutrients that influence the adaptation of muscle and bone to arduous military training, which will help identify appropriate interventions to reduce injury risk and optimise training. 1. Izard et al (2014) Changes in Tibial Density and Geometry in Infantry Recruits Following Initial Military Training. ICSPP, Boston.

Effects of 12-Weeks of DFit.ca Fitness Training on the Performance of the Common Military Task Fitness Evaluation and Force Evaluation in Canadian Armed Forces (CAF) Personnel

Presenter: Jacqueline Laframboise (Canada)

J. Laframboise MSc*, B. Stockbrugger MSc Canadian Forces Morale and Welfare Services; Directorate of Fitness; Human Performance Research and Development Corresponding author: Jacqueline.Laframboise@forces.gc.ca Introduction: The Canadian Armed Forces (CAF) recently implemented the FORCE Evaluation (Fitness for Operational Requirements of CAF Employment), a field expedient fitness test designed to predict the physical capabilities of completing the Common Military Task Fitness Evaluation (CMTFE). The CMTFE includes the following task simulations: escape to cover, casualty extrication, picking and digging, stretcher carry, sandbag fortification, and picket and wire carry. The FORCE includes: sandbag lift, intermittent loaded shuttles, 20-m rushes and sandbag drag. With the adoption of a new Physical employment Standard, it is important to demonstrate that the required fitness level is achievable through training. Therefore, concurrent to the development of the FORCE and CMTFE, an online self directed fitness training website, DFit.ca, was developed to assist in providing operationally relevant fitness training to all CAF members. In addition, one of the main purposes of DFit.ca is to provide training programs which will prepare CAF members for successful completion of FORCE and the CMTFE. Purpose: The purpose of this study was to determine if FORCE and CMTFE performance are trainable after 12 weeks of DFit.ca generated training in CAF personnel. Methods: Twenty-two CAF members participated in the study (9 males, 13 females, mean age=44, SD=7). They self identified as either not participating in regular fitness training or being concerned with passing the requirements of FORCE. To obtain a true baseline score, they performed the CMTFE and FORCE 3 times each prior to beginning 12 weeks of DFit.ca training. Upon completion of the 12th week of training, performance was retested with FORCE and the CMTFE. Fitness training was generated with DFit.ca by selecting a 'Domestic' Operation and 5 days/week. Results: Participants completed 10-11 weeks of the 12 weeks of training due to common constraints (e.g. family illness). Pre-training results confirm that performance due to learning stabilizes after 2-3 trials. The average coefficient of variation between the 2nd and 3rd pre-training trials were: FORCE (CV% = 5.7%) and CMTFE (CV% = 4.1%). Notably, there was also on average an improvement in performance of 5% for all FORCE components and 4.8% for all CMTFE tasks across these pre-tests. Paired T-test analysis of the prebest-post training for each performance variable indicated there was a significant ($P<0.05$) positive effect of training on all components of FORCE (5.1-18.7%) and the CMTFE (4.3-17.3%) except for the digging task. Furthermore, cross tab analysis of sensitivity indicates that improvements in FORCE were accompanied by improvements in the CMTFE an average of 81% of the time across all tasks. Conclusion: This study shows the trainability of these 2 evaluations can be obtained through practice and after 12-weeks of DFit.ca fitness training.

French Mountain Troops Basic Training: Efficiency and Tolerance in New Recruits

Presenter: Alexandra Malgoyre (France)

French mountain troops basic training: efficiency and tolerance in new recruits Malgoyre A.1, Meunier A.1, Harmand C.2, Ginon B.2, Koulmann N.1,Sanchez H.1 1 Institut de Recherche Biomédicale des Armées, BP 73, 91223 Brétigny/Orge, France. 2 Centre de Formation Initiale Militaire, Quartier Général Guillaume, 05000 Gap, France E-mail : alexandra.malgoyre@irba.fr Infantry basic training of French army is a 12 weeks standardized program. The physical fitness of 135 new recruits from mountain units (infantry: 76%, artillery: 24 %) was evaluated before and at the end of their basic formation. The components of physical fitness measured were body composition, aerobic capacity, and both sub-maximal power ofupper and lower extremities.Overtraining or overreaching syndrome and occurrence of injuries were also studied. Physical Fitness: A significant increase of body weight (+2.8%, p<0.0001) concerning mainly lean mass (+2 kg) was observed, while fat mass trends to decrease (-2.3%; p=0.09). Obviously, the fattest soldiers lose more fat mass than others, but this stronger alteration of body composition was not related to a more important improvement of physical performance. Aerobic capacity was strongly augmented (+8.8%, p<0.0001). When subjects were categorized by their maximal aerobic speed level (MAS <14 km/h, between 14-15 km/h and >15km/h), the improvement was inversely dependent on the initial MAS value, respectively +15%,+10% and +6% (p<0.001). The mean power developed by lower limb during a 30s jumps test was augmented of +4.8% (p<0.001). Submaximal power of upper limb developed during 6 repetitions of bench press performed at 40% of body weight was increased of +3.7% (p<0.0001). Nevertheless, subjects who practiced sport more than 4 times/week before recruitment do not alter their sub-maximal power of upper limb compared with less sporty subjects. Basic formation tolerance:For the whole population studied, both mean score of overtraining questionnaire and prevalence of overreaching were decreased. Injuries prevalence was less than 15% for the whole population and corresponded to a huge decrease in comparison with previous data (47% in 2009). Overreaching score was three times higher in artillery than in infantry, without significant elevation of injuries risk. When body composition, training level before recruitment and the initial MAS value were taken in account to study the risk of injuries, we observed that: - The fattest subjects have 19 times more chance to get injured than the thinnest. - Having a low training level before recruitment was not a risk factor of injuries during basic formation, since subjects doing no sport or once a week present an injuries prevalence of 6%. - Soldiers showing a weak initial MAS value had not a higher risk of injuries, but they display a 4 times chance to have an elevated overreaching score in comparison with fastest soldiers. Conclusion: Infantry basic training of French army leads to important modifications of body composition, aerobic capacity and sub-maximal power of upper and lower limbs. Strength development should be optimized in comparison to aerobic training. Injuries prevalence is low, but initial fat mass could be an important risk factor of wound development during basic formation.

Walking with Night Vision Goggles Increases Metabolic Demand

Presenter: Lena Norrbrand (Sweden)

Lena Norrbrand1, Mikael Grönkvist1, Björn Johannesson1, Annika Rappe2, Johan Sjölin2, Ola Eiken1 1 KTH Royal Institute of Technology, School of Technology and Health, Environmental Physiology, Solna, Sweden 2 Swedish Armed Forces, Swedish Armed Forces Sports Centre (FMIF), Stockholm, Sweden Purpose: Foot-borne soldiers commonly undertake nighttime operations; sometimes the motivation for performing the operation at night is to reduce heat strain. However, we have previously found that metabolic demand, and hence endogenous heat production, during walking may be increased by 25% when performed in darkness. The aim of the present study was to evaluate the effect of wearing Night Vision Goggles (NVG) on the mechanical efficiency during walking in darkness. Methods: A group of cadets (11 men, 3 women, age: 25±7 yrs, height: 178±8 cm, weight: 78±13 kg) participated. At nighttime, each subject performed 10-min walks at slow velocity (4 km/hour) on a straight, flat gravel road (n=14) and on a somewhat hilly forest trail (n=9). Both walks were performed under four different conditions, wearing: a headlamp (Light), monocular NVG (MNVG), binocular NVG (BNVG), or a blindfold (Blind). During the 10-min walk, oxygen uptake was measured, and the rates of perceived exertion, comfort and mental stress were assessed. Results: Oxygen uptake was higher in all three conditions with limited vision (MNVG; BNVG; Blind) than in the Light condition (p<0.05), both when walking on the gravel road (+5-8%) and on the forest trail (+6-14%). On the gravel road, there were no differences in oxygen uptake between the Blind, MNVG, and BNVG (p>0.05). By contrast, on the forest trail, the increase in oxygen uptake was more pronounced (p<0.05) in the Blind (1.33±0.18 l/min, +14%) and BNVG (1.29±0.22 l/min, +11%) conditions than in the MNVG condition (1.24±0.20 l/min, +6%). The rate of perceived exertion was generally low for all conditions. The rate of mental stress was also low, but slightly higher (p<0.05) in the Blind condition than in the Light, MNVG and BNVG conditions. Some discomfort was experienced during the BNVG condition due to heaviness of the BNVG. Conclusions: Whilst walking on a gravel road, wearing a blindfold, BNVG, or MNVG significantly increased metabolic demand. Whilst walking on a hilly trail, energy expenditure was even more augmented by the blindfold, MNVG and BNVG. Thus, despite that in darkness foveal vision is markedly improved by NVG, it appears that the mechanical efficiency during walking is lower whilst wearing NVG than with full vision. Presumably, reduced peripheral vision may have contributed to the reduced mechanical efficiency during walking with NVG. Notably, present exercises were all perceived as easy. The effects of NVG during more demanding nighttime operations remain to be established.

The Use of Ability Based Training in Police Force Recruits

Presenter: Robin Orr (Australia)

*Robin M Orr, #Michael Stierli, *Kelsie Ford *Bond University, Gold Coast, Australia. #New South Wales Police Force, Sydney, Australia Purpose. Current physical training protocols for police recruits employ an aerobically-focused, one-size-fits-all, approach. The aim of this study was to investigate whether an Ability Based Training (ABT) program derived from the 30-15 Intermittent Fitness Test (IFT), would improve the aerobic fitness of police recruits to the same extent as current training processes, in less time and with fewer injuries. Methods. A total of 287 police recruits (Session 1: n=54: Session 2: n=233) participated in this study. Within each session, officer syndicate groups were randomly assigned to a control or intervention group. Recruits in the control group performed the current physical training program (~60mins in length) consisting predominantly of push-ups, sit-ups and long slow distance group running. Recruits in the intervention group completed push-ups, sit-ups and the ABT program of running intervals derived from their 30-15 IFT score (~45mins in length). Interval distance was derived from the formula: Interval distance=running speed in m/s (score) x % of effort x duration of interval. Physical training was completed once a week over 10-weeks for both sessions. At the commencement and completion of the training period, 20m shuttle run data were collected to evaluate aerobic fitness. Injury data were collected using the NSW Police College Accident and Incident form in accordance with College protocols. Recorders and data processors were blinded to the research. In this study injury was defined as damage to the musculoskeletal system that was serious enough to warrant submission of formal paperwork. T-tests were used to investigate differences in fitness between (independent) and within (paired) cohorts with a Chi-squared test investigating differences in injuries between cohorts. Results. In the Session 1 cohort; there were no significant differences in aerobic fitness between groups either pre or post training. While aerobic fitness was maintained, it did not improve significantly in either group over the 10-week period. In Session 2; there were no significant differences in aerobic fitness between the groups either pre or post training. However, both groups did significantly improve their aerobic fitness ($p<0.001$) with the intervention group improving their aerobic fitness to a greater degree (pre = 60.98 ± 16.45 shuttles: post = 70.11 ± 16.54 shuttles) than the control group (pre = 63.32±SD 15.70 shuttles: post = 67.48 ± 15.95 shuttles). Injury rates, although noticeably lower for the intervention group in both sessions, did not reach significance. Of the Session 1 cohort; four recruits in the control group (14%) suffered an injury while only one recruit (4%) was injured in the intervention group ($x2(1)=1.533$, $p=0.216$). For Session 2; 12 recruits (10%) in the control group suffered an injury and seven recruits in the intervention group (6%) were likewise injured ($x2(1)=1.252$, $p=0.263$). Conclusion. An ABT training program as derived from 30-15IFT scores was as effective as group based aerobic fitness training methods, yet yielded fewer injuries and was more time efficient.

Monitoring of Mental, Physical, and Organizational Determinants of Dropout in Initial Infantry Training

Presenter: Bertil Veenstra (Netherlands)

Bertil Veenstra 1, Olaf Binsch 2, & Pierre Valk 2 1 Royal Netherlands Army (RNLA)/ Training Medicine and Training Physiology, Utrecht, The Netherlands; 2 The Netherlands Organization for Applied Scientific Research (TNO), Department of Human Factors, Soesterberg, The Netherlands Introduction For infantry units of the RNLA, high dropout rates during initial training are a persistent problem. The reasons for these dropout rates, varying from 40 up to 70%, are diverse. A better insight into the determinants of attrition is a prerequisite for taking preventive measures. The RNLA has initiated a research program focusing on the determinants of readiness and performance of soldiers. The goal of this research program is to develop a monitoring system that integrates the effects of physical, mental, and organizational determinants on operational readiness. In a previous study, we selected a subset of relevant factors and developed monitoring tools to measure these factors in initial infantry training (Binsch at al., 2014). The aim of the current study was to implement the monitoring tools in order to evaluate which set of determinants predicts dropout in initial infantry training. Methods Eighty-five recruits were followed during their 25-week infantry training. Prior to the training, recruits were screened for medical, psychological and physical fitness. In addition, they were submitted to a 3-day selection test. Mental determinants were distinguished and subdivided into cognitive, personality, and social factors, respectively. Cognitive factors were obtained with a computerized vigilance test. Social and personality determinants were measured with questionnaires. A Daily Load Monitor (DLM) was used to assess physical and mental fitness and functioning over the last 24 hours. Also, a Weekly Load Monitor (WLM) was used, containing items regarding self-efficacy, physical condition, sleep quality, social support, coping styles, and motivation. Physiological determinants (HR, HRR, skin temperature, number of steps, speed) were measured using a Hidalgo EQ-02 monitor. In the first training week, anthropometric parameters (body height, body mass, fat percentage and somatotype) were measured and a physical fitness test (12-minute run, push ups, sit ups and pull ups) was conducted. Organizational determinants concerned the class affiliation and the external (instructor) assessment of the recruits. Every week, the instructors assessed the recruits on items like effort, learning ability, chances of passing the training, and the 'quality to be an infantry soldier'. A survival analysis method was used to analyse the determinants as individual and grouped predictors of dropout. Results Forty recruits failed the training course (dropout rate 48%). Dropout was predicted by several physiological and mental determinants. However, the instructors judgement on 'quality to be an infantry soldier' predominated the physiological and mental determinants. The survival analysis allowed us to analyse the interactions between the different determinants. Conclusion The monitoring system was successfully implemented in the infantry training. In this particular training, organizational determinants had the strongest influence on dropout. Reference Binch O, Jetten A, Kruse A, Aarts O, Valk P, Veenstra B. Determinants of operational readiness regarding military personnel, internal report RNLA

THEMATIC FREE COMMUNICATIONS/POSTERS – FOOTWEAR/LOWER LIMB INJURY

Trunk Posture Impacts Lower Limb Energy Absorption During Drop Landings with Body Borne Load

Presenter: Tyler Brown (USA)

Tyler N. Brown, Meghan O'Donovan, Leif Hasselquist, Brian Corner, Jeffrey M. Schiffman U.S. Army Natick Soldier Research, Development and Engineering Center Drop landings with body borne load, in particular soldier-relevant configurations, elevate the risk of musculoskeletal injury. Actively absorbing the increased kinetic energy of landing with a body borne load, via eccentric contractions of the lower extremity musculature, can potentially reduce this injury risk. Reportedly, greater trunk flexion when landing with small body borne loads (i.e. 10% of BW) impacts lower limb effort, and increases energy absorption. However, when landing with soldier-relevant load configurations (i.e., 20-40 kg), it remains unknown if trunk posture relates to lower limb energy absorption. The purpose of this study was to determine whether greater trunk flexion while landing with soldier-relevant body borne loads correlated with increased energy absorption (EA) by the lower limb. Fifteen male (20.9 ± 3.1 yrs, 1.8 ± 0.1 m and 75.6 ± 11.6 kg) military personnel had trunk flexion, and hip, knee and ankle EA quantified during the deceleration phase of 30-cm drop landings. Drop landings required participants step off a 30-cm box and land with each foot on a separate force platform. Participants performed three drop landings with three load configurations (light (6 kg), medium (20 kg) and heavy (40 kg)). During the deceleration phase – from initial contact to peak knee flexion – of the drop landing, trunk flexion range of motion was calculated as the difference between peak angle and angle at initial contact and hip, knee and ankle EA were quantified for each landing. Subject-based means of the dependent variables were calculated and submitted to linear regression analysis to assess the relationship of trunk range of motion with EA at the hip, knee and ankle for each body borne load. A one-way ANOVA (alpha level $P<0.05$) was performed on the regression coefficients to determine if they differed significantly between the body borne loads (light, medium and heavy). Greater trunk range of motion during landing predicted increased EA by the hip with medium ($R2=0.499$, $b=0.017$, $P=0.003$) and heavy ($R2=0.326$, $b=0.015$, $P=0.026$) loads, but not with the light load ($R2=0.215$, $b=0.011$, $P=0.081$). Greater trunk flexion also predicted increased EA by the knee with the light ($R2=0.417$, $b=0.041$, $P=0.009$) and medium ($R2=0.301$, $b=0.035$, $P=0.034$) loads, but not for the heavy load ($R2=0.055$, $b=0.018$, $P=0.400$). The regression coefficients, however, between trunk posture and hip and knee EA were not significantly different between any of the body borne loads. Furthermore, trunk posture was not a significant predictor of ankle EA for any of the body borne load configurations. Relying on greater trunk flexion during landing may increase active attenuation of the landing force by the hip and knee musculature. To reduce musculoskeletal injury risk, training soldier's to use greater trunk flexion when landing with body borne loads may be warranted. However, further study is needed to determine if greater knee EA is attainable when landing with heavy body

Lower Extremity Biomechanics and Self-Reported Foot Strike Patterns Among Runners in Traditional and Minimalist Shoes

Presenter: Donald Goss (USA)

LTC Donald Goss, PT, PhD1; Michael Lewek, PT, PhD2; Bing Yu, PhD2; William Ware, PhD2; LTC(P) Deydre Teyhen, PT, PhD1, Michael Gross, PT, PhD2 1. US Army-Baylor DPT Program, Fort Sam Houston, TX 2. University of North Carolina at Chapel Hill Background: Injury incidence rates among runners are approximately 50%. Some individuals have advocated anterior foot striking to reduce ground reaction forces and injury rates they attribute to rearfoot striking. The proportion of minimalist shoe wearers who adopt an anterior foot strike pattern remains unclear. Purposes: To evaluate the accuracy of self-reported foot strike patterns, to report average vertical loading rates, and to compare ankle and knee joint angular work between runners using different foot strike patterns and wearing traditional or minimalist shoes. Methods: Healthy volunteers with more than 6 months of experience using traditional or minimalist shoes were asked to classify their foot strike pattern. Subjects ran in their preferred shoes on an instrumented treadmill with 3D motion capture. Self-reported foot strike patterns were compared to a 2D video assessment. Runners were classified into 3 groups: traditional shoe rearfoot strikers (TSR, n = 22), minimalist shoe anterior foot strikers (MSA, n = 21), and minimalist shoe rearfoot strikers (MSR, n = 17) based on video assessment. Ankle and knee negative angular work and average vertical loading rates during stance phase were compared among groups. Results: From our sample of 60 runners, only 41 runners reported foot strike patterns that agreed with video assessment (68.3%, $X2 = .42$, $p < 0.001$). TSR runners demonstrated significantly greater ankle dorsiflexion negative work (ADNW) (-0.004 ± < 0.001 J/BH*BW) than MSA runners (< -0.001 ± < 0.001 J/BH*BW, $p = .03$) and MSR runners (< -0.001 ± < 0.001 J/BH*BW, $p = .04$). TSR runners also demonstrated greater knee extension negative work (KENW) (-0.332 ± 0.110 J/BH*BW, $p < 0.001$) than MSA runners (-0.161 ± 0.133 J/BH*BW) and MSR runners (-0.227 ± 0.138 J/BH*BW, $p = .01$). MSA runners demonstrated greater ankle plantar flexion negative work (-0.523 ± 0.227 J/BH*BW) than TSR runners (-0.315 ± 0.131 J/BH*BW, $p < 0.001$). The MSR group demonstrated a significantly greater AVLR (105.7 ± 35.7 BW/s) than the other 2 groups (TSR = 68.6 ± 15.5 BW/s, $p < 0.001$; MSA = 54.5 ± 30.9 BW/s, $p < 0.001$). Conclusion: Accuracy of self-reported foot strike pattern was poor for runners in the study who wore minimalist running shoes. We have identified an unexpected cohort of runners who wore minimalist shoes for a minimum of 6 months, and who demonstrated a rearfoot strike pattern and potentially injurious rates of ground reaction force loading. We also observed that runners who utilize a rearfoot strike pattern in traditional shoes demonstrated more overall knee excursion, greater knee extension negative work, and greater ankle dorsiflexion negative work than runners wearing minimalist shoes, regardless of foot strike pattern.

The Influence of Footwear on Vertical and Anteroposterior Ground Reaction Impulses

Presenter: Steve Jamison (USA)

Jamison, ST; Ruder, MC; Rainbow, MJ; Davis, IS Spaulding National Running Center, Harvard Medical School Purpose: Lower extremity musculoskeletal overuse injuries are the most common reason for discharge in the military. Due to its repetitive nature, running during training is considered a significant contributor to lower extremity injury risk. There has been a recent trend among some soldiers towards barefoot and minimal footwear running with the goal of reducing injury risk. Vertical impacts and loading rates have been associated with running injuries. Studies have shown reductions in these variables for barefoot and minimal footwear compared with standard shoes having a cushioned footbed and elevated heel. The effect of footwear on vertical impulse, an indication of overall vertical loading being managed by the lower extremity, has not been studied. It has also been suggested that running in minimal footwear encourages mechanics that reduce braking and propulsion, thereby improving efficiency of running, though this too has not been examined. Therefore, the purpose of this study was to compare vertical and anteroposterior impulses for runners that habitually run in standard neutral shoes (NS) to runners that habitually run barefoot or in minimal footwear (BF_MIN). Methods: This is an ongoing study where 12 NS and 10 BF_MIN subjects (NS=30.7±7.6yrs; BF_MIN=40.2±7.4yrs; p<0.01) traversed a 30m runway at a speed of 3.13 m/s (+/-5%), landing on force plates embedded at its center. To ensure that steps were at constant velocity, only those with a center of mass velocity change over stance phase of less than 2% were included (NS=159 steps; BF_MIN=125 steps). Braking, propulsive, and vertical impulses were calculated and normalized by subject mass [N*s/kg=□v m/s]. Results: The BF_MIN group exhibited increased normalized braking (NS=-0.200±0.023; BF_MIN=-0.209±0.029; p<0.001) and propulsive (NS=0.204±0.020; BF_MIN=0.217±0.018; p<0.01) impulses, despite shorter stance times (NS=264±19ms BF_MIN=270±18ms; p<0.01). The NS group exhibited greater normalized vertical impulse (NS=3.62±0.18; BF_MIN=3.52±0.14; p<0.001), resulting in longer flight times (NS=114±18ms vs. BF_MIN=94±24ms; p<0.001). Center of mass velocity, mass, and body height were not significantly different between groups (p>0.05). Conclusion: Our results indicate that, when running at the same speed, habitually barefoot and minimally shod runners have higher normalized braking and propulsive impulses but lower normalized vertical impulse compared to runners who habitually run in standard shoes. Increases in braking and propulsive impulses in the barefoot and minimal footwear runners could have a negative impact on running economy since additional energy will be used to slow and then propel the body forward. It is not clear how differences in vertical impulse will impact running economy. For a single stance, increases in vertical impulse will be associated with increases in required energy. Over a given distance at a constant velocity however, the increase in flight time will increase flight distance (step length), reducing the number of steps required. Additionally, vertical loading rate has been associated with running injury and will likely be increased in the standard shoe group that experienced higher normalized vertical impulse during a shorter stance time.

The Relationship Between Arch Height Type and Arch Flexibility

Presenter: Rebecca Zifchock (USA)

Dr. Rebecca Zifchock [1], COL Michael Neary [1], Dr. William Brechue [1], Dr. Jinsup Song [2], Dr. Howard Hillstrom [3] [1] US Military Academy, West Point, NY [2] Temple University, Philadelphia, PA [3] Hospital for Special Surgery, New York, NY PURPOSE: Foot type, defined using measures of both arch height and arch flexibility, has been previously related to injury susceptibility. Therefore significant research has been devoted to describing foot structure. It is generally believed that high arches are stiff, while low arches are flexible. However there is insufficient quantitative evidence to support this assumption. The first purpose of this work is to determine whether there is a relationship between arch height and arch flexibility. Analogous to the three categories of arch height (high, moderate, low), this research group has recently proposed five arch flexibility categories: very stiff, moderately stiff, average, moderately flexible, very flexible. Therefore, an individual foot can be classified based both on arch type and arch flexibility. Therefore, the second purpose of this work is to determine whether individuals in each arch type category tend to distribute differently among arch flexibility categories. This second purpose supports the first, but further identifies how the two dimensions of foot structure relate to each other. METHODS: Arch height index (AHI) and arch height flexibility (AHF) were calculated from measurements of both feet of 1124 incoming West Point cadets. Of those, complete data were available for 1062 left feet and 1071 right feet. AHI was correlated to AHF using Pearson's Product Correlation. Additionally, AHI was used to categorize feet as high, moderate, or low-arched, while AHF was used to categorize feet in one of five flexibility categories. The distribution of foot flexibility types was compared among arch type categories using a Chi-Square Test of Goodness of Fit. RESULTS AND DISCUSSION: AHI and AHF were different between the right and left sides (p<0.001). Therefore analyses were conducted separately on each side. AHI and AHF were weakly correlated in the right and left feet (r = 0.17 and 0.14, respectively). The chi-square analysis suggested that there was a significant difference in the distribution of arch flexibility types among the arch type categories. On both the left and right sides, the percentage of very flexible foot types increased from "high" to "moderate" to "low" arch height categories, while the percentage of very stiff foot types correspondingly decreased. The percentage of moderately stiff, average, and moderately flexible foot types appeared to be randomly distributed amongst the arch categories. A follow-up chi-square test conducted on the three moderate arch flexibility types suggested that there was not a significant difference in the distribution of arch flexibility types among the arch type categories. CONCLUSION: This work discredits the general belief that high arches are stiff and low arches are flexible, and suggests that this relationships may only be significant for those with extremely stiff or extremely flexible arches.

INVITED SPEAKERS

Physiological Implications, Performance Assessment and Risk Mitigation Strategies for Women in Combat-Centric Occupations

Speaker: Dr. Julie Greeves

Julie P Greeves, PhD, Headquarters Army Recruiting and Training Division. Historically women have featured in military conflicts, serving in combat roles disguised as men, performing leadership roles as queens, serving as camp domestics, or operating on the battlefield as nurses and aids. Women were formally integrated into the military in the twentieth century, but occupations were mainly restricted to clerical or support roles. As an increasing number of occupations have opened to women, including the opportunity to serve in combat arms, the physical demands of new roles have increased and in recent conflicts hundreds of women have been required to carry heavy loads over long distances. Inherent biological differences typically lower aerobic and anaerobic capacity, lower muscle mass and higher percentage body fat of women place female military personnel at a performance disadvantage, forcing them to work harder when undertaking the same tasks as men. This is reflected, in part, by the greater risk of musculoskeletal injuries of women observed notably during integrated military training. A shorter stature and smaller skeleton (ie lower cross sectional area and bone strength) also increase the risk of specific injuries such as tibial and pelvic stress fractures. To ensure that women are suitably selected to cope with the demands of military tasks with minimal risk, in terms of both injury and operational effectiveness, occupational standards must be based on the physical requirements of the role, and remain gender neutral or 'free'. The development and implementation of such standards is more important than ever as more countries allow women to enter direct combat roles that represent the most physically challenging occupation in the Armed Forces. The new challenges for women of modern warfare will likely involve the ability to perform lift and carrying tasks for prolonged periods, requiring upper body strength where women have a pronounced disadvantage; research efforts must focus on the prediction of load carriage performance in both sexes. In spite of gender free pre-employment standards, the risk of injury has remained higher in female recruits undertaking basic military training because women typically work 33% harder than their male counterparts in mixed sex platoons. Initiatives such as single sex training and an extension to basic military training courses to reduce cardiovascular strain and allow appropriate physiological adaptation, has contributed to a reduction in lower limb musculoskeletal injuries, although injury rates still remain two fold higher in women. Nevertheless, women experience substantial gains in aerobic power and strength with appropriate and targeted training, closing the gap in physical performance between the sexes. Evidence-based occupational standards and optimal training programs provide short term solutions for integrating women in combat, and indeed direct, combat roles, but the longer term effects on health of exposing women to physiological and metabolic stresses of intense and austere training and operational conditions warrant particular attention.

Physiological Readiness and Resilience: Scientific Underpinnings of Military Preparedness

Speaker: Dr. William Kraemer

William J. Kraemer, Human Performance Laboratory, University of Connecticut, Storrs, CT, USA. The physical development of the human body to take on the stress of mission essential tasks is vital for optimal performance. To augment the psychological and mental aspects of any mission proper physical readiness plays a dramatic role meeting the demands. Each MOS and the role played by every warfighter maybe highly individualized and vary across the force yet fundamental physical capabilities will resonate for performance optimization. It is the integration of physiological development from conditioning that determines readiness and a trained neuromuscular system will in part determine the recovery capabilities and resilience from mission demands. The fundamental factors related to physical development remain a balanced integration of cardiovascular development, muscular strength, power, local muscular endurance and flexibility. The process of exercise prescription in the military is faced with almost impossible demands arising from command structures, policy development, differential MOS and mission requirements, lay opinions on conditioning, lack of information flow to the grass roots, limited conditioning expertise assured at the company level, commercial influence, need for individualization of programming, and equipment availability. The ability to address conditioning programs with the perspectives of enthusiasm and camaraderie must surround fundamentally sound workout practices. Fundamental to this phenomenon is the scientific fact that muscle tissue that is recruited via neural activation (Size Principle) will stipulate the physiological systems that are needed to support motor unit recruitment and thus be trained synonymously either in a positive or negative manner. Understanding what motor unit recruitment is in relationship to exercise demands plays a fundamental role in understanding exercise prescription and also mission demands. The challenge in such exercise prescription resides in limiting the amount of overreaching and ultimately overtraining which reduced both recovery and resilience over time and in the latter case are difficult to correct. Composited with other environmental factors concomitant with sleep and nutrition a more holistic view of the warfighter is needed. While the warfighter analogies to being an athlete has been criticized, and in a sense rightly so, what is often times overlooked is the additional development of "athleticism" in order to allow for task capabilities to be performed in both an economic and effective manner reducing the stress vectors from mechanical and biochemical challenges in recovery. Effective progressions in conditioning programs related to general physical development with subsequent targeted MOS specific task target training carries with it a lot of the same exercise prescription elements that are vital to same process used by recreational fitness and athletic populations. Understanding the fundamental basis for each of these elements and their integrative prescription and management is vital to meet the demands of preparedness. This presentation will overview the physiological basis and integrative programming needed for dealing with the diverse starting points of fitness and the demands and cutoffs for physical development of warfighters.

Protection versus Physiology: Interactions Between Physiological Regulation and Protective Equipment

Speaker: Dr. Nigel Taylor

Nigel A.S. Taylor Centre for Human and Applied Physiology, School of Medicine, University of Wollongong, Australia. There is often a fine line between providing the appropriate level of protection and compromising worker capability. In some occupations and situations, protection must come first. In other circumstances, capability is paramount. In military scenarios, mission objectives can force personal protection to be less than ideal. Indeed, the use of protection that may be deemed appropriate within the civilian context could jeopardise operational success. For operations conducted in the heat that demand load carriage and armoured protection with almost total-body clothing coverage, one often first thinks of the likely thermal impediment to soldier performance. Whilst this is not an inappropriate consideration, it may result in failing to correctly identify the cause of, and therefore the solutions to preventing, physiological collapse. For instance, whilst classical heat illness absolutely occurs at the age extremes, and affects all when air temperatures are exceptionally hot, frank hyperthermia is not generally the primary cause of exhaustion when working in the heat. Indeed, in addition to participating in temperature regulation, during exercise in the heat, the cardiovascular system must also deal with oxygen delivery, waste removal and blood pressure regulation, and so the elevated cardiac output that accompanies all forms of work must now be shared. Accordingly, the case will be developed that thermoregulatory failure is often not the primary causal mechanism for soldier collapse, even though such individuals are certainly hot. Instead, moderately, but not excessively, hyperthermic soldiers working under these conditions are perhaps more likely to collapse from cardiovascular failure: cardiovascular insufficiency that precipitates hypotension. Since it is quite probable that natural selection provided mammals with an hierarchical configuration of physiological regulatory systems, then it is equally probable that more catastrophic system failures might be prevented before less urgent, albeit still potentially lethal, regulatory failures. For instance, in erect individuals, a failure to regulate blood pressure reduces the perfusion of vascular beds above the heart, possibly leading to impaired central nervous system function. However, given that hypotension has less dramatic immediate consequences, and that it generally occurs before hyperthermia, then syncope may act as a fail-safe mechanism in preventing catastrophic outcomes. This state was perhaps first recognised (or hypothesised) to exist by Bass (1963). It was subsequently described as a form of systemic competition by Rowell (1977), and this topic was most recently reviewed by Kenney et al. (2013). In this presentation, research evidence supporting cardiovascular insufficiency will be reviewed.

Human Performance Optimization (HPO) Strategies: Integrating Research, Education, and Clinical Services' Line of Efforts for Soldier Readiness

Speakers: Dr. Patty Deuster and COL Francis O'Connor

Patricia A. Deuster and Francis G. O'Connor, Consortium for Health and Military Performance, Uniformed Services University, Bethesda, MD
The Department of Defense (DoD) faces unprecedented challenges as the Nation confronts balancing a strong military to confront threats with the realities of diminishing financial resources. That each warfighter is a critical resource was underscored the Special Operations principal tenet "humans are more important than hardware." These challenges have popularized the term "Human Performance Optimization" (HPO), which became ingrained in DoD around 2005. The concept of HPO, however, has been appreciated a long time in the American military culture. Civil War physician, Dr. Jonathan Letterman sought to focus all healthcare providers on HPO - the military medical corps leading mission was "to strengthen the hands of the Commanding General by keeping his Army in the most vigorous health, thus rendering it, in the highest degree, efficient for enduring fatigue and privation, and for fighting" - an indirect reference to HPO. We will highlight the challenges confronting the 21st century warfighter and underscore the "gaps" demanding a HPO program. We will define the term and concept of HPO, describe other terms used (e.g., Performance Enhancement; Performance Sustainment, Performance Restoration; and Human Performance Modification), and introduce a model for HPO. Finally, we will familiarize the audience with the Consortium for Health and Military Performance (CHAMP) - the DoD CoE for translational HPO - and it's educational resource, the Human Performance Resource Center (HPRC). CHAMP's key mission - the translation of HPO information - is achieved through four major focus areas: 1) initiating research to fill identified HPO gaps; 2) providing clinical consultations and creating selected clinical guidelines; 3) educating current and future healthcare providers and warfighters; and 4) making policy recommendations for issues relating to HPO. HPRC is CHAMP's online education platform for delivering and disseminating highly relevant and digestible information to military members and other communities who can benefit most. The platform is specifically geared to meet the needs of warfighters by providing evidence-based, written materials with an evolving emphasis on including interactive multimedia. HPRC content is based on the Total Force Fitness paradigm, with information on nutrition, dietary supplements, physical fitness, environmental threats, mind tactics, families and relationships, and integrative health. Other educational approaches include hands-on experiential, didactic and mentoring activities – with medical and graduate students, sports medicine fellows, and other military personnel. Our clinical and research efforts at CHAMP include determining whether warfighters can return to duty following exertional heat stroke and rhabdomyolysis as well as multiple other facets of warrior health – from sickle cell trait and PTSD to how caffeine affects muscle damage, and the healing effects of nature and service dogs. As the DoD Military Health System Center of Excellence for HPO, CHAMP will continue building the evidence base essential for many new emerging practices and technologies to ultimately improve the health and performance of our warfighters and their families.

Physiological Adaptations and Military Applicability to Low-Volume, High-Intensity Interval Training in Health and Disease

Speaker: Dr. Martin Gibala

Martin Gibala, PhD Department of Kinesiology, McMaster University, Hamilton, Ontario, Canada Interval training refers to the basic concept of alternating periods of relatively intense exercise with periods of lower intensity effort or complete rest for recovery. The practice has long been an essential component of programs designed to maximize performance in trained individuals, which typically involve a relatively high volume of submaximal, moderate-intensity continuous training (MICT) (1). While less well appreciated, interval training per se is a potent stimulus to induce physiological remodeling that resembles — or indeed may be superior to — changes typically associated with traditional endurance training (2,3). In an effort to standardize terminology, a classification scheme was recently proposed in which the term "high intensity interval training" (HIIT) be used to describe protocols in which the training stimulus is "near maximal" or the target intensity is between 80-100% of maximal heart rate. In contrast, it was suggested that "sprint interval training" (SIT) be used for protocols that involve "all out" or "supramaximal" efforts, in which target intensities correspond to workloads greater than what is required to elicit 100% of maximal oxygen uptake (VO2max) (3). While there is no universal definition, "low-volume" interval training refers to sessions that involve a relatively small total amount of exercise (i.e., ≤10 min of intense exercise), as compared to MICT protocols that are generally reflected in public health guidelines. Both low-volume SIT and HIIT constitute relatively time-efficient training strategies to rapidly enhance the capacity for aerobic energy metabolism and elicit physiological remodeling that resembles changes normally associated with high-volume MICT (2). The adaptations include an increase in both whole body and skeletal muscle oxidative capacity, as reflected by changes in VO2max, cardiovascular structure and function, mitochondrial enzyme content and substrate metabolism during matched-work exercise. Short-term SIT and HIIT protocols have also been shown to improve health-related indices including cardiorespiratory fitness and markers of glycemic control in both healthy individuals and those at risk for or afflicted by cardiometabolic diseases (2,3,4). Recent evidence from a limited number of studies has highlighted potential sex-based differences in the adaptive response to SIT in particular. Specific nutritional interventions have been shown to influence both acute and chronic adaptations to low-volume interval training. These findings may have implications for performance as well as clinical relevance. (1) Laursen PB. Training for intense exercise performance: high-intensity or high-volume training? Scand J Med Sci Sports. 20 Suppl 2:1-10, 2010. (2) Gibala, MJ, Little JP, MacDonald MJ, Hawley JA. Physiological adaptations to low-volume, high-intensity interval training in health and disease. J Physiol. 590:1077-1084, 2012. (3) Weston KS, Wisløff U, Coombes JS. High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. Br J Sports Med 2013; Oct 21. doi: 10.1136/bjsports-2013-092576. [Epub ahead of print] (4) Gist NH, Fedewa M V, Dishman RK, Cureton KJ. Sprint interval training effects on aerobic capacity: a systematic review and meta-analysis. Sports Med. 44:269-279, 2013.

Concurrent Strength and Aerobic Training Modes for Developing Physical Performance

Speaker: Dr. Keijo Häkkinen

Keijo Häkkinen, Department of Biology of Physical Activity, University of Jyväskylä, Finland Strength training leads to improved strength of trained muscles primarily due to neural adaptations and muscle hypertrophy, while aerobic training enhances endurance performance. It is within scientific and practical interests to study the magnitude and time course of performance adaptations to concurrent strength and aerobic training. Although physiological stimuli directed to the neuromuscular system as a result of strength and aerobic training are divergent in nature, concurrent training may not impair adaptations in strength, muscle activation or hypertrophy induced by strength training over short-term periods or when the volume/frequency of training is low. High volume combined training led to no interference in strength gains during initial weeks of training but a plateau was reached after continued training and finally followed by decreased strength (Hickson 1980). Running seems to interfere more than cycling with strength gains during combined training (Wilson et al. 2012). When the volume of concurrent training was diluted by a longer time period using low frequency training (Häkkinen et al. 2003), concurrent training (2+2/wk) for 21 weeks resulted in large strength gains accompanied with muscle hypertrophy and maximal voluntary activation. However, even this low frequency concurrent training led to interference in explosive strength and rapid voluntary muscle activation. Strength and endurance can be trained on different days or during the same session in two different orders, strength first followed by endurance or vice versa. Training order of combined training had no specific effects on biological adaptations leaving the exercise order up to personal preference (Schumann et al. 2014). However, since in the early phase of training recovery of the group starting with endurance was prolonged, caution should be paid when performing high volume or high frequency training. Neural adaptations may be compromised, if the endurance/strength order is utilized beyond 24 weeks (Eklund et al. 2014). In endurance athletes, both maximal and explosive strength training performed concurrently with endurance training will improve strength, power, and muscle activation. Combined training also prepared for increased endurance training volume and coincided with improvements in measures of aerobic performance including running economy (Taipale et al. 2010). Combined strength and endurance training in endurance athletes and untrained persons usually does not interfere with endurance development. Santtila et al. (2009) showed that in conscripts strength and endurance training combined with an 8-week basic training improved both strength and endurance performance with no increases in explosive strength. Strength training combined with military training may require more periodization or individualization and decreases in the volume of aerobic based military training to minimize interference in strength/power development. REFERENCES Hickson Eur J Appl Physiol 215,255–263, 1980. Häkkinen et al. Eur J Appl Physiol 89, 42-52, 2003. Santtila et al. JSCR 23,1300-8, 2009. Taipale et al. Int J Sports Med, 28, 468-476, 2010. Wilson etal. JSCR 26, 2293-2307, 2012. Schumann et al. Eur J Appl Physiol 114, 867-880, 2014. Eklund et al. Submitted 2014.

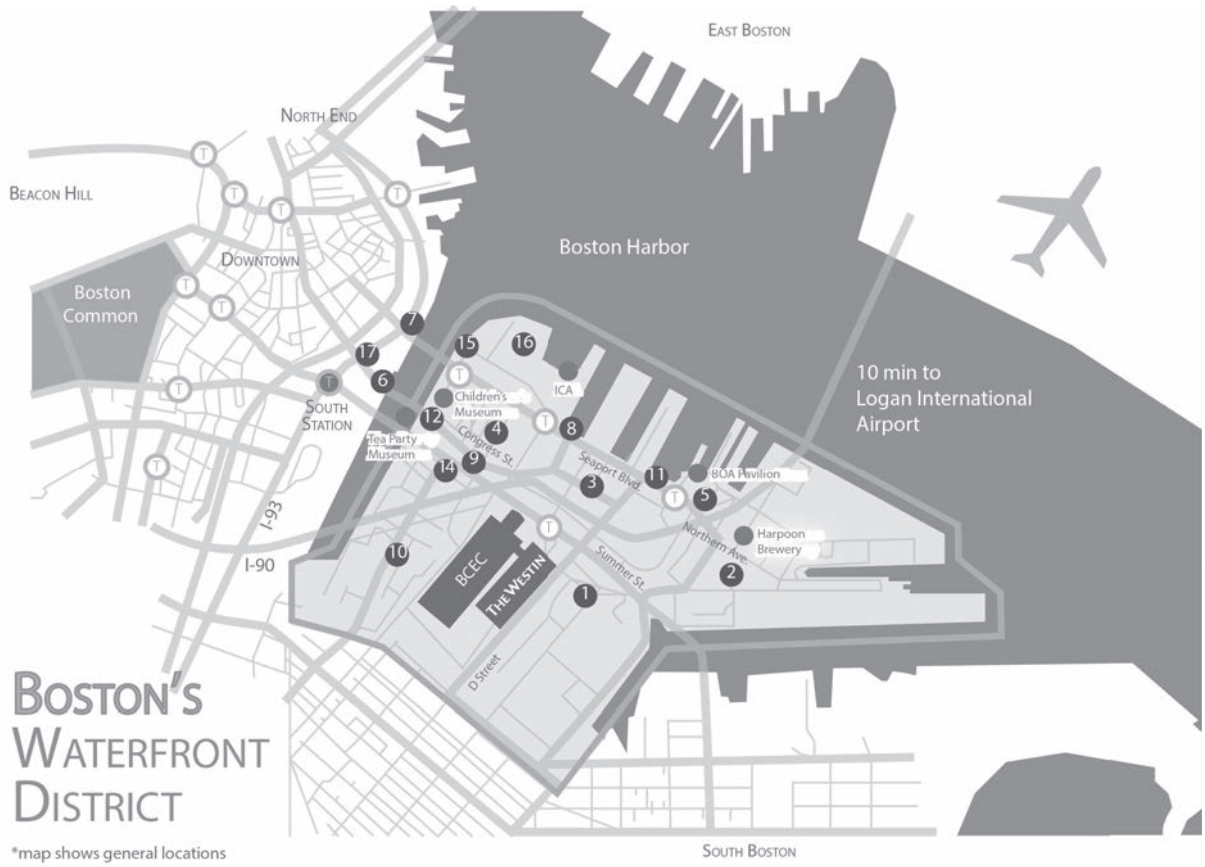
Are There Ethical Limitations for Improving Physical Performance in Soldiers?

Speaker: MG Xavier Bigard

Xavier Bigard (1), Alexandra Malgoyre (2), Nathalie Koulmann (2), Herve Sanchez (2). 1. French Anti Doping Agency, Paris, France 2. French Armed Forces Biomedical Research Institute, Bretigny/Orge, France Like athletes, soldiers improve their individual performance by specific, mixed and progressive physical and technical training. The technical efficiency of soldiers results from several factors, including the individual responsiveness to training, the nature of both physical and mental training, and then depends on the individual talent and quality of training. However, whatever the sport activity, or even simply living longer, the desire to improve performance is deeply rooted in human nature. Drugs have been used from pre-Christian times and even in mythology, and recent revelations about the development of THG, the use of AICAR and other designer drugs in laboratories support the fact that researches to improve human performances are burning issues. Doping uses therapeutic advances in exercise physiology and clinical pharmacology to provide unfair advantages to athletes. While training, practicing and studying are all successful and ethically acceptable strategies to improve performance, the use of performance-enhancing drugs (PED) is at risk of adverse health consequences. Cases abound of athletes using performance-enhancers, support why it is very important to be clear about the ethical foundations of sport and the arguments for and against the use of performance enhancing technologies. These issues emerging from the sport community also rise several issues in Army. First of all, drug are considered as prohibited substances in sport if they meet any of two of the following three criteria, 1) they enhance performance, 2) are dangerous to the athlete's health, 3) are contrary to the spirit of sport. Clearly this definition of prohibited substances for athletes cannot be transposed for soldiers. Many soldiers probably covertly use drugs that enhance performance, without medical or biological control. In parallel with these individual initiatives, the issue emerges from the collective recommendation of the use of PED. Advocates of doping in sport claim that the consequences of drug taking are less serious than the irreversible and sometimes even mortal injuries caused by the practice of sport itself. Such question, which is of great interest for soldiers, remains a matter of debate and has been revisited regarding the development of asymmetric warfare, a conflict in which the resources of two belligerents differ in essence and that involves strategies and tactics of unconventional warfare. The key issues concern the limits that we accept to train Human in the context of modern and asymmetric warfare. The ethical dimension of improving performance in soldiers mainly involve two major points, the need to prevent adverse health effects and/or injuries, and the informed consent. From the medical point of view, prescribing potentially harmful drugs for nontherapeutic uses is contrary to all standards of medical practice and this is a non-negotiable requirement.

AUTHOR INDEX

BOSTON'S WATERFRONT DISTRICT MAP



Cafe/Grab & Go

1	Fargo's Deli Of Course, 451 D St. 617.261.1664	(.1 miles)
3	Sebastian's, 157 Seaport Blvd. 617.624.7990	(.3 miles)
11	J Pace & Sons, 225 Northern Ave. 857.366.4640	(.4 miles)
4	Flour Bakery, 12 Farnsworth St. 617.338.4333	(.5 miles)
5	Yankee Lobster, 300 Northern Ave. 617.345.9799	(.5 miles)
6	Boloco, 290 Congress St. 857.284.7488	(.7 miles)
6	Sorelle, 282 Congress St. 617.426.5475	(.8 miles)
7	James Hook Lobster, 15 Seaport Blvd. 617.423.5500	(.9 miles)

Lounge/Tavern

8	Atlantic Beer Garden, 146 Seaport Blvd. 617.357.8000	(.4 miles)
8	Whiskey Priest, 150 Seaport Blvd. 617.426.8111	(.4 miles)
9	Drink, 348 Congress St. 617.695.1806	(.5 miles)
9	Lucky's Lounge, 355 Congress St. 617.357.5825	(.5 miles)
10	Barlows Restaurant, 241 A St. 617.338.2142	(.6 miles)

Casual Dining

16	Gather, 75 Northern Ave. 617.982.7230	(.3 miles)
11	Jerry Remy's, 250 Northern Ave. 617.856.7369	(.3 miles)
11	LTK, 225 Northern Ave. 617.330.7430	(.3 miles)
11	Salvatore's, 225 Northern Ave. 617.737.5454	(.3 miles)
11	No Name Restaurant, 15 Fish Pier 617.423.2705	(.4 miles)
14	Papagayo, 283 Summer St. 617.423.1000	(.4 miles)
12	Tavern Road, 343 Congress St. 617.790.0808	(.5 miles)
9	Sportello, 348 Congress St. 617.737.1234	(.6 miles)
15	The Barking Crab, 88 Sleeper St. 617.426.2722	(.8 miles)
9	Row 34, 383 Congress St. 617.553.5900	(.6 miles)

Restaurants

11	75 on Liberty Wharf, 220 Northern Ave. 617.227.0754	(.3 miles)
11	Del Frisco's Steakhouse, 250 Northern Ave. 617.951.1368	(.3 miles)
11	Legal Harborside, 270 NorthrnAve. 617.477.2900	(.3 miles)
11	Morton's Steakhouse, 2 Seaport Lane 617.526.0410	(.3 miles)
8	Rosa Mexicano, 155 Seaport Blvd. 617.476.6122	(.3 miles)
11	Temazcal Cantina, 250 Northern Ave. 617.439.3502	(.3 miles)
14	Blue Dragon, 324 A St. 617.338.8585	(.5 miles)
9	Menton, 354 Congress St. 617.737.0099	(.5 miles)
16	Sam's, 60 Northern Ave. 617.295.0191	(.6 miles)
16	Strega, 1 Marina Park Dr. 617.345.3992	(.6 miles)
16	Empire, 1 Marina Park Dr. 617.295.0001	(.6 miles)
6	Smith & Wollensky, 290 Congress St. 617.778.2200	(.8 miles)
17	Trade, 540 Atlantic Ave. 617.451.1234	(.8 miles)
17	Nebo, 520 Atlantic Ave. 617.723.6326	(.8 miles)

Local Attractions

Blue Hills Bank Pavilion, 290 Northern Ave. 617.728.1600	(.4 miles)
Spirit of Boston, 200 Seaport Blvd. 866.310.2469	(.4 miles)
Bee's Knees Supply Co. 12 Farnsworth St. 617.292.2337	(.5 miles)
Boston Fire Museum, 344 Congress St. 617.338.9700	(.5 miles)
Boston Harbor Walk	(.5 miles)
ICA, 100 Northern Ave. 617.426.6500	(.5 miles)
Tea Party Museum, Congress St. Bridge 617.592.0422	(.6 miles)
Children's Museum, 308 Congress St. 617.426.6500	(.6 miles)
Harpoon Brewery, 306 Northern Ave. 617.574.9551	(.6 miles)
New England Aquarium, 1 Central Wharf 617.973.5200	(1.2 miles)
Faneuil Hall Marketplace 617.523.1300	(1.3 miles)
North End - Little Italy	(1.6 miles)
JFK Library, 220 Morrissey Blvd. 617.514.1600	(3.2 miles)

THE WESTIN
BOSTON WATERFRONT
425 Summer Street | Boston, MA 02210
P: 617.532.4600 | westinbostonwaterfront.com

WESTIN BOSTON WATERFRONT FLOOR PLAN