

From the Institute of Movement and Neuroscience

German Sport University Cologne

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**Selected Aspects of Physical and Psychosocial Health in the Context of  
Childhood Obesity and Weight Management Programs**

Doctoral thesis accepted for the degree

Doktorin der Sportwissenschaft

by

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from

Marburg

Cologne (2023)

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Thesis defended on: 29.06.2023

## **Affidavits**

Affidavits following §7 section 2 No. 4 and 5 of the doctoral regulations from the German Sport University Cologne, February 20<sup>th</sup> 2013:

Hereby I declare:

The work presented in this thesis is the original work of the author except where acknowledged in the text. This material has not been submitted either in whole or in part for a degree at this or any other institution. Those parts or single sentences, which have been taken verbatim from other sources, are identified as citations.

I further declare that I complied with the actual “guidelines of qualified scientific work” of the German Sport University Cologne.

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Date, Signature

## Acknowledgements

This dissertation would not have been possible without the support and work of many helping hands. For this I would like to express my deep gratitude.

First of all, I would like to thank my supervisor Prof. Dr. Dr. Christine Joisten. Christine, I can't tell you enough how much I have learned through you during my PhD and how enriching this experience has been for my personal and professional growth. I am so grateful to you for so easily accepting me into your team, for challenging me and that you have again and again taken the time and effort to engage with me and my papers, shaping them so substantially with your comments and ideas.

I would also like to thank Prof. Dr. Klara Brixius as second supervisor for accepting this work and taking the time to review it. I also wish to thank you for accepting me into the TEAMWORK<sup>Science</sup> Mentoring Program for young female sport scientists. The 16-months program was truly empowering and gave me the feeling (even during the hard pandemic lockdown) that I was not alone with my struggles.

Next, I would like to thank the CHILT III team and all participating families; with your diligence and dedication you have really made this dissertation possible. Special thanks to Fabi, Marlen, David, Steffi, Lisa & Martin for your unwavering support - and again, thank you, Christine, that I could be part of such a vibrant, kind, and multifaceted team that you have assembled and for allowing me to work with this valuable data.

I would also like to thank my mentor Prof. Dr. Sebastian Vollmer. You always showed me trust and appreciation and have been significant in supporting my career in fields that I am so passionate about.

No one has supported me on my journey and in my development the way my mother, Dr. Marianne Eisenburger, has. Dear Mama, I am so grateful that you accompanied me in every up and down, with advice, an always open ear, empathy, admiration, and patience. And even though it's a different path in many ways, I'm so happy and touched that I can –at least a little– follow in your footsteps. Thanks also to my father Rolf, my brother Max, and my boyfriend Flo. I know that each of you always did your best to understand what I was going through and working on, and I knew that I could always count on you and your support –each in your own way. Now, I am so looking forward to spending more free time together that lies hopefully ahead of us.

Each of you has been a role model for me and has shaped not only this work but also me as a person over the past years. Thank you.

# Content

<b>I. List of Figures and Tables .....</b>	<b>7</b>
<b>II. List of Abbreviations .....</b>	<b>8</b>
<b>III. Summary .....</b>	<b>9</b>
<b>IV. Zusammenfassung.....</b>	<b>11</b>
<b>V. List of Publications .....</b>	<b>13</b>
<b>1. Introduction .....</b>	<b>14</b>
<b>2. Childhood Obesity .....</b>	<b>18</b>
<b>2.1 Consequences of Childhood Obesity.....</b>	<b>21</b>
<b>2.2 Causes and Determinants of Childhood Obesity .....</b>	<b>24</b>
<b>2.2.1 Selected obesity-relevant Factors influencing Children's Health and Weight Development .....</b>	<b>26</b>
2.2.1.1 Eating habits and Diet .....	27
2.2.1.2 Physical Activity.....	28
2.2.1.3 Physical Fitness .....	29
2.2.1.4 Sedentary Behavior and Media consumption.....	31
2.2.1.5 Familial and Demographic Factors .....	32
<b>2.3 The COVID-19 Pandemic and Childhood Obesity .....</b>	<b>35</b>
<b>2.4 Multidisciplinary Weight Management .....</b>	<b>39</b>
<b>2.4.1 General Program Design .....</b>	<b>39</b>
<b>2.4.2 Program Effectiveness .....</b>	<b>41</b>
<b>2.4.3 Predictors of Weight Loss and Program Success .....</b>	<b>44</b>
2.4.3.1 Characteristics of implementation.....	44
2.4.3.2 Family Characteristics .....	46
2.4.3.3 Child Characteristics.....	48
<b>3. Research Gap and Research Objectives .....</b>	<b>51</b>

<b>4. The CHILT III Program .....</b>	<b>54</b>
<b>4.1 General Framework.....</b>	<b>54</b>
<b>4.1.1 Program Objectives and Structure .....</b>	<b>55</b>
<b>4.1.2 Program Contents .....</b>	<b>58</b>
<b>4.2 Scientific monitoring.....</b>	<b>61</b>
<b>4.2.1 Data Assessment Relevant to this Dissertation .....</b>	<b>62</b>
4.2.1.1 Anthropometric Data.....	62
4.2.1.2 Demographics and Lifestyle Determinants .....	63
4.2.1.3 Physical Fitness .....	64
4.2.1.4 Health-Related Quality of Life.....	65
4.2.1.5 Self-Concept.....	65
<b>5. Publications.....</b>	<b>67</b>
<b>5.1 Study I .....</b>	<b>67</b>
<b>5.2 Study II .....</b>	<b>71</b>
<b>5.3 Study III .....</b>	<b>75</b>
<b>5.4 Study IV .....</b>	<b>79</b>
<b>6. Summarized Discussion .....</b>	<b>82</b>
<b>6.1 Methodological limitations .....</b>	<b>82</b>
<b>6.1.1 Study I, II, IV.....</b>	<b>82</b>
6.1.1.1 CHILT III Database.....	82
6.1.1.2 Anthropometric Measurements.....	84
6.1.1.3 Bicycle Ergometry .....	85
6.1.1.4 Questionnaires to assess Lifestyle Patterns and Demographics.....	86
6.1.1.5 GW-LQ-KJ.....	88
6.1.1.6 FSK-K.....	89
<b>6.1.2 Study III .....</b>	<b>90</b>
<b>6.2 Main Findings, Implications and Discussion .....</b>	<b>92</b>

6.2.1.1	The Underappreciated Role of Physical Fitness .....	92
6.2.1.2	Lessons learned from the COVID-19 Pandemic .....	95
6.2.1.3	Outlook.....	98
<b>7.</b>	<b>Conclusion.....</b>	<b>100</b>
<b>8.</b>	<b>References.....</b>	<b>102</b>
<b>9.</b>	<b>Appendix.....</b>	<b>132</b>
9.1	Original CHILT III Questionnaire (German) .....	132
9.2	Original GW-LW-KJ, Version B (German).....	149
9.3	Original FSK-K (German).....	150

## **I. List of Figures and Tables**

### *Figures*

Figure 1: Body mass index percentiles for boys aged 0-18 years (Kromeyer-Hauschild et al., 2001).....	19
Figure 2: Body mass index percentiles for girls aged 0-18 years (Kromeyer-Hauschild et al., 2001).....	19
Figure 3: Determinants of Child Health and Child Weight Status based on Davison and Birch (2001) .....	25
Figure 4: Emotional Eating and Reinforcement Learning Process. Modified from Warschburger (2011).....	27
Figure 5: Pillars of CHILT III .....	56

### *Tables*

Table 1: Exemplary CHILT III Schedule .....	57
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## II. List of Abbreviations

AGA	Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter (Working Group on Childhood and Adolescent Obesity)
Approx.	Approximately
BMI	Body mass index
BMI SDS	Body mass index standard deviation score
ca.	circa
CHILT	Children's health interventional trial
COVID-19	coronavirus disease 2019
cm	centimeter
e.g.	exempli gratia (for example)
ECG	Electrocardiogram
et al.	et altera (and others)
Fig.	Figure
HRQOL	Health-related quality of life
i.e.	id est (that is to say)
KiGGS	Kinder- und Jugendgesundheitssurvey (child and adolescent health survey)
kg	Kilogram
m	Meter
mm	Millimeter
n	sample size
p	Probability of error/ significance
SPPC	Self-perception profile for children
WHO	World Health Organization

### **III. Summary**

Childhood obesity is a recognized global public health problem that is associated with several physical and psychosocial health concerns. Among the most effective strategies for tackling childhood obesity are multidisciplinary weight management programs that address the multifactorial nature of the problem by building on multiple components. Nonetheless, managing childhood obesity remains a challenge, as evidenced by the fact that weight regain often occurs after program completion.

Given the persistently high rates of childhood obesity, the difficulties in achieving long-term success after weight management program participation, the complex cause-and-effect relationship underlying the development of obesity, including current challenges posed by the coronavirus pandemic (COVID-19), this cumulative dissertation aims to draw implications for optimizing existing programs and the sustainability of their health outcomes.

For this rationale, the four articles relevant to this cumulative dissertation analyzed the adaptations of German weight management programs during the COVID-19 pandemic and the determinants of psychosocial health and long-term BMI-SDS reduction in the context of childhood obesity, while also considering the potential relevance of physical fitness. Studies 1, 2, and 4 focused on statistical analysis of data from a German multidisciplinary weight management program called Children's Health Interventional Trial (CHILT) III. Study 3 examined data from 14 different weight management programs in Germany.

The key findings of studies 1 and 2 included the emphasis on the significant role of physical fitness in the context of childhood obesity. Physical fitness was cross-sectionally positively associated with self-concept and health-related quality of life in children with obesity (study 1) and longitudinally with reductions in adjusted BMI-SDS

from pre- to post-intervention and even one year later (study 2). At the same time, psychosocial health was also identified as a determinant for long-term BMI-SDS reduction in study 2. Physical fitness should therefore be recognized to a much greater extent as a direct target for intervention because it is important not only in itself but also to promote psychosocial health and (thus) to contribute to reducing BMI-SDS in the short and longer term.

In addition, this work showed in study 3 that German weight management programs quickly adapted to the pandemic situation, to the satisfaction of participating families, and that these adaptations did not harm CHILT III program success in terms of BMI-SDS reductions, fitness, and self-concept improvements (study 4). Accordingly, a combined approach to weight management that encompasses both traditional face-to-face components and newly developed digital units is effective and could be more widely used in the future. However, both the benefits of digitization strategies (e.g., customization, accessibility, flexibility) but also potential risks (role of digital media on physical activity and psychosocial health) should be considered.

#### **IV. Zusammenfassung**

Adipositas im Kindesalter ist ein weltweit anerkanntes Gesundheitsproblem, das mit diversen körperlichen und psychosozialen gesundheitlichen Beeinträchtigungen verbunden ist. Zu den wirksamsten Strategien zur Bekämpfung von Adipositas gehören multidisziplinäre Gewichtsmanagementprogramme, die auf mehreren Komponenten aufbauen und so die multifaktorielle Natur des Problems berücksichtigen. Dennoch bleibt der Kampf gegen Adipositas bei Kindern eine Herausforderung, was sich auch daran zeigt, dass es nach Programmabschluss häufig zu erneuter Gewichtszunahme kommt.

Angesichts der anhaltend hohen Adipositasraten bei Kindern, der Schwierigkeiten bei der Erzielung langfristiger Erfolge von Gewichtsmanagementprogrammen, des komplexen Ursache-Wirkungs-Gefüges, das der Entstehung von Adipositas zugrunde liegt, einschließlich aktueller Herausforderungen durch die Coronavirus-Pandemie (COVID-19), zielt diese kumulative Dissertation darauf ab, Implikationen für die Optimierung bestehender Programme und die Nachhaltigkeit ihrer Gesundheitsergebnisse aufzuzeigen.

Vor diesem Hintergrund analysierten die vier dissertationsrelevanten Artikel die Anpassungen von Gewichtsmanagementprogrammen während der COVID-19-Pandemie sowie die Determinanten der psychosozialen Gesundheit und der langfristigen BMI-SDS-Reduktion im Kontext der kindlichen Adipositas, wobei auch die potenzielle Bedeutung der körperlichen Fitness berücksichtigt wurde. Die Studien 1, 2 und 4 konzentrierten sich dabei auf die statistische Analyse von Daten aus einem Kölner multidisziplinären Gewichtsmanagementprogramm namens Children's Health Interventional Trial (CHILT) III. In Studie 3 wurden Daten aus 14 verschiedenen Programmen in Deutschland untersucht.

Zu den wichtigsten Ergebnissen der Studien 1 und 2 gehörte die Herausstellung der entscheidenden Rolle der körperlichen Fitness im Kontext der Adipositas bei Kindern. In einer Querschnittsstudie war die körperliche Fitness positiv mit dem Selbstkonzept und der gesundheitsbezogenen Lebensqualität von Kindern mit Adipositas verbunden (Studie 1), im Längsschnitt mit einer Verringerung des adjustierten BMI-SDS von vor bis nach der Intervention und sogar auch noch ein Jahr später (Studie 2). Gleichzeitig wurde außerdem die psychosoziale Gesundheit als Determinante für eine langfristige BMI-SDS-Reduktion ermittelt. Die körperliche Fitness sollte daher in noch viel stärkerem Maße als direktes Interventionsziel anerkannt werden, da sie nicht nur in sich, sondern auch zur Förderung der psychosozialen Gesundheit und (somit) zur kurz- und längerfristigen Senkung des BMI-SDS wichtig ist.

Darüber hinaus zeigte diese Arbeit in Studie 3, dass sich deutsche Gewichtsmanagementprogramme zur Zufriedenheit der teilnehmenden Familien schnell an die Pandemie-Situation anpassten und dass diese Anpassungen den Erfolg des CHILT III Programms nicht beeinträchtigten (Studie 4). Dementsprechend ist ein kombinierter Ansatz für das Gewichtsmanagement, der sowohl traditionelle Face-to-Face-Komponenten als auch neu entwickelte digitale Einheiten umfasst, wirksam und könnte in Zukunft breiter eingesetzt werden. Allerdings sollten sowohl die Vorteile von Digitalisierungsstrategien (z. B. Personalisierung, Zugänglichkeit, Flexibilität) als auch potenzielle Risiken (Rolle digitaler Medien für körperliche Aktivität und psychosoziale Gesundheit) berücksichtigt werden.

## V. List of Publications

This cumulative dissertation consists of four scientific publications, each of which has been peer-reviewed by the indicated journals.

Eisenburger, N., Friesen, D., Haas, F., Klaudius, M., Schmidt, L., Vandeven, S., & Joisten, C. (2021). Predicting Psychosocial Health of Children and Adolescents with Obesity in Germany: The Underappreciated Role of Physical Fitness. *International Journal of Environmental Research and Public Health*, 18(21), 11188. MDPI AG. <http://dx.doi.org/10.3390/ijerph182111188>

Eisenburger, N., Ferrari, N., Friesen, D., Haas, F., Klaudius, M., Schmidt, L., Vandeven, S., & Joisten, C. (2023). Cardiovascular endurance and psychosocial health predict short- and long-term BMI-SDS reduction: Results from the CHILT III program. *European Journal of Pediatrics*. <https://doi.org/10.1007/s00431-023-04876-7>

Eisenburger, N., Schmidt, N., Ortmann, S., Friesen, D., Haas, F., Wessely, S., & Joisten, C. (2021). Gewichtsmanagementprogramme für Kinder und Jugendliche während der Covid-19-Pandemie in Deutschland – Was wir daraus lernen können. *Adipositas - Ursachen, Folgeerkrankungen, Therapie*, 15(04), 212–219. <https://doi.org/10.1055/a-1638-6128>

Eisenburger, N., Friesen, D., Haas, F., Klaudius, M., Schmidt, L., Vandeven, S., & Joisten, C. (2022). Short report: Weight management of children and adolescents with obesity during the COVID-19 pandemic in Germany. *PloS One*, 17(4), e0267601. <https://doi.org/10.1371/journal.pone.0267601>

# 1. Introduction

The worldwide high prevalence of overweight and obesity in children and adolescents remains an alarming global health problem (Di Cesare et al., 2019; Garrido-Miguel et al., 2019). While the rise in obesity in Germany appeared to have stabilized prior to the 2019 coronavirus (COVID-19) pandemic outbreak (Abarca-Gómez et al., 2017; Robert Koch-Institut, 2018), first scientific results indicate that childhood and adolescent obesity will increase again as a result of the restrictive pandemic measures which have contributed to obesogenic environments, including high levels of physical inactivity, unhealthy eating behaviors, stress, and anxiety (Pietrobelli et al., 2020; Vogel et al., 2021; Weihrauch Blueher et al., 2023).

Obesity in children and adolescents is of particular concern because it is associated with several negative physical and psychosocial comorbidities, which are likely to persist into adulthood, imposing a corresponding burden on both the individual and the health care system (Di Cesare et al., 2019). Accompanying physical symptoms may include hypertension, elevated blood lipids, premature osteoarthritis, cardiovascular disease, or the presence of insulin resistance (among many others; E. P. Williams et al., 2015). Anxiety, low self-esteem, a poor self-concept, social exclusion, and discrimination can be among the psychosocial impairments associated with obesity (Schvey et al., 2019; Warschburger, 2011), all of which can lead to a decreased health-related quality of life (HRQOL; Buttitta et al., 2014).

To address the complexity of childhood and adolescent obesity with its multiple physical and psychosocial consequences, multidisciplinary treatment approaches are currently considered the most effective strategy, as they include medical, psychological and nutritional counseling, exercise sessions, as well as the surrounding environment, i.e. parents/family and peers, in behavior modification training (Gow et al., 2020;

Vermeiren et al., 2021). However, they too have been affected by the constraints of the COVID-19 pandemic and treatment centers had to be closed or adapted in times of social distancing and strict hygiene regulations, posing challenges for both the organizers and the participants (O'Hara et al., 2020).

The current high rates and trends of childhood obesity, the associated health burden, and the pandemic-related societal and public health challenges clearly demonstrate the need for continued evolution and adaptation of weight management programs based on the latest research to ensure continued, effective care for affected children and adolescents and their families (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019; Dicker et al., 2020). Especially with regard to the long-term success of treatment – which aims beyond short-term weight loss towards sustained maintenance of weight control, healthy lifestyle changes, and an improvement in the overall HRQOL of children and adolescents with obesity – consistent research is crucial to help tailor weight management programs accordingly (Buscemi et al., 2013; Wing & Hill, 2001).

While the root of childhood obesity can be traced to an energy imbalance, the causes of childhood obesity and weight development are much more complex (S. C. Schmidt et al., 2015). Various factors, ranging from genetics to household income or national policies, may affect a child's health on multiple levels, complicating obesity management and treatment (Harrison et al., 2011). For example, the physical and psychosocial stress associated with obesity can lead to a never-ending cycle of weight gain as the child's suffering prevents participation in physical activities or leads to comfort eating (Buttitta et al., 2017; Warschburger, 2011). Pandemic-related restrictions may have exacerbated this vicious cycle (Dicker et al., 2020; Weihrauch Blueher et al., 2023).

From a different perspective, however, there is also evidence that improvements in physical risk factors and psychosocial health are positively associated with weight loss and control (Lowry et al., 2007; Murray et al., 2017) – even in the long-term (Buscemi et al., 2013; Moens et al., 2010). Thus, a deeper understanding of these underlying interrelationships and the holistic nature of the problem might help to derive important insights for managing childhood obesity. Analyzing relevant components of health related to obesity may help to better explain not only why some children/adolescents are more vulnerable to weight gain but also why some are more successful at losing weight or controlling their weight and weight-related behaviors than others. Identifying effective health determinants, program components and adjustments may contribute to optimizing existing programs accordingly.

As a response to this ongoing need, this dissertation places particular emphasis on the role of selected aspects of physical and psychosocial health in the context of childhood obesity. It is centered primarily on the analysis of a juvenile multidisciplinary weight management program, the **Children's Health Interventional Trial (CHILT) III** in Cologne, Germany. The objective of this work is to contribute to the development of improved care for affected children and adolescents in terms of holistic and lasting positive health outcomes.

This cumulative dissertation is structured as follows: Chapter 2 provides a broad overview of the current state of research and scientific evidence from numerous studies on selected topics related to childhood obesity; First, the problem and concepts of childhood and adolescent obesity are briefly introduced. Then, the consequences of childhood obesity, causes and factors that may positively or negatively affect the physical and psychosocial health of children with obesity are presented in more detail. The role of the COVID-19 pandemic for children with obesity is the focus of the

subsequent Chapter. Multidisciplinary approaches to weight management are then discussed, including the determinants of successful long-term weight loss. This theoretical framework leads to the presentation of the research gap and research objectives in the next step in [Chapter 3](#). [Chapter 4](#) is dedicated to the research project on which this thesis is mainly based; the CHILT III program. This methodology Chapter presents the juvenile weight management program, and the data collection processes relevant to this dissertation in detail. [Chapters 5](#) contains summaries of the four thesis-relevant publications. In the discussion in [Chapter 6](#), the methodological limitations and the main findings of the publications are summarized, and implications for future research and development of weight management programs for children and adolescents with obesity are derived. The dissertation ends with an overall conclusion in [Chapter 7](#).

## 2. Childhood Obesity<sup>1</sup>

The World Health Organization (WHO) defines obesity as abnormal or excessive fat accumulation that presents a risk to health and recognizes it as a disease (WHO, 2000). There are different methods to diagnose and quantify obesity. In adults, the body mass index ( $BMI = \text{body weight} / \text{height}^2 \text{ [kg/m}^2\text{]}$ ) is used as a standard for determining overweight and obesity (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019; Cole et al., 2005), with overweight being a BMI greater than or equal to 25; and obesity a BMI greater than or equal to 30 (WHO, 2000). Since the BMI in childhood and adolescence is influenced by age- and sex-specific characteristics in accordance with physiological changes in percent body fat mass, BMI percentiles are commonly used to define overweight and obesity in childhood and adolescence. The percentiles are calculated using the LMS method (Cole et al., 1998) to assess the Standard Deviation Scores (SDS):

$$BMI\text{-}SDS = (BMI / M(t)) L(t)^{-1} / (L(t) \times S(t)).$$

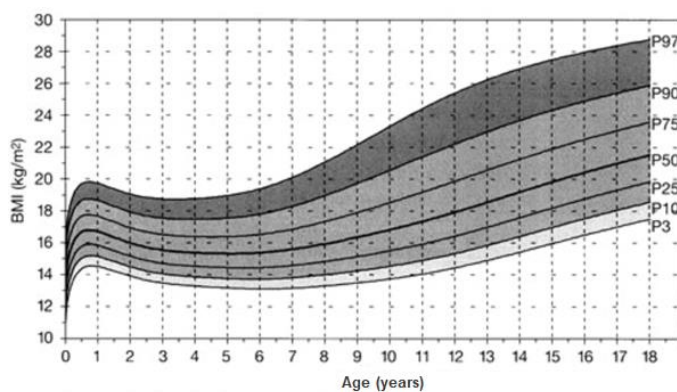
$M(t)$ ,  $L(t)$ , and  $S(t)$  are the corresponding parameters for the child's age ( $t$ ) and sex ( $L$  = Box-Cox power transformation;  $M$  = median;  $S$  = coefficient of variation). The BMI-SDS values (or BMI Z-scores) indicate by how much one standard deviation of the individual BMI is above or below the median for a given age and sex, allowing for more accurate differentiation and the comparison of an individual value with the data of a reference group.

In Germany, the values developed by the *Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter* (AGA, Working Group on Childhood and Adolescent Obesity) are used to define overweight and obesity in children and adolescents

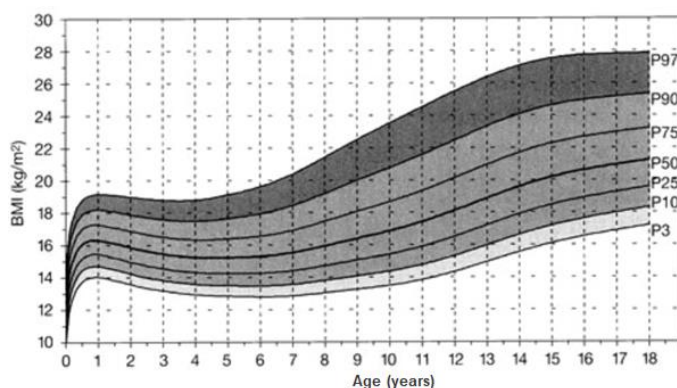
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<sup>1</sup> Used as an umbrella term for obesity in childhood and adolescence

(Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019; Kromeyer-Hauschild et al., 2001). They are based on pooled data of 17147 boys and 17275 girls aged 0-18 years from 17 studies conducted between 1985 and 1999 in different regions of Germany (Kromeyer-Hauschild et al., 2001) and define overweight as a BMI value above the 90th percentile (ca. one standard deviation), and obesity as a BMI value above the 97th percentile (ca. two standard deviations; Fig. 1 & 2). This definition allows an almost continuous transition to the above-mentioned fixed BMI threshold values in adulthood.



*Figure 1: Body mass index percentiles for boys aged 0-18 years (Kromeyer-Hauschild et al., 2001)*



*Figure 2: Body mass index percentiles for girls aged 0-18 years (Kromeyer-Hauschild et al., 2001)*

On a global level, changing lifestyles, such as a decline in physical activity and an increase in the consumption of high caloric foods and drinks, sedentary behaviors and media use such as television, computers, game consoles and cell phones in the last decades (Manz et al., 2014), are seen as reasons for rising obesity rates (Ang et al., 2013; Di Cesare et al., 2019). In Germany, according to data from 2014 - 2017 of the Children and Adolescents Health Survey (KiGGS) of the Robert Koch Institute, 26.3% of 5- to 17-year-olds were affected by overweight (including obesity) and 8.8% by obesity (based on the international WHO reference system; Robert Koch-Institut, 2018). At ages 3 to 17, the prevalence of overweight (including obesity) was 19.3%, with the obesity prevalence being 4.7%. In addition, KiGGS results show that rates of obesity were twice as high among respondents with high media use (>3h/day) compared to respondents with low media use (<1h/day) (Lampert et al., 2007; Manz et al., 2014).

Although recent studies show that obesity growth rates have reached a plateau (Robert Koch-Institut, 2018), the continuing severity of this complex health problem should not be underestimated. On the one hand, prevalence rates remain very high and are projected to increase as a consequence of the 2019 coronavirus disease (COVID-19) and resulting national restrictive health measures and lifestyle changes (see Chapter 2.3.; Pellegrini et al., 2020; Pietrobelli et al., 2020). On the other hand, there has been no stagnation among vulnerable groups such as children from socially deprived and/or educationally disadvantaged families and children with a migration background (Nobari et al., 2018; Vrijkotte et al., 2020). Childhood and adolescent obesity with its multiple causes and consequences therefore remains a serious global public health concern.

## **2.1 Consequences of Childhood Obesity**

In particular, high overweight and obesity rates among children and adolescents are alarming because they are associated with several negative physical and psychosocial comorbidities many of which are likely to track into adulthood (Di Cesare et al., 2019; Kelsey et al., 2014). In a longitudinal analysis of 2392 participants, for example, 65% of children who were overweight grew into adults with obesity (Freedman et al., 2007). Several studies have shown significant associations between adolescent obesity and the development of metabolic syndrome, cardiovascular morbidity, increased risk of cancer and mortality in adulthood (Reilly et al., 2003; E. P. Williams et al., 2015).

Obesity increases the risk of developing a variety of debilitating and chronic medical conditions already in childhood and adolescence. A review on health consequences of childhood obesity showed that 34 studies consistently reported associations between obesity and major cardiovascular risk factors such as high blood pressure, raised cholesterol and dyslipidemia, abnormalities in left ventricular mass or function and abnormalities in endothelial function, impaired glucose tolerance as a result of insulin resistance (Reilly et al., 2003). Serious medical conditions associated with childhood obesity include the risk of developing type 2 diabetes mellitus, hepatic and gastric complications, orthopedic impairments, asthma and sleep apnea (WHO, 2000). The link between childhood and adult obesity and debilitating health problems such as premature osteoarthritis, respiratory problems, chronic musculoskeletal problems, skin problems, and infertility is widely recognized (Kelsey et al., 2014; WHO, 2000).

In addition to poor physical health, obesity in childhood and adolescence is associated to psychosocial impairments. Psychosocial health can be defined as a multidimensional construct consisting of psychological, social, mental, emotional,

cultural, and spiritual components that influence the realization of an individual's full potential as a productive member of society (C. Kumar, 2020).

Affected children and adolescents may experience stigmatization, social exclusion, weight based teasing, bullying, peer rejection, or discrimination (Rankin et al., 2016; Sagar & Gupta, 2018; Schvey et al., 2019). In this context, it is relevant for the development of the child's psychosocial self-image that not only peers, but also adult caregivers (parents, teachers) or even strangers make negative comments about the weight status (Helfert & Warschburger, 2013; Warschburger & Kröller, 2005). Overweight and obesity are commonly negatively stereotyped, and often associated in society with various negative characteristics, such as being “undisciplined”, “unmotivated”, “lazy”, “incompetent”, “ugly”, or “unattractive” (Gmeiner & Warschburger, 2021; Tomiyama, 2014). Children as young as preschool age evaluated overweight silhouettes as negative and described individuals with overweight as “uncontrolled”, “unpopular”, or “stupid” (Warschburger, 2011).

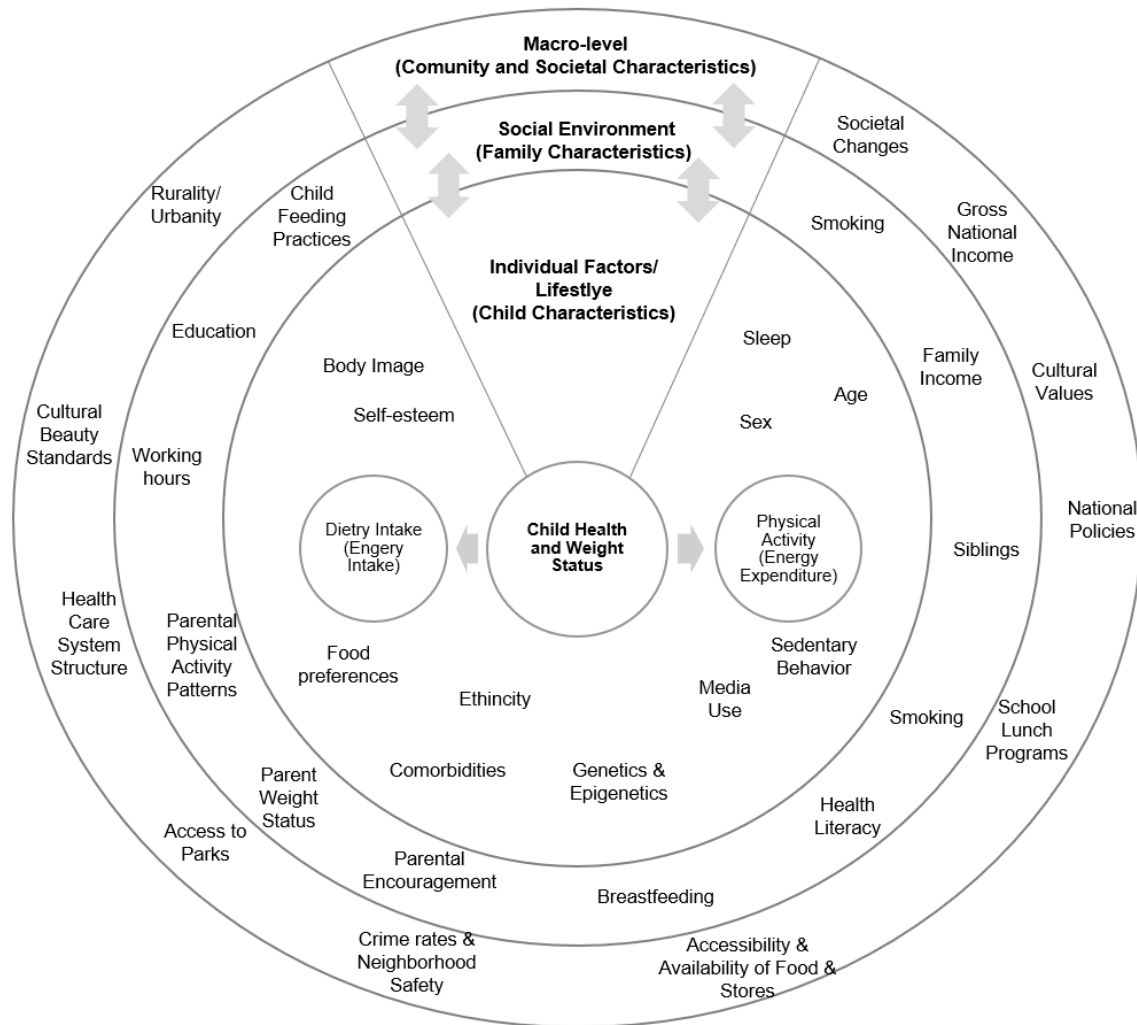
Correspondingly, childhood obesity has also been found to be negatively related to the personal self-concept and HRQOL, both of which represent multidimensional constructs aggregating different dimensions of self-perceived physical, psychosocial, and emotional health. A popular study by Schwimmer et al. (2003), for example, has shown that adolescents with severe obesity seeking weight-related treatment obtained HRQOL scores similar to those of children with cancer undergoing chemotherapy. Particularly with regard to physical performance, the assessment of their own physical attractiveness (Grünberg et al., 2023) as well as social integration and competence, children with overweight show lower values than their normal-weight peers (Buttitta et al., 2014).

In addition, low self-worth is considered a risk factor for mental disorders (Warschburger & Kröller, 2005): Obesity in childhood is associated with an increased risk of developing eating disorders during adolescence and adulthood like excessive body shape concerns, dieting or unhealthy weight-control behaviors (including, for instance, diet pills and smoking), binge eating, sneaking, hiding or hoarding food, eating in the absence of hunger or embarrassment when eating in front of others (Giuseppe et al., 2019; Moustafa et al., 2021). Children and adolescents with obesity furthermore report more behavior problems (including externalizing behavioral disorders, aggressive or dissocial behavior, inhibitory control deficiencies) and are at higher risk of developing psychopathology such as depression, anxiety disorder and attention deficit hyperactivity disorder (Kulendran et al., 2014; Rankin et al., 2016; Sagar & Gupta, 2018; Warschburger, 2011).

## **2.2 Causes and Determinants of Childhood Obesity**

In principle, the development of obesity can be explained by a "positive" energy balance in which energy intake exceeds energy demand and leads to excessive storage of adipose tissue (Papoutsis et al., 2013). However, the causes of increased body weight and obesity in childhood and adolescence are multifactorial (Papoutsis et al., 2013). They range from dietary behaviors and physical inactivity over genetics and epigenetics, to family environment, environmental, community and cultural factors (Ang et al., 2013; Wolch et al., 2011). Figure 3, a ring model based on the ecological model on predictors of child overweight by Davison and Birch (2001), its expanded version by Reed et al. (2011) and the conceptual model of S. C. Schmidt et al. (2015), attempts to illustrate the different levels of factors associated to child health and weight status.

In this model, the individual is considered in the context of external factors operating at different levels, i.e., the child's health status and weight and individual characteristics are the central focus, while influencing factors on the family- and community-level are listed in the two outer rings. These influencing factors in Figure 3, albeit not exhaustive, also incorporate elements of Pratt et al. (2013) and the Six-Cs model by Harrison et al. (2011). Following their models, the third level has been referred to here as macro-level and includes not only community (local community, organization), but also country (state and national characteristics) and cultural and social characteristics.



standards, social change and technical progress all contribute to shaping individual lifestyle determinants that go beyond mere levels of physical activity and food choices: Gross national income and national policies, for instance, might not only be related to aspects of community health care but also to individual working hours and urbanization. The availability of food and advertising influence family food choices but at the same time these depend on the level of parental education and household income (Schneider et al., 2009).

### **2.2.1 Selected obesity-relevant Factors influencing Children's Health and Weight Development**

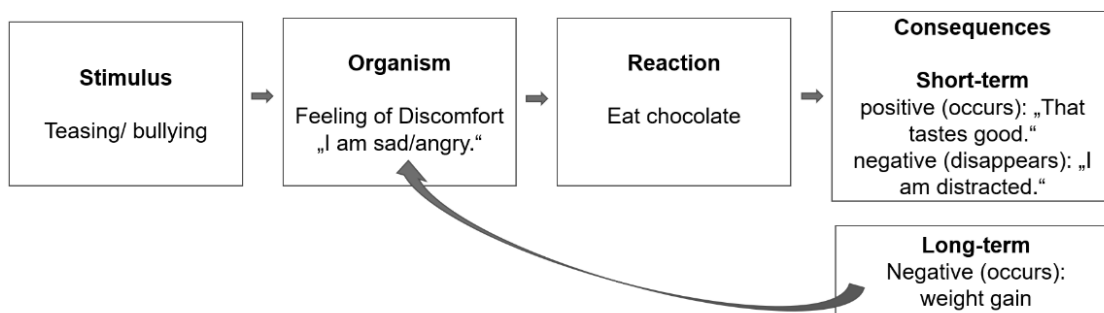
As outlined in the previous chapter, the interplay of the various factors associated with child weight development is complex. Not only do they interact with each other, but many of them impact different dimensions of child health. According to the WHO, “health is a state of complete physical, mental and social well-being” (WHO, 2000). Therefore, the following section is particularly intended to elaborate on individual- and family-level physical and psychosocial aspects of health relevant to obesity.

Physical and psychosocial aspects of obesity are deeply intertwined and therefore cannot and should not be considered separately. The psychological burdens associated to childhood obesity, for example, can result in increased social withdrawal or depressed mood, which can be barriers to healthy habits. Physical activity or participation in group sports, for example, may thus be avoided (Buttitta et al., 2017; Lowry et al., 2007; Poulsen et al., 2011; Warschburger, 2005). Consequently, it is hypothesized that the psychological impairments associated with obesity are both a contributor and a consequence of obesity, resulting in a vicious cycle of weight gain (Gmeiner & Warschburger, 2021; Schvey et al., 2019). In this context, Tomiyama

(2014) described the vicious cycle between weight-based stigma/ teasing and weight gain as follows: Weight stigma is characterized as a psychological stressor which initiates a cascade of behavioral, emotional, and physiological responses including stress-induced cortisol secretion. At the same time, unhealthy coping mechanisms such as overeating can trigger feelings of shame, which in turn cause the release of cortisol as well. As a result, increased cortisol or coping attempts such as comfort eating lead to further weight gain; and probably simultaneous increased weight-based stigmatization.

#### 2.2.1.1 Eating habits and Diet

That psychosocial and emotional aspects of obesity play a critical role in health-related lifestyle behaviors becomes very evident when examining emotional eating behaviors (Kulendran et al., 2014; Reinelt et al., 2020; Fig. 4).



*Figure 4: Emotional Eating and Reinforcement Learning Process. Modified from Warschburger (2011)*

Eating chocolate in response to a feeling of discomfort, for instance, may trigger positive feelings in the short term, but the resulting weight gain may increase the feeling of discomfort in the long term (Warschburger, 2011). Nevertheless, because of reinforcement learning/ conditioning, the short-term positive consequences (e.g., the

pleasant taste and distraction from unpleasant feelings) of eating chocolate may increase the likelihood that a learned eating behavior will continue to occur. In addition, there is evidence that emotional eating behaviors are more prevalent in overweight children and adolescents than in normal-weight peers (Efe et al., 2020).

Thus, disordered eating behaviors and unhealthy diet quality such as high caloric food consumption or eating out of boredom are not only related to weight gain and associated physiological symptoms but also with decreased psychological well-being in children and adolescents (Chen et al., 2005; Kärkkäinen et al., 2018; Mozzillo et al., 2021; Wu et al., 2019). Chen et al. (2005), for example, found that in addition to going to bed late, low levels of physical activity, and time spent watching television, skipping breakfast had a significant negative impact on both HRQOL and weight development. Mozzillo et al. (2021) investigated the link between HRQOL in adolescents with obesity and health-related behaviors including an adherence to the Mediterranean diet. The adherence to the Mediterranean diet as a measure of good diet quality was associated with better physical and psychological functioning in this sample. A systematic review on the effect of diet quality and dietary behavior on HRQOL by Wu et al. (2017) postulated similar results for normal-weight children and adolescents.

#### *2.2.1.2 Physical Activity*

On the one hand, numerous studies deal with the positive relationship between physical activity and physical health parameters or weight control (Andersen et al., 2017; Lindsay et al., 2019; Rauner et al., 2013; Robinson et al., 2017). On the other hand, the physical comorbidities associated with obesity are profound and reinforce decreased physical activity and sedentary behaviors, contributing to the never-ending spiral of obesity (E. P. Williams et al., 2015). Increasing levels of physical activity and

decreasing physical inactivity therefore represent a central role in weight management programs (Al-Khudairy et al., 2017; Gow et al., 2020).

In addition, there are several studies that documented the positive effect of physical activity on mental and social health of children with normal weight, overweight and obesity (Andersen et al., 2017; Babic et al., 2014; Eddolls et al., 2018; Vedul-Kjelsås et al., 2012). Reciprocally, Sánchez-Miguel et al. (2019) also reported that the perceived physical self-concept was significantly positively associated to the intention to be physically active. While most of these studies showed a positive association between levels of physical activity and mental health indicators, a negative relationship between physical activity and body self-esteem in the context of childhood obesity has also been reported (Sánchez-Miguel et al., 2020). This may be explained by the fact that high levels of body dissatisfaction may be a motivator for physical activity (Mohnke & Warschburger, 2011; Sánchez-Miguel et al., 2020). However, engaging in physical activity may also reveal fundamental movement-skill difficulties compared to non-overweight peers, leading to an impairment of physical self-concept (Poulsen et al., 2011). In this regard, Lowry et al. (2007) found that adolescents with lower self-esteem tend to be more shy and fearful of new activities and others' opinions, which can be a hindrance to physical activity. This relationship was found to be particularly concerning in the primary school setting where body dissatisfaction and physical activity were negatively correlated (Olive et al., 2012).

#### *2.2.1.3 Physical Fitness*

Physical Fitness is commonly used as an objective measure of physical activity (Bermejo-Cantarero et al., 2021; Ortega et al., 2008), defined as a set of attributes referring to a person's ability to perform physical activities requiring aerobic capacity,

endurance, strength, or flexibility (Ortega, Cadenas-Sanchez, et al., 2018). In this thesis, physical fitness refers to cardiorespiratory fitness, the most used component of health-related physical fitness, often employed interchangeably with cardiovascular endurance, aerobic capacity, and maximal oxygen uptake (Ortega, Cadenas-Sanchez, et al., 2018).

There are multiple ways to assess physical fitness, such as the 20m shuttle-run test (Léger & Lambert, 1982; Redondo-Tébar et al., 2019), the 6-minute run (Beck & Bös, 1995), the multistage treadmill test (C. F. Williams et al., 2019), spiro/bicycle ergometry (see [Chapter 4.2.1.3.](#); Santana et al., 2017; Trappe, 2000), the Aerobic Cardiovascular Endurance Run (PACER; Gu et al., 2016; Mendoza-Muñoz et al., 2020), the Cooper-test (Cooper, 1987), or the ALPHA health-related fitness test battery for Youths (Ruiz et al., 2011; among others).

High levels of physical fitness are associated with lower levels of BMI (Rauner et al., 2013) and cardiovascular disease risk factors, better skeletal health, scholastic performance (Gopinath et al., 2012; Ortega et al., 2008) and functional movement quality (Molina-Garcia et al., 2019). In fact, there is emerging evidence that moderate to high cardiorespiratory fitness may counteract the negative health consequences of obesity (Ortega, Ruiz, et al., 2018). Interestingly, these studies even show that normal-weight but untrained individuals have a higher risk of cardiovascular disease mortality than obese but fit individuals.

Additionally, physical fitness is related to increased levels of HRQOL (Evaristo et al., 2019), self-concept (Mitchell et al., 2012), optimism (Rodriguez-Ayllon et al., 2018), and life satisfaction (Marques et al., 2017), positively affecting aspects such as the social relationship with peers (Gopinath et al., 2012; Grünberg et al., 2023) or the school environment including subjective and objective academic performance and

school attendance (Padilla-Moledo et al., 2012; Santana et al., 2017). A recent systematic review and meta-analysis by Bermejo-Cantarero et al. (2021) documented the positive relationship between HRQOL and cardiovascular fitness on the one hand and muscular fitness on the other in normal weight children and adolescents. Perez-Sousa et al. (2018) identified physical fitness as a mediator in the relationship between childhood and adolescent obesity and HRQOL. This finding is supported by the results of a longitudinal study by C. F. Williams et al. (2019) who found that psychosocial health of children with overweight improved significantly after an 8 months aerobic exercise program as opposed to a sedentary program.

#### *2.2.1.4 Sedentary Behavior and Media consumption*

Sedentary behavior is characterized by energy expenditure  $\leq 1.5$  metabolic equivalents and predominantly involves prolonged sitting and/or laying, e.g., screen-viewing activities, passive transportation (Barnett et al., 2021; Ortega, Ruiz, et al., 2018). It is often reflected by the time spent consuming media (Wu et al., 2017) which has significantly increased in the last decades (Robinson et al., 2017). Numerous studies connect this trend to increasing BMI levels in industrialized countries (e.g., Ang et al., 2013; Garrido-Miguel et al., 2019). A few studies have also reported that increasing media use and sedentary behavior is not only associated to physical but also to psychological health as represented by an impaired HRQOL among frequent media users (Chen et al., 2005; Gopinath et al., 2012; Robinson et al., 2017). Because high levels of media use, such as playing computer or video games, surfing the Internet, and time spent on cell phones, compete with time spent exercising (Spengler et al., 2015), it plays a central role in the weight development of children – with and without obesity – from both a physical and a psychosocial perspective. Focusing on the latter,

it is also important to consider the time spent with social media networks (Neill et al., 2021). Several studies have examined the impact of social media engagement in childhood and adolescence, with mixed results depending on various parameters such as sex and type of online social interaction (Booker et al., 2018; Minsky et al., 2021; Vannucci et al., 2017; Wulff & Wagner, 2018). In this context, Verduyn et al. (2017) suggested that there are differences between passive and active users. Active users may experience an increase in social capital and connectedness, leading to an increase in psychosocial well-being, while passive users are more likely to experience increased social comparison, leading to a decrease in well-being. Negative mental health consequences due to increased interaction with social media were found particularly for female adolescents (Booker et al., 2018).

Another recent issue impacting the mediating role of media use and sedentary lifestyle in the relationship between BMI and parameters of physical and and psychological well-being is the COVID-19 pandemic (Pietrobelli et al., 2020; Violant-Holz et al., 2020). A more elaborate description of the postulated causalities can be found in Chapter 2.3.

#### *2.2.1.5 Familial and Demographic Factors*

Several studies have documented an association between the family's socio-economic or migration background and weight-related behaviors of the child (Cislak et al., 2012; Silventoinen et al., 2010; Vrijkotte et al., 2020). In this respect, parental full-time employment, family structure (e.g., single parenthood, number of siblings) and the cultural background, including religious affiliation, the specific sociocultural view of overweight and obesity, and culturally influenced eating habits and dietary traditions, play a role (Zeijher et al., 2016). In Germany, there is evidence that children with a

migration background or a lower social status are more prone to overweight and obesity (Koschollek et al., 2019; Lange et al., 2010). A negative relationship between low educational/ income levels/socio-economic status and HRQOL and mental health has also been reported (Bau et al., 2011; Krause et al., 2014; Reiss et al., 2019)

Parenting practices such as modeling healthy behaviors, being physically active together with the child and praising are favorable to encourage physical activity in children and thus may contribute to a healthy weight (Lindsay et al., 2019). While social encouragement and support are important for the child's physical activity and eating patterns, they also predicted higher levels of all dimensions of HRQOL in children with obesity in a study by Meixner et al. (2020). According to Helfert and Warschburger (2013) appearance-related social pressure by parents and peers, in particular teasing and exclusion, are also highly relevant for the mental well-being of children and adolescents with obesity and overweight, indicating a fine line between support and pressure. Furthermore, there is evidence that higher levels of parental weight-specific self-efficacy and parents' mental quality of life may be positively associated to both children's lifestyle and quality of life (Warschburger & Kühne, 2014). Zeller and Modi (2006) identified perceived lack of classmate social support and the presence of depressive symptoms as important predictors of HRQOL of children with obesity while race, parental and teacher social support did not show any significant associations.

On an individual level, sex and age naturally play a crucial role in the development of body composition in childhood and adolescence. Di Cesare et al. (2019) reported significant regional differences in the relationship between levels of obesity and sex, and demonstrated that obesity increased more rapidly in 5–19-year-olds than in younger children. In addition, sex and age have been found to impact psychosocial aspects of health, physical activity and media use of children who are already affected

by obesity (Harrist et al., 2016; Meixner et al., 2020; Wulff & Wagner, 2018). Especially with regard to the physical self-concept (Sánchez-Miguel et al., 2019) including body esteem (Shriver et al., 2013), body image (Gow et al., 2020; Hoffmann & Warschburger, 2015; Jiménez Flores et al., 2017) and body satisfaction (Mäkinen et al., 2012; Neumark-Sztainer et al., 2004), research has shown decreasing levels from childhood to puberty. These findings have been found to be especially alarming in girls with obesity who in many studies report lower levels of perceived physical attractiveness (Klein et al., 2017) and HRQOL than their male peers with obesity (Buttitta et al., 2014; Costarelli et al., 2013; Meade & Dowswell, 2016; Meixner et al., 2020). However, Helfert and Warschburger (2013) hypothesize that the differences between the sexes may be due to the instruments used, which, for example, focus only on the slimness ideal, that may be inappropriate for assessing boys' body image. In addition, the reciprocal association between weight stigma and body weight is apparently independent of sex (Gmeiner & Warschburger, 2021).

### **2.3 The COVID-19 Pandemic and Childhood Obesity**

As discussed in the position statement “Obesity and COVID-19: The Two Sides of the Coin” by Dicker et al. (2020), the COVID-19 pandemic and the restrictions needed to mitigate the spread of the disease affected adults, children, and adolescents with obesity in multiple ways.

The individual and population-based restrictions were associated with serious lifestyle changes, many of which are important predictors of weight gain and obesity (Panda et al., 2021; Woolford et al., 2021). Due to school closures, social isolation, the loss of regular routines, children and adolescents were particularly affected by these measures (Iqbal & Tayyab, 2021; Singh et al., 2020). Several studies have reported decreases in physical activity and increases in sedentary behavior with severe consequences for children’s physical and psychological health (Füzéki et al., 2020; S. C. E. Schmidt et al., 2020; Weihrauch Blueher et al., 2023). At the same time, numerous studies reported an increase in media consumption during the pandemic (Neill et al., 2021; Pandya & Lodha, 2021). In Germany, for example, leisure screen time in the 4–17 age group in Germany increased by about one hour while organized sport was suspended during the pandemic (S. C. E. Schmidt et al., 2020). Muñiz-Velázquez et al. (2021) found that increased screen time, i.e., television viewing for entertainment and social networking, negatively impacted well-being during the pandemic lockdown. Although digitalization allowed many children and adolescents to remain socially and emotionally connected during the stay-at-home order, screen time also led to irritability, coronary anxiety, sleep disturbances, emotional exhaustion, and isolation (Pandya & Lodha, 2021). In general, exposure to screen media is associated with a higher risk of obesity in children and adolescents due to increased eating while watching television, exposure to high-calorie and low-nutrient foods and beverages

that influence children's preferences, purchasing desires, and consumption habits, and reduced sleep duration (Robinson et al., 2017).

Additionally, an increased number of negative psychosocial comorbidities such as depressive symptoms, anger, worries, helplessness, temper tantrums, fear, stress, sleep disturbances, and loneliness has been reported at pandemic times (Sinanović et al., 2020; Violant-Holz et al., 2020; Vogel et al., 2021). In normal-weight German children and adolescents, in particular the lack of social contact during the pandemic led to an increased number of children and adolescents reporting lower HRQOL, more mental health problems, and higher anxiety levels by about 1.5 to 3 times (Ravens-Sieberer et al., 2021). At the same time, anxiety and stress during the lockdown influenced dietary behaviors, as many people found comfort in eating (Cherikh et al., 2020). Eating out of boredom, loss of meal structure, a high caloric diet and increased snacking as a result of the pandemic lockdown have also been documented (Androutsos et al., 2021; Nicodemo et al., 2021; Panda et al., 2021).

Researchers predicted that children and adolescents with obesity are particularly vulnerable to the negative health consequences of the pandemic restrictions because they already face barriers to healthy lifestyles and social isolation might thus exacerbate existing health inequities (Dicker et al., 2020; Rundle et al., 2020; Woo Baidal et al., 2020). In line with this, Neshteruk et al. (2021) theorized that children with obesity in particular are affected by a loss of daily structure and consistent routines during the lockdown, as weight-related behaviors are better regulated when children are exposed to a more structured environment. Thus, there is evidence that overweight and obesity not only represented risk factors for a more severe and complicated course of COVID-19 (Tsankov et al., 2021) but also for weight gain during the lockdown (Rundle et al., 2020; Sidor & Rzymiski, 2020).

Consequently, the need for appropriate health promotion and care strategies for children and adolescents with obesity to avert the risk of worsening health disparities following the COVID-19 pandemic becomes ever more apparent (O'Hara et al., 2020). However, during the pandemic lockdown, weight management programs – like many other services – had to be omitted or adapted (Dicker et al., 2020). As a result, treatment-seeking children and adolescents with obesity and their families received much less assistance (Ravens-Sieberer et al., 2021). An Italian study showed that implementing a healthy lifestyle without external support was difficult for the participants of an outpatient program during the lockdown, mainly because of the increase in sedentary lifestyle (Nicodemo et al., 2021). While including telemedicine into weight management might be a way to ensure continuity of care during social distancing and pandemic restrictions, it also imposes difficulties and potential disadvantages such as the reduction of in-person contact and group activities (Neshteruk et al., 2021).

Lastly, several studies worldwide addressed the amplifying effect of COVID-19 lockdown policies on social inequalities (Bajos et al., 2021; Okonkwo et al., 2020; Weihrauch Blueher et al., 2023). Wessely et al. (2022) found that children from socioeconomically deprived backgrounds were especially prone to an increase in measurements of overweight/obesity and underweight, as well as a decrease in motor performance. On the one hand, children of socially disadvantaged families might especially be affected by insufficient technical equipment or know-how to participate in digital weight management programs (Woo Baidal et al., 2020). On the other hand, as mentioned in the previous Chapter 2.2.1, a low socio-economic background affects not only weight development and weight-related behaviors but also obesity-relevant determinants of psychosocial health. Hence, the pandemic and the resulting lifestyle

changes may potentiate not only the prevalence of childhood and adolescent and obesity but also the associated psychosocial impairments.

So far, there is little evidence on the long-term health consequences of the COVID-19 pandemic-related restrictions, but initial findings point to an increase in childhood obesity (Bantel et al., 2021; Vogel et al., 2021). Comparing data before the pandemic (2005-2019) and during the pandemic in Germany (2019-2020), Vogel et al. (2021) found that the proportion of children who gained weight increased while the proportion of children who lost weight over the period decreased. Their results confirm that the change in mean BMI-SDS was substantially higher than in previous years and that weight gain effects were most pronounced in the already affected population of children with overweight or obesity.

## **2.4 Multidisciplinary Weight Management**

To address the burden of childhood obesity with its multifaceted physical and psychological causes and consequences, multidisciplinary weight management programs aim to support affected children, adolescents and their caregivers by achieving weight loss/stagnation and lifestyle change through multiple components (Gow et al., 2020; Gurnani et al., 2015; see [Chapter 4](#) for a detailed example of a multidisciplinary weight management program).

### **2.4.1 General Program Design**

In Germany, the design of programs for the treatment of obesity in childhood and adolescence is guided by the AGA guidelines. AGA recommends that the basis of obesity therapy at any age should be a multimodal program that includes the components of nutrition, exercise, and behavioral therapy (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019). With a focus on lifestyle change, AGA recommends the combined use of medical and interdisciplinary care, counseling, education, paper-based materials, and an intensity of intervention tailored to the individual and their family environment depending on the target parameters in structured, playful, and interdisciplinary programs (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019).

In the sense of a family-oriented approach, the patient's parents, family or caregivers must be an equal target group for the therapy of childhood obesity in addition to the patient. Family involvement and parent education are essential not only because parents model weight-related behaviors but also because a supportive family environment is critical to the development of children's self-esteem and self-efficacy (Lowry et al., 2007) as well as daily physical activity behaviors. As the influence of

parents diminishes during child development, this applies to a lesser extent to the care of adolescents with obesity (DeBar et al., 2012).

According to the AGA guidelines, a BMI-SDS reduction of 0.2 units in one year is considered as a treatment success criterion. Aspects of nutrition therapy such as the promotion of energy-reduced diets and healthy eating are critical to achieving this goal, as they can have a positive impact on food choices and consumption of vegetables and fruits, and can also lead to a reduction in the consumption of high-fat and high-sugar foods and beverages. At the same time, rigid diet plans or diets with extreme nutrient ratios are discouraged and the importance of combining nutrition therapy with other therapy components is emphasized.

Thus, increasing physical activity and decreasing inactive leisure time, sedentary behavior and screen-based activities also play an important role in the programs (Tanaka et al., 2014). Promoting physical activity in everyday life should be the primary goal of exercise therapy, as it is more effective in reducing weight in the long term than participation in time-limited exercise programs (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019). AGA advocates gradually introducing participating children and adolescents to the recommended 90 minutes of moderate activity per day through progressive exercise training of moderate intensity (45-55% of  $VO_2\text{max}$ ) that is easy on the joints and adapted to the degree of obesity.

Given the potential bilateral interrelation between psychosocial distress and weight gain (Ma et al., 2021; Schvey et al., 2019), individualized strategies to improve self-esteem, self-worth, self-efficacy, and body image represent central elements in holistic weight management programs. To this end, motivational interviewing, realistic goal setting, and frequent individual psychological counseling, including behavior modification, and (physical activity) group sessions to improve social skills are among

the methods employed (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019; Fruh, 2017).

In the behavior modification pillar, reinforcement mechanisms such as praise, training of flexibly controlled eating behavior, and combination of different techniques/strategies are important. Because childhood obesity is associated with impulsivity and lack of inhibitory control, self-regulatory training is gaining increasing attention in research to improve current treatment approaches, with promising results in terms of weight loss and well-being (Kulendran et al., 2014; Naets et al., 2018; Vermeiren et al., 2021). Reinelt et al. (2020) emphasize that emotion regulation strategies can reduce stress, which is characterized by increased cortisol secretion, which in turn stimulates appetite.

#### **2.4.2 Program Effectiveness**

Multidisciplinary weight management programs are generally considered the gold standard for the treatment and prevention of obesity and have proven more effective than dietary or exercise interventions alone (S. Kumar & Kelly, 2017; Mead et al., 2017; Naets et al., 2018). Several studies have demonstrated a clinically significant impact on BMI-SDS, physical activity levels, physical fitness, and psychosocial well-being in children and adolescents (Braet et al., 2004; Giuseppe et al., 2019; Graf et al., 2005; Lier et al., 2020b; Rank et al., 2014). A meta-analysis including 64 randomized controlled trials with a total of 5230 participants by Oude Luttikhuis et al. (2009), for instance, indicated beneficial effects on obesity from baseline to end of intervention or 6 and 12 months follow up in multimodal lifestyle interventions involving children and adolescents (with BMI, BMI-SDS and/or measures of body fatness as primary outcome parameters). A series of reviews of 7 multidisciplinary weight management programs

for children with obesity aged 0 to 6 years (Colquitt et al., 2016), 70 programs for children aged 6 to 11 years (Mead et al., 2017), and 44 programs for adolescents aged 12 to 17 years (Al-Khudairy et al., 2017) found reductions in BMI-SDS at the end of the intervention of -0.3 units, -0.06 units, and -0.13 units, respectively.

In line with this, weight-loss as intervention outcome has been found to be associated with positive changes in eating disorders in youth with obesity such as binge eating and loss of control eating (Giuseppe et al., 2019; Moustafa et al., 2021). Additional promising evidence relates to the cost-effectiveness of multicomponent obesity treatment programs (Hollingworth et al., 2012; Lier et al., 2020a).

In a review on effective behavior change techniques in the context of childhood obesity and its multidisciplinary therapy, Martin et al. (2013) concluded that stress management/emotional control training and training of general communication skills achieved 100% effectiveness ratios (defined here as group reduction of at least 0.13 BMI units or a significant difference in BMI between intervention and control groups at follow-up). These previous findings were reinforced in a study by Reinelt et al. (2020), which showed that emotion regulation strategies significantly predicted weight loss during obesity therapy.

However, studies show that without adequate outpatient follow-up, some of the effect is lost as the disease progresses (MacLean et al., 2015; van Egmond-Fröhlich et al., 2006; Warschburger et al., 2016). For this reason, the AGA also makes recommendation for treatment chains (pre- [e.g., counseling sessions with parents] and aftercare [e.g., regular telephone contacts]). Accordingly, obesity treatment requires continuous long-term care which can be provided in outpatient as well as inpatient or school settings.

Nevertheless, research highlights that it is difficult to achieve and monitor long-term success, indicating problems with weight control after program completion and renewed weight gain at follow-up, despite the positive impact on short-term weight loss or lifestyle change (Zolotarjova et al., 2018). According to Wing and Hill (2001) there is even a sense of pessimism, “a general perception that almost no one succeeds in long-term weight loss maintenance”.

This pessimism can be traced back to the 1950s, when Stunkard and McLaren-Hume observed 100 individuals with overweight participating in a weight loss nutrition-based program and found that 2 years after treatment, only 2% maintained a weight loss of at least 20 pounds. A somewhat more recent review by Wing and Phelan (2005) concluded that only about 20% of individuals with overweight achieve long-term weight loss, defined as intentionally losing at least 10% of their original body weight and maintaining the loss for at least one year. A large study of 21,784 children and adolescents with overweight in 129 German obesity centers showed that although 83% of the children reduced their overweight after 6 months, there was a lost-to follow-up and drop-out rate of 92% 2 years later, demonstrating a lack of reliability regarding the long-term effectiveness of interventions (Reinehr et al., 2009). In 2017, although the series of reviews on the effectiveness of multidisciplinary weight management in children and adolescents mentioned above reported BMI-SDS reductions from pre- to post-intervention, they called for urgent longitudinal studies because the quality of evidence was low and research on sustained long-term intervention effects was limited (Al-Khudairy et al., 2017; Colquitt et al., 2016; Mead et al., 2017).

Today, in 2022, evidence on long-term success of weight management programs remains mixed, despite ongoing efforts to maximize program effectiveness and lasting change (Kinlin et al., 2022; Vermeiren et al., 2021). Therefore, identifying factors

associated with long-term weight loss or weight loss maintenance continues to be an urgent research priority to tailor intervention strategies to individual needs.

### **2.4.3 Predictors of Weight Loss and Program Success**

Following Warschburger (2011), previous literature on the predictors of successful weight loss – as the main criterion for weight management program success – is presented in the following in three different levels: characteristics of implementation (components of the program or adherence); characteristics of the family (parental support); characteristics of the child (personality characteristics).

#### *2.4.3.1 Characteristics of implementation*

Several program/ process variables such as satisfaction with obesity treatment in childhood, regular participation in exercise groups, self-monitoring weight, and changes in dietary habits after treatment have been identified as affecting long-term success in weight management programs (Fruh, 2017; Moens et al., 2010; Wing & Hill, 2001). Fruh (2017) also mentioned the role of the interdisciplinary team of nutritionists, sports scientists, psychologists, pedagogues, nursing staff, and physicians as elemental to the success of the program. Regarding frequency and intensity of treatment, the AGA's evidence-based recommendations point to daily therapy contact in ambulatory treatment centers as more effective for weight loss than weekly contact (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019). Furthermore, while Reinelt et al. (2020), for example, found longer treatment to positively affect BMI-SDS reduction, there is no apparent relationship between length of the intervention

and effectiveness according to a review of 21 weight control, weight maintenance and weight loss programs (McLean et al., 2003).

Adherence to the program was also cited as an important factor in maintaining weight loss over the long term (Fruh, 2017). However, two reviews on attrition rates in pediatric weight management have found that adherence to the program itself is influenced by various components (Kelleher et al., 2017; Skelton & Beech, 2011). For example, the children's positive social experiences during the program, such as having fun and making friends, fostered a desire to continue whereas scheduling problems and programs not meeting family needs or expectations led to dropout (Kelleher et al., 2017). In their systematic review, Kelly and Kirschenbaum (2011) found that inpatient programs had significantly lower dropout rates and produced greater reductions in percent-overweight compared with outpatient treatments.

Several researchers agree that the group setting can be a powerful mechanism through which to provide opportunities for bonding, support, a sense of belonging, peer skill development, and positive peer interaction (Lowry et al., 2007; Morano et al., 2016; Murray et al., 2017). This might increase intrinsic motivation through enjoyment of physical activity and thus long-term exercise adherence (Morano et al., 2016). In this regard, group composition and opportunities to increase engagement in group sessions should be considered when designing programs aimed at long-term outcomes (Kinlin et al., 2022; Lier et al., 2020b). For example, DeBar et al. (2012) hypothesized that strategies with parental involvement might be less attractive to adolescents, and thus examined a 5-months lifestyle intervention specifically tailored to female adolescents with obesity. The authors found significant and sustained decreases in BMI-SDS among the participating adolescent girls compared with those receiving usual care at 12-months follow-up. Similarly, Warschburger and Zitzmann

(2019) summarized that the content and methodology of pediatric multidisciplinary weight management approaches should be appropriate to the developmental stage of individuals and take age-related needs into account.

In the last decade, research increasingly dealt with the use of telehealth for the treatment of childhood obesity (Tully et al., 2020). Mobile health has shown promise, especially in reaching rural or hard-to-reach patients (Vajravelu & Arslanian, 2021). Particularly in light of the COVID-19 pandemic and the associated nationwide restrictions and lockdowns, innovative approaches to continuity of care were urgently needed and piloted (Minsky et al., 2021; Woo Baidal et al., 2020). Verbeken et al. (2013) as well as Vermeiren et al. (2021) for example, investigated the effects of a computer-based self-control training with mixed but promising results. However, the use of telemedicine in the context of childhood obesity treatment is still an emerging field, with few long-term studies, heterogeneous findings, and insufficient evidence of cost-effectiveness (Tully et al., 2020).

#### *2.4.3.2 Family Characteristics*

The role of family demographic variables as potential predictors of lasting treatment outcome is an important research topic because parents may pass on lifelong health-related habits to their children and pay attention to their children's treatment (Braet, 2006; Lowry et al., 2007). Although parent/family involvement is a key pillar of multidisciplinary weight management for children and adolescents, there is limited evidence on the influence of family or parent characteristics on the child's long-term adherence to a healthy lifestyle (Golley et al., 2011; McLean et al., 2003). Warschburger et al. (2016) for example, did not find striking results in the child's long-term weight maintenance and psychosocial well-being after additional parent training

through complementary cognitive-behavioral group sessions. Therefore, a number of researchers caution that further research is needed due to incongruent outcomes especially related to socioeconomic factors (van Egmond-Fröhlich et al., 2006) or parental coping skills as families with overweight children experience more parenting stress (Moens et al., 2009; Moens et al., 2010). Answering this need, a review by Van der Kruk et al. (2013) focused on parental involvement in long-term European childhood weight control interventions and provided a list of parenting skills that proved important in effective interventions. Among the skills listed in the review are authoritative parenting, enforcing, and establishing dinner table/ family rules and reward systems. According to Reinehr et al. (2009), a lack of parenting skills and family psychosocial support may contribute not only to difficulties in maintaining a healthy lifestyle, but also to high dropout rates from lifestyle interventions for patients with obesity.

Further analysis of children's long-term weight development point to environmental variables such as access to park and recreational resources (Wolch et al., 2011). Besides, numerous studies identified a family history of obesity as a determinant of lasting weight loss (Epstein et al., 1987; Fruh, 2017). Eliakim et al. (2002), for example, demonstrated that children whose parents did not have obesity had a significantly greater decrease in BMI than children of parents with obesity. Maternal BMI and maternal psychopathology in particular have been identified as important negative factors influencing treatment outcomes in children with obesity (Moens et al., 2010; Togashi et al., 2002). In addition, White et al. (2004) found parents' satisfaction with life and family satisfaction to be positively associated to the child's weight loss. In line with this, Warschburger and Kühne (2014) found that childhood obesity was associated with reduced parental HRQOL. However, these studies report cross-

sectional or short-term outcomes. Several further family characteristics have been analyzed in previous studies on predictors of childhood obesity including number of children, family structure, and life events, but no significant association to long-term weight loss retention has been found (Moens et al., 2009).

#### *2.4.3.3 Child Characteristics*

Characteristics of the individual which have shown to have a significant impact on long-term weight change or stabilization include psychosocial health, maintaining a high level of physical activity (1 hour per day), eating a low-calorie, low-fat diet, eating breakfast regularly, medical triggers (e.g. a family member having a heart-attack), following a consistent eating pattern on weekdays and weekends (Wing & Phelan, 2005), inner motivation to lose weight, better coping strategies, self-efficacy, autonomy and taking responsibility in life (Elfhag & Rössner, 2005).

Both in adults and children one common predictor is the degree of overweight at baseline (Braet, 2006; Moens et al., 2010; Vogels et al., 2005). Vogels et al. (2005) speculated that in proportion it is easier for people with obesity and a high body fat percentage to lose a lot of weight (which according to the authors is mostly fat) in a small period of time than it is for people without obesity. In comparison, Rodriguez-Ayllon et al. (2018) interpreted that the positive correlation between high levels of obesity at baseline and weight loss is due to the degree of psychological distress associated with obesity. Accordingly, the suffering pressure may be a motivator for change.

Consistently, it is reported that another important factor of long-term success is initial weight-loss in treatment (Braet, 2006; Moens et al., 2010; Vogels et al., 2005). Wing

and Phelan (2005), for example, reported that the odds of long-term success increased significantly after individuals successfully maintained their weight loss for 2-5 years. Kinzl et al. (2006) found that satisfaction with weight loss showed a significant correlation with the extent of weight loss after a minimum follow-up of 30 months.

The findings on initial weight reduction and weight loss maintenance, however, could not be confirmed in a more recent review on treatment effects in children and adolescents with morbid obesity (Zolotarjova et al., 2018). The authors instead found gender and age to be significant predictors, indicating that younger or male children were more successful in retaining their weight loss. However, the results regarding the association between sex and weight loss are not congruent, as a study by Reinelt et al. (2020), for example, indicated a positive association between BMI-SDS reductions and female sex.

Buscemi et al. (2013) demonstrated that psychological quality of life – represented by a shape concern score, a depression score, and a psychological discomfort score – was highly correlated with weight maintenance at 10-year follow-up after multidisciplinary treatment. Low depression scores have also been strongly associated with long-term maintenance of weight loss (Wing & Phelan, 2005). A study by Zeller et al. (2004) reported that children with more depressive symptomatology and lower self-esteem were less likely to complete the weight management program at all. Gurnani et al. (2015) underline that psychosocial stressors and comorbidities may make behavior change difficult. Other researchers agree that psychosocial impairments associated with childhood obesity can negatively impact treatment outcomes, as low self-esteem or weight-based teasing, for example, can discourage participation in physical or group activities (Lowry et al., 2007; Sagar & Gupta, 2018; Warschburger, 2005).

In contrast, psychosocial suffering has also been identified as a significant predictor for BMI-SDS reduction, suggesting that it may increase motivation to change in some children (van Egmond-Fröhlich et al., 2006). Interestingly, realistic subjective body shape perceptions also proved significant for longer-term weight loss (Hoffmann & Warschburger, 2015): Subjective underestimation of body shape was negatively correlated to longer-term weight loss.

### **3. Research Gap and Research Objectives**

The mechanisms and influencing factors that promote or prevent childhood obesity and the associated psychosocial burden are complex, and scientific discourse is far from providing a one-size-fits-all solution to the problem. Although multidisciplinary strategies to treat childhood obesity yield promising health outcomes in the short term, achieving and monitoring sustainable positive treatment effects, such as lasting behavior change and weight loss maintenance are, unfortunately, difficult (MacLean et al., 2015; Zolotarjova et al., 2018). In light of consistently high obesity rates, analyses of secondary trends related to childhood obesity have shown that the association between high BMI-SDS and negative self-concept has not improved over the past 15 years (Grünberg et al., 2023).

Thus, there is an ongoing need to advance the research and development of holistic, multidisciplinary weight management approaches in order to maximize their impact (Buttitta et al., 2017; Gow et al., 2020). Given the complex causal relationships between weight gain and physical and psychosocial aspects of health (Tomiya, 2014), a deeper understanding of the underlying dynamics might help to uncover predictors of more sustainable weight loss and to derive implications for holistic therapy and care.

There are studies, albeit limited, that intend to include multiple variables in their predictive models to better explain and understand the dynamics behind the psychophysical cycle associated with weight gain (Meixner et al., 2020; Zeller & Modi, 2006). One of the problem at this point, however, is that a majority of these studies focus on adults or normal-weight children, and few specifically target children and adolescents with obesity (Buttitta et al., 2017). Furthermore, many studies have used HRQOL to reflect psychosocial health. Fewer studies have focused on other or multiple

indicators of psychosocial health such as self-concept, body dissatisfaction, or life satisfaction (Gow et al., 2020).

While some obesity-relevant determinants of health seem to be already well documented, others have received little attention. In this context, several researchers call for further investigation of the predictive potential of physical fitness to better explain its role in psychophysical causalities associated to childhood obesity (Babic et al., 2014; Perez-Sousa et al., 2018; Reddon et al., 2017). Because physical fitness appears to be important for both physical risk factors and psychosocial health (see [chapter 2.2.1.3](#)), and thus for the design of weight management programs, these calls should be addressed with urgency. Additionally, more studies that incorporate into their examination the impact of the current COVID-19 pandemic and related nationwide restrictions that affected children's health at multiple levels, particularly related to obesity, are still much needed.

Last but not least, there is an urgent need for longitudinal studies that allow for causal conclusions (Rodriguez-Ayllon et al., 2018). Longitudinal studies are critical to understanding why some children are more successful in weight loss/ retention and in maintaining necessary lifestyle changes in the long term, i.e., longitudinal studies might help identifying modifiable factors of lasting success and refining programs accordingly. Although a number of longitudinal studies on predictors of weight gain and weight loss exist (see [Chapter 2.4.3](#)), many of them are limited by the fact that they only measure treatment outcome shortly after the intervention and that, given the large number of potential influencing factors, there are many that have been little studied or yielded contradictory results (e.g., family variables, self-concept; Braet, 2006; Stoner et al., 2016). Given the cross-sectional evidence of the important role that physical fitness plays in the health of children with obesity, the inclusion of objective measures

of physical fitness is also essential in longitudinal studies addressing sustained, holistic weight control.

Therefore, this dissertation aims to derive implications for the further advancement of current multidisciplinary weight management approaches by analyzing

- a. physical fitness among the predictors of HRQOL and self-concept in children and adolescents with obesity and among predictors of long-term BMI-SDS reduction
- b. multidisciplinary weight management program adaptations needed to ensure continuity of care during the COVID-19 pandemic.

To achieve this goal, analysis of data from a multidisciplinary weight management program for children and adolescents with overweight and obesity in Cologne, Germany, the CHILT III program, were fundamental to three of four studies in this cumulative dissertation.

## **4. The CHILT III Program**

Data of CHILT III, an outpatient weight management program for children and adolescents aged 8-16 years with obesity, form the core of this dissertation (see study 1, 2 and 4). It was a multicomponent program conducted at the Institute of Movement and Neuroscience of the German Sport University Cologne from 2003 to 2021 ([www.chilt.de](http://www.chilt.de)).

### **4.1 General Framework**

In total, each CHILT III cycle lasted one school year minus vacation periods, i.e., 11 months/ 40 weeks. The target population were children and adolescents with severe obesity (> 99.5th percentile) or obesity (> 97th percentile) if they displayed obesity-related risk factors or pathologies such as arterial hypertension or hyperlipoproteinemia. Further inclusion criteria were: Prescription from a pediatrician; approved application for cost coverage from the health insurance company; signed participation agreement; sufficient German language skills of the children and of at least one parent/ guardian; sufficient motivation of the children and parents/guardians to actively participate in the sessions; normal ability to attend school; previous outpatient medical treatment according to currently available guideline recommendations (e.g., AGA) was unsuccessful. Participants with mental disorders or illnesses (e.g., eating disorders, bulimia), inadequate group capacity, or obesity due to a medical condition (e.g., Prader-Willi syndrome) were excluded. Discontinuation criteria were defined as no regular attendance, i.e., three consecutive absences and failure to attend the next session (in the case of absence due to illness, an interruption of up to four weeks was accepted), or occurrence of mental disorders, including eating

disorders, or of other serious health disorders that made regular attendance no longer possible.

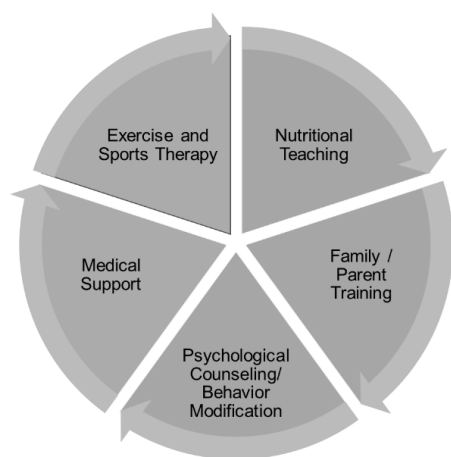
#### **4.1.1 Program Objectives and Structure**

The aims of the CHILT III program were the following:

- Depending on initial weight: weight stabilization or reduction (/ BMI-SDS reduction)
- Permanent change in eating and nutritional behavior
- Permanent change in exercise behavior in leisure time and everyday life
- Increase in physical and motor performance
- Prevention of secondary diseases and side effects of obesity
- Promotion of positive physical, psychological, and social development
- Long-term: achievement of an unimpaired quality of life

The primary success/ outcome criteria were defined as weight reduction, decrease in body weight by at least 5% (reduction in BMI-SDS by at least 0.2), or increase in physical performance by at least 10% (measured in watts or watts/kg). These success criteria should either be achieved at the end of the program and be maintained until the follow-up (at least 6 months later) or achieved at the time of the follow-up.

CHILT III measures were based on five pillars: Exercise and sports therapy, nutritional teaching, medical support, psychological counseling/ behavior modification, and training of the family environment/ parent training (Fig. 5).



*Figure 5: Pillars of CHILT III*

Starting each August, the children and adolescents participated in nutritional, medical, and psychosocial, and exercise sessions twice a week (see Table 1). Following a family-based approach, parents also received one nutritional or psychological counseling session per week, and an exercise class was held once a month for the whole family. A group session with a physician on medical content was held three times per cycle for the entire group, including the children and their parents. In total, the children were supervised for approximately four to five hours per week, and the parents for two to three hours per week during their participation.

*Table 1: Exemplary CHILT III Schedule*

	<b>Monday</b>		<b>Thursday</b>
	<b>Children</b>	<b>Parents</b>	<b>Children</b>
<b>Medical Consultation</b>	16.15 – 16.45	17.00 – 17.45	
<b>Theory</b> (alternating nutrition class and psychosocial counseling; 3x medical group session with physician)	17.00 – 17.45	18.00 – 19.00	
<b>Exercise</b>	18.00 – 19.00		17.00 – 18.30

Since the program's inception in 2003, there have been some adjustments. Up to and including 2010, each cohort was divided into two subgroups, with children over 12 separated from younger participants. In 2011, an additional group was added at a different location in Cologne-Meschenich with similar content. The main difference between the group in Cologne-Meschenich and at the German Sport University was that the theoretical content was taught in compact days instead of weekly sessions in Meschenich. The group in which families participated depended on the distance from their home. In addition, participants at Meschenich could enroll each quarter, while the group at the sports university was a closed group for the entire cycle. Lastly, there was no monthly exercise class for the whole family in Meschenich. During the COVID-19 pandemic lockdown starting in March 2020, the program was offered digitally until July 2020. The new cycle began in person in August 2020 under strict hygiene rules: No cooking together or family activities, only outdoor or digital training courses with no contact sports. During this time, the participation agreement was softened, allowing easier exit from the adapted program during the pandemic.

#### **4.1.2 Program Contents**

The program was conducted by trained experts in the fields of sport science, nutrition, psychology/pedagogy, and medicine. Based on a structured approach to patient education that takes into account current scientific evidence and a planned impact logic, written (age-appropriate) educational materials were distributed at CHILT III.

Medical consultation was provided by a physician 30 - 45 min per week for each participant and their parents and 3 x 45 min per program cycle for the entire group. The contents discussed included education about obesity, providing medical and theoretical information on the definition, causes, consequences (e.g., comorbidities, metabolic and pathogenetic aspects), treatment options of obesity and goal setting. Both children and their parents were weighed weekly and weight progress was discussed on a regular basis. At the beginning and end of the program the medical examination also included blood pressure measurement, bioelectrical impedance analysis, calipometry, blood sampling, anthropometric data collection, ergometry and exercise testing/ spiro ergometry (see [Chapter 4.2](#)).

Exercise sessions focused on achieving sustainable change in exercise behavior, improvement or stabilization of motor skills, improvement of endurance and coordination, increase of energy metabolism, injury prevention, preservation and building of muscle mass. The key goal was the positive experience of sports and physical activity and the promotion of a permanently exercise-oriented leisure time activity together with the social environment. In this regard, the group setting and the support of parents, classmates and instructors played a major role in mutual motivation. Instead of performance requirements, the program concentrated on awareness about and integration of exercise opportunities and sports clubs close to home, getting to know different exercise opportunities and learning sport-specific skills

and techniques. Specifically, these objectives were pursued in a total of 150-minute sports units per week (1x 60 min., 1x 90 min.), whereby strength and endurance training were paired with attractive and motivating forms of movement, didactic sports games and exercises that were adapted to sex and the individual degree of obesity. The sports practiced ranged from team sports such as soccer, flag football, and dodgeball to strength training, martial arts, and outdoor sports such as skateboarding and geocaching. In addition, theoretical knowledge transfer on the effect and benefit of physical activity took place and the consequences of increased sedentary behavior and screen-based activity was discussed. Once a month, one of the exercise sessions was held for the whole family.

The nutrition class took place 45 - 60 minutes per week in an alternating format: one week for children, the next only for parents, alternating with psychological consultation. Both for children and parents they dealt with the basics of a balanced, varied diet for children, nutritional psychology and the responsible handling of food and beverages. A well-trained professional informed the families about the principles of dietary change and guided the counseling through an energy-reduced mixed diet, taking into account the glycemic index of food and beverages. In close cooperation with the physician and the psychologist, she paid attention to eating disorders and psychological conditions such as depressions. Different methods were used to teach the fundamentals of healthy eating such as the food pyramid, a traffic light system (e.g., “red foods” = should be consumed sparingly/ are energy dense/ provide few nutrients relative to energy content) or the Nutri-Score. In addition, the nutrition class also involved joint cooking and grocery activities for the whole group once per cycle. Therapeutic strategies used should promote the social importance and value of eating, allow for sociable learning of food preferences (also changing the choice of beverages in favor of water), and

encourage flexible control of eating behaviors. Rigid diet plans (e.g., frequent weight reduction diets, fasting) were not used because their long-term success is questionable (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019).

Behavioral therapy is useful for implementing and maintaining the changes in diet and exercise behavior that have been achieved (Verbeken et al., 2013). Thus, stabilizing new behaviors and rules in the areas of nutrition, eating and exercise were of primary importance in the counseling sessions held by CHILT III pedagogues or psychologists. The psychological group counseling sessions, which were given separately for children and parents, dealt with the creation of an adequate awareness of the problem of obesity, motivation with regard to the reduction of weight, improving self-perception, strengthening self-confidence and self-acceptance. Applying a variety of techniques, behavioral therapy sessions addressed the use of role-models, a general training of communicative skills, the direct practice of the learned behavior and coping and problem-solving strategies. In the sessions with parents alone, the focus was also on capacity building and training of parenting skills including rewarding and reinforcement.

## 4.2 Scientific monitoring

CHILT III is registered in the German Clinical Trials Registry under ID DRKS00026785.

As defined by the WHO, a clinical trial is “any research study in which human participants or groups of people are prospectively assigned to one or more health-related interventions to evaluate the effects on health outcomes” (<https://www.who.int/clinical-trials-registry-platform>, accessed in March 2023). WHO defines health-related interventions as follows: “A health intervention is action taken for, with, or on behalf of a person or population, the purpose of which is to assess, improve, maintain, promote, or change health, functioning, or health status”.

From a scientific perspective, CHILT III aimed to evaluate the long-term effectiveness of an outpatient family-based approach on lifestyle (active daily and leisure time behavior, diet, etc.), anthropometric data/body composition, motor and physical performance (spiroergometry/ shuttle-run/ Dordel-Koch-Test [Jouck et al., 2006]), selected cardiac parameters (blood pressure, resting ECG) as well as selected biomarkers (lipids, adipokines, cytokines, etc.) and psychosocial factors (health-related quality of life, perception of self-competence/ self-concept) of children with obesity. To this end, the corresponding parameters as well as general personal information and data on socioeconomic status were analyzed before (t1) and after the project (t2) up to a follow-up of one (t3), two (t4), three (t5) and ten years after the program (t6).

A deposit system served as an additional incentive for regular participation in the measurements even after the end of the program: At the beginning, each family pays a deposit of 100 euros, which was refunded proportionally at each follow-up measurement once the examinations have taken place and the questionnaires have been completed. To ensure the quality of the measures, all data collected were entered

into an obesity patient tracking program (Adipositas-Patienten-Verlaufsdokumentation [APV]) and into an IBM SPSS Statistics database.

Participation was on a voluntary basis. All data was only collected after obtaining written consent. All patient data were subject to medical confidentiality and were, if at all, only passed on in anonymous form. Compliance with data protection regulations was expressly guaranteed ("World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects," 2013). Ethics approval for the trial was granted by the Sport University Cologne Committee for Ethics, for ethics application number 107/2014, updated on May 17, 2021.

A control group consisted of children and their families who were on the waiting list, i.e., they were interested in participating in the program but were not yet able to do so due to the group size (max. 12 – 15 participants) or other excluding factors. At the beginning and end of the program, the same data collection methods were used as for the intervention group.

#### **4.2.1 Data Assessment Relevant to this Dissertation**

##### *4.2.1.1 Anthropometric Data*

To measure body height, the children/adolescents stood barefoot with their feet in full contact with the ground and in an upright position with their backs against a wall. Contact points were the back of the head, the buttocks, and the heels. The head was kept straight, and the knees were extended. The measurement was taken with a measuring rod fixed to the wall (Seca Scale 225). Body height was determined to the nearest 0.1 cm. Before determining body weight, a digital scale was tared (Seca scale 761) and secure footing was checked. Body weight was determined to the nearest 0.1

kg while barefoot and wearing light clothing. BMI was determined, and sex- and age-specific BMI Z-scores (BMI SDS) were calculated according to the German percentile charts of Kromeyer-Hauschild et al. (2001). Body composition at the beginning and end of the program was determined by measuring skinfold thickness to the nearest 0.2 mm in triplicate at tragus, base of tongue, axilla pectoris, axilla 10th rib, navel, hip, subscapular, triceps, patella and calf using a body fat caliper (Harpender Skinfold Caliper HSK-BI, British Indicators, West Sussex, England). The mean of the three measurements was considered the final value. Weight and height measurements were first performed at the beginning of the program and then repeated at all follow-up visits. Calipometry was performed up to t3.

#### *4.2.1.2 Demographics and Lifestyle Determinants*

Parents completed standardized questionnaires (see [appendix](#)) in which they recorded demographic data and lifestyle habits of themselves and their children at all measurement points (t1-t6). The demographic variables included children's sex, age, migration background, and parents' educational background. If there was no information on the child's nationality, the child's migration background was determined by language spoken at home (Plachta-Danielzik & Müller, 2015). Parents' educational background was assessed by their highest educational degree (Lange et al., 2010).

To examine lifestyle patterns, parent-reported physical activity and media consumption, a commonly used indicator of sedentary behavior (Wu et al., 2017), were included. Regarding the child's level of physical activity, parents were asked whether the child participates in sports regularly or irregularly, and if so, which sports and for how many minutes. Media use was assessed by asking parents to indicate the total

amount of time per day their child spent watching TV, on a game console, on the computer, on the Internet, listening to music, and/or using a cell phone.

#### *4.2.1.3 Physical Fitness*

In this work, physical fitness was determined using bicycle ergometry. The bicycle ergometry was performed at t1, t2 and t3 on a speed-independent ergometer unit (Ergometrics 900 from ERGOLINE GmbH & Co KG, Bitz, Germany) with integrated electrocardiogram (ECG) analysis recording and blood pressure measurement.

Prior to performing the exercise stress test, a 12-lead ECG recording was performed that included both extremity and chest wall leads to assess clinical eligibility (Lawrenz et al., 2019). After individual adaptation of the bicycle ergometer to the subject, the test began with a load of 25 W and was increased by 25 W every 2 minutes (Lier et al., 2020b; Trappe, 2000). For standardization, a flat rate of rotation of the ergometer between 60 – 80 rpm was specified. In the last 30 seconds of the respective load level, the arterial blood pressure was measured, capillary blood was taken from the earlobe to determine the lactate concentration, peak mechanical power and heart rate were determined, and ECG analysis was performed with simultaneous screen display and print documentation. Gas exchange was measured breath-by-breath, and the peak  $\text{VO}_2$  was determined via a Spirograph system (ZAN 600 CPET, Oberthulba, Germany). In this dissertation, peak mechanical power to body weight ratio (W/kg) was used as the measure of physical fitness.

The children and adolescents exercised until subjective exhaustion or until the discontinuation criteria described by Lawrenz et al. (2019) occurred. The maximal stress limit was clearly defined, e.g., using the BORG scale or blood pressure increase

of >250 mmHg systolic. Throughout the test, participants were verbally encouraged by staff to exert maximum effort while at the same time being carefully monitored throughout the exercise testing and during the recovery period. After stopping, the child/ adolescent remained seated on the bicycle for a further 6 minutes, continuing to ride without resistance and reduced speed.

#### *4.2.1.4 Health-Related Quality of Life*

Version B of the "Weight-Related Quality of Life Questionnaire for Overweight and Obese Children and Adolescents" (GW-LQ-KJ) by Warschburger et al. (2005) was used to assess HRQOL (see [appendix](#)). The GW-LQ-KJ consists of 11 items. On a five-point Likert scale from "always" to "never", children and adolescents rated 11 statements such as "preferred to be alone than with others because of my weight" for the past two weeks." Results were adjusted to fall within a range of 0-100 and recoded and so that high scores indicated high HRQOL. The test was conducted at all measurement points. Cronbach's  $\alpha$  was calculated for reliability analysis (Cohen & Cohen, 1983). The internal consistency of the HRQOL score was both satisfactory at baseline with  $\alpha_{t1} = 0.82$  ( $n = 411$ ) and at follow-up  $\alpha_{t2} = 0.84$  ( $n = 164$ ) and  $\alpha_{t3} = 0.86$  ( $n = 133$ ), corresponding to previous validation values (Warschburger et al., 2004; Warschburger et al., 2016).

#### *4.2.1.5 Self-Concept*

For the assessment of the self-concept, the "Fragebogen zur Erfassung von Selbst- und Kompetenzeinschätzungen bei Kindern" (FSK-K; Questionnaire for the assessment of self and competence in children) by Wünsche and Schneewind (1989)

was used (see [appendix](#)). The FSK-K is a German version of Harter's Self-Perception Profile for Children (Harter, 1982) which is widely used in the context of childhood obesity (Christison & Khan, 2012; Reinehr et al., 2005). In the 30-item questionnaire, each item was rated on a scale of 1 to 4 in an alternative statement format, with a positive statement on one side (e.g., "I like my body the way it is") and a negative statement on the other side (e.g., "I want my body to be different"). At all measurement points, the child/adolescent then decided which side of the description was kind of true/ almost true/ really true for him/her.

Five subscales resulted from the FSK-K: scholastic; social; physical, and behavioral self-concept, and global self-worth. After recoding, the highest self-concept in each subscale was defined with a mean of 100. The internal consistencies of the subscales at baseline and follow-up (t2, t3) were, respectively,  $\alpha_{t1} = 0.79$ ;  $\alpha_{t2} = 0.77$ ;  $\alpha_{t3} = 0.76$  for scholastic SC ( $n = 419$ ; 300; 133),  $\alpha_{t1} = 0.82$ ;  $\alpha_{t2} = 0.82$ ;  $\alpha_{t3} = 0.83$  for social SC ( $n = 401$ ; 304; 127),  $\alpha_{t1} = 0.76$ ;  $\alpha_{t2} = 0.78$ ;  $\alpha_{t3} = 0.83$  for physical SC ( $n = 389$ ; 152; 121),  $\alpha_{t1} = 0.77$ ;  $\alpha_{t2} = 0.79$ ;  $\alpha_{t3} = 0.78$  for behavioral SC ( $n = 409$ ; 306; 126), and  $\alpha_{t1} = 0.71$ ;  $\alpha_{t2} = 0.77$ ;  $\alpha_{t3} = 0.78$  for global self-worth ( $n = 388$ ; 302; 128; compare Strauss, 2000).

## 5. Publications

### 5.1 Study I

#### **Predicting Psychosocial Health of Children and Adolescents with Obesity in Germany: The Underappreciated Role of Physical Fitness**

##### **Citation**

Eisenburger, N., Friesen, D., Haas, F., Klaudius, M., Schmidt, L., Vandeven, S., & Joisten, C. (2021). Predicting Psychosocial Health of Children and Adolescents with Obesity in Germany: The Underappreciated Role of Physical Fitness. *International Journal of Environmental Research and Public Health*, 18(21), 11188. MDPI AG. <http://dx.doi.org/10.3390/ijerph182111188>

##### **Abstract**

The aim of this study was to analyze the inhibitory and promotive factors of psychosocial health in the context of childhood obesity, incorporating physical fitness as an additional, potentially relevant predictor. The sample comprised cross-sectional data of 241 children and adolescents with obesity and overweight from the German Children's Health InterventionAL Trial III program ( $12.5 \pm 2.1$  years; 51.9% girls). Demographics and lifestyle patterns were assessed via parent reports. Anthropometric data and physical fitness in relation to body weight (W/kg) were measured. Children and adolescents completed standardized questionnaires (GW-LQ-KJ, FSK-K) to assess health-related quality of life (HRQOL) and five dimensions of self-concept (scholastic, social, physical, behavioral, and self-worth). Multiple linear regression analysis showed that HRQOL was significantly related to relative physical fitness (W/kg;  $\beta = 0.216$ ,  $p = 0.011$ ) as were scholastic ( $\beta = 0.228$ ,  $p = 0.008$ ) and social self-

concept ( $\beta = 0.197$ ,  $p = 0.023$ ). Increasing body mass index (BMI) Z-scores, age, physical activity (hours/day), low parental educational levels, and/or migration background were negatively associated with three subdomains of self-concept (physical, behavioral, self-worth; all  $p < 0.05$ ). The results emphasize BMI Z-scores, age, physical activity, migration background, and parents' educational level as relevant predictors of psychosocial health in the context of childhood obesity. Additionally, this study adds physical fitness as a key determinant of HRQOL and self-concept. To enable the development of more effective weight management, therapeutic strategies should therefore consider addressing these aspects and improving physical fitness in particular not only for weight loss but also to strengthen psychosocial health.

## **Summary**

**Background:** Childhood obesity is not only related to serious physical health issues but also to psychosocial impairments (Sagar & Gupta, 2018). Therefore, in addition to weight reduction or stabilization, strengthening psychosocial health plays an important role in multidisciplinary weight management programs. To appropriately target multidisciplinary approaches, a deeper understanding of the obesity-related factors that influence the psychosocial health of children with obesity, either positively or negatively, is critical (Meixner et al., 2020). Current research suggests that, for example, age, sex, migration background, socioeconomic status, physical (in-)activity, and physical fitness may be among the key determinants of weight development on the one hand and psychosocial health on the other (Eddolls et al., 2018; Vedul-Kjelsås et al., 2012).

Objective: Thus, by analyzing cross-sectional data of the CHILT III program, this paper aimed at analyzing potential predictors of HRQOL and self-concept in the context of childhood obesity to derive implications for improved weight management strategies.

Methods: The minimum criteria for inclusion in this study were participation in the CHILT III program between 2003 and 2020; complete height, weight, age, and body fat percentage data at baseline; and fully completed HRQOL and/or self-concept questionnaires. The final sample consisted of 241 children and adolescents (51.9% girls) with obesity. HRQOL (Warschburger et al., 2005) and sub-dimensions of self-concept (scholastic, social, physical, behavioral and global self-worth, Wünsche & Schneewind, 1989) were explored using backward stepwise multiple linear regression analysis including BMI Z-scores, body fat percentage, and relative physical fitness, media use, physical activity levels, and demographic data as potential predictors. For this study, parental education was treated as a dichotomous variable (low vs. high= both parents had completed high school, Plachta-Danielzik & Müller, 2015). Slaughter et al.'s (1988) fat percentage equations were used according to Rodríguez et al. (2005) to assess body fat percentage.

Results: The statistical results showed that the determinants of psychosocial health were negative associated to increasing age, high BMI Z-scores, migration background, low parental education, and physical activity, and positively related to physical fitness. The predictors explained approximately 3% - 17% of variance in the final regression models.

Discussion: Consistently with the literature, the findings of this study undermine the importance of early intervention and parental involvement in weight management programs to address at-risk children in particular (Plachta-Danielzik & Müller, 2015). Because high BMI-Z scores can negatively impact body self-perception, strategies to

improve physical self-concept may be critical, especially in adolescence, where participants in this study were particularly vulnerable to body dissatisfaction (Sánchez-Miguel et al., 2019). Furthermore, the results indicate the importance of physical fitness for increasing psychosocial well-being. Given the complex interplay between weight development, physical fitness, and psychosocial health, our results hence suggest that a focus on improving fitness could lead to more sustainable therapy outcomes than short-term weight loss. In addition, since the relationship between self-reported physical activity and self-concept was negative, improving motor skills to account for deficiencies is recommended (Korsten-Reck et al., 2007).

## 5.2 Study II

### Cardiovascular Endurance and Psychosocial Health Predict Short- and Long-term BMI-SDS Reduction – Results from the CHILT III Program

#### Citation

Eisenburger, N., Ferrari, N., Friesen, D., Haas, F., Klaudius, M., Schmidt, L., Vandeven, S., & Joisten, C. (2023). Cardiovascular endurance and psychosocial health predict short- and long-term BMI-SDS reduction: Results from the CHILT III program. *European Journal of Pediatrics*. [https://doi.org/10.1007/s00431-023-04876-](https://doi.org/10.1007/s00431-023-04876-7)

7

#### Abstract

This longitudinal study analyzes data from the Children's Health Interventional Trial (CHILT) III, an 11-month juvenile multicomponent weight management program. The objective is to identify predictors of changes in body mass index standard deviation scores (BMI-SDS), so as to further enable the advancement of existing interventions with sustained impact.

This study's sample consists of 237 children and adolescents with obesity (8–17 years, 54 % girls) participating in the CHILT III program between 2003 and 2021. Anthropometrics, demographics, relative cardiovascular endurance (W/kg) and psychosocial health (i.e., physical self-concept and self-worth), were assessed at program entry (t1), end (t2) and one-year follow-up (t3;  $n = 83$ ).

From t1 to t2, the mean BMI-SDS was reduced by  $-0.16 \pm 0.26$  units ( $p < 0.001$ ). Media use and cardiovascular endurance at baseline, and improvements in endurance and

self-worth over the course of the program predicted changes in BMI-SDS (adj.  $R^2 = 0.22$ ,  $p < 0.001$ ). From t2 to t3, mean BMI-SDS increased ( $M = 0.09 \pm 0.29$ ,  $p = 0.005$ ). Changes in BMI-SDS from t2 to t3 were associated with parental education, improvements in cardiovascular endurance and physical self-concept, and BMI-SDS, media use, physical self-concept, and endurance level at program end (adj.  $R^2 = 0.39$ ,  $p < 0.001$ ).

This study highlights the need for comprehensive, sustainable weight management approaches, in order to sustain the initial treatment benefits. In this context, improvements in cardiovascular endurance and psychosocial health could be essential strategies to pursue in practice, as they significantly predicted reductions in BMI-SDS – both pre- to post-intervention and at follow-up.

## **Summary**

**Background:** Multidisciplinary weight management approaches are essential to support children and adolescents affected by obesity and their families. However, while these obesity treatment strategies are often effective in achieving weight loss in the short-term, long-term success remains challenging (Al-Khudairy et al., 2017; Zolotarjova et al., 2018). It is therefore crucial to identify factors associated with sustained weight loss and/or stabilization to optimize existing interventions. Several predictors of sustainable treatment success such as degree of overweight at baseline, initial weight loss success, physical activity levels, and psychosocial health have been identified in earlier studies (Buscemi et al., 2013; Elfhag & Rössner, 2005; Wing & Phelan, 2005). Other potential influencing factors, however, such as sex, self-concept, family demographic variables, media consumption, or cardiovascular fitness, have

yielded contradictory results or have received little or no research attention (Braet, 2006; van Egmond-Fröhlich et al., 2006).

**Objective:** Using CHILT III longitudinal data, this study intends to determine factors associated with short- and long-term BMI-SDS reduction at program completion and one-year follow-up to draw conclusions for effective long-term weight management.

**Methods:** The sample consisted of a data set of 237 children and adolescents (54 % girls) and their parents ( $n = 449$ : 235 mothers; 214 fathers) who participated in CHILT III between 2003 and 2021. Two-tailed t-tests were performed to detect significant changes in participant characteristics from the beginning ( $t_1$ ) to the end ( $t_2$ ) of the CHILT III program and at one-year follow-up ( $t_3$ ,  $n = 83$ ). Changes in BMI-SDS from  $t_1$  to  $t_2$  and from  $t_2$  to  $t_3$  were examined using backward multiple linear regression analysis. Relative cardiovascular endurance (W/kg), physical self-concept and self-worth and several additional confounders, e.g., sex, age, media use and parental educational level, were included as predictors.

**Results:** From program start to program end, BMI-SDS was significantly reduced while cardiovascular endurance and physical self-concept increased (all  $p < 0.005$ ). From  $t_2$  to  $t_3$  BMI-SDS increased again ( $t[236] = 2.9$ ,  $p = 0.005$ ,  $d = 0.33$ ) and no significant change in the other variables was found. Backward multiple linear regression analysis revealed significant associations between BMI-SDS reductions and cardiovascular endurance (at baseline [ $\beta = -0.14$ ,  $p = 0.022$ ] and changes from  $t_1$  to  $t_2$  [ $\beta = -0.35$ ,  $p < 0.001$ ]), global self-worth ( $\beta = -0.23$ ,  $p = 0.001$ ), age ( $\beta = 0.36$ ,  $p = 0.001$ ), adolescence stage ( $\beta = 0.26$ ,  $p = 0.009$ ), and media use ( $\beta = 0.14$ ,  $p = 0.048$ ) from  $t_1$  to  $t_2$ . From  $t_2$  to  $t_3$ , cardiovascular endurance ( $\beta = -0.60$ ,  $p < 0.001$ ), physical self-concept ( $\beta = -0.23$ ,  $p = 0.02$ ), parental education ( $\beta = 0.22$ ,  $p = 0.025$ ), sex ( $\beta = -0.22$ ,  $p = 0.020$ ), BMI-

SDS at program end ( $\beta = -0.41$ ,  $p = 0.003$ ), and media use ( $\beta = -0.25$ ,  $p = 0.007$ ) predicted the magnitude of changes in BMI-SDS.

*Discussion:* Our study confirms the short-term success of a multidisciplinary approach to reducing childhood obesity, while also demonstrating how difficult it is to sustain. In this respect, the findings highlight the important role of psychosocial health, i.e., physical self-concept and self-worth, and cardiovascular endurance among the predictors of short- and long-term BMI-SDS reduction. In contrast to the other variables that showed significant associations to changes in BMI-SDS in our study (e.g., parental education, sex, age, and stage of adolescence), these parameters can be directly targeted in interventions. Lastly, our study also adds to the scientific discourse that media consumption may have a role in the long-lasting success of weight management programs. This should be further explored.

### 5.3 Study III

#### **Lessons Learned from Juvenile Weight Management Programs During the Covid-19 Pandemic Across Germany**

##### **Citation**

Eisenburger, N., Schmidt, N., Ortmann, S., Friesen, D., Haas, F., Wessely, S., & Joisten, C. (2021). Gewichtsmanagementprogramme für Kinder und Jugendliche während der Covid-19-Pandemie in Deutschland – Was wir daraus lernen können. *Adipositas - Ursachen, Folgeerkrankungen, Therapie*, 15(04), 212–219. <https://doi.org/10.1055/a-1638-6128>

##### **Abstract**

The aim of this study was to analyze if and how weight management providers implemented or adapted their programs during the first COVID-19 pandemic lockdown and how this was perceived by the participating families. A combined quantitative and qualitative approach was used. In May 2020, fourteen of 29 weight management providers in Germany completed online questionnaires. Fifty-five participating families responded to a family-level questionnaire. All providers made digital adjustments during the pandemic including counseling via telephone, email and video calls. Despite challenges, especially in terms of practical implementation, a lack of familiar routines and group dynamics, providers reported positive outcomes for internal organization and participants mentioned improved accessibility and individualized attention. Twenty families (30.9%) observed weight changes in the participating children, including 10 reporting weight gain (18.2%;  $M=5.0 \pm 4.0$  kg).

The digital implementation of weight management programs as a result of the COVID-19 restrictions was feasible and was mostly viewed positively, particularly due to greater time flexibility and improved accessibility. Nevertheless, children's weight increased during the lockdown. To maximize the effectiveness of weight management programs, a combination of conventional strategies and the intentional use of digital elements, for example in individual counseling sessions, is recommended in the long term.

## **Summary**

**Background:** To mitigate the spread of the COVID-19 pandemic, hygiene, and distancing rules, as well as contact restrictions were implemented in Germany. Because of nationwide lockdowns and school closures, children and their families were forced to stay at home. Current scientific evidence suggests that as a consequence, physical activity levels decreased while media consumption, stress and anxiety increased during the pandemic (Androutsos et al., 2021; Iqbal & Tayyab, 2021; Ravens-Sieberer et al., 2021). It is particularly critical that these factors not only promote the development of weight gain (Rundle et al., 2020), but that at the same time weight management programs for children and adolescents with obesity had to be adjusted or discontinued during the pandemic.

**Objective:** Therefore, the purpose of this study was to use a mixed methods approach to examine whether and how weight management program providers offered their programs during the lockdown and how this was perceived by participating families.

**Methods:** This analysis was primarily based on the results of a program-level survey of currently operating outpatient weight management providers in Germany ( $n = 29$ ).

Additionally, a second survey was carried out among participating families to complement the findings with their perspective. Both questionnaires were developed by the research group in cooperation with the Childhood Obesity Working Group. Qualitative data were analyzed according to the Grounded Theory (Glaser & Strauss, 1967) and managed using MAXQDA 2020. Quantitative data were analyzed graphically in MS Excel and SPSS 27.0 was used for descriptive analysis.

**Results:** In total, 14 weight management providers in Germany were included in the survey (Ten did not respond, six were excluded because they did not meet the inclusion criteria). On average, the number of children and adolescents participating in the obesity therapy and prevention programs was  $28.6 \pm 33.2$  (Min:10, Max:140). Analyses of the responses to the questionnaire revealed four main themes containing a different number of subthemes: (Digital) adjustments of sessions during pandemic restrictions, challenges, positive outcomes, and consequences for the organization and the future of the program.

Fifty-five of 401 families participating in the German programs responded to the family-level questionnaire. Seventeen participating families (30.9%) observed changes in the child's weight during the pandemic in terms of weight loss ( $n = 7$ ,  $M = 3.0$  kg,  $SD = 1.3$  kg) and weight gain ( $n = 10$ ,  $M = 5.0$  kg,  $SD = 4.0$  kg). Open responses to the questionnaire were clustered into three main themes: positive feedback, negative feedback, and suggestions.

**Discussion:** In sum, the continuation of the programs (albeit mostly in digital form), the individualized care, and the time savings in terms of flexible scheduling and lack of travel for both providers/trainers and parents were all viewed positively. However, the lack of group dynamics, personal contact and technical equipment/know-how in low-income households were criticized. Concerns were thus expressed about the

programs' impact on weight loss and lifestyle changes. In addition, the digital components of the weight management programs resulted in even more media time than what was already required by homeschooling. Nonetheless, our results imply that the addition of digital components, more outdoor activities, and opportunities for individual contact through virtual exchanges could be valuable lessons for the future. Among them, the importance of mandatory schedules and binding commitments to regulate children's weight-related behaviors (Neshteruk et al., 2021).

## 5.4 Study IV

### Short Report: Weight Management of Children and Adolescents with Obesity during the COVID-19 Pandemic in Germany

#### Citation

Eisenburger, N., Friesen, D., Haas, F., Klaudius, M., Schmidt, L., Vandeven, S., & Joisten, C. (2022). Short report: Weight management of children and adolescents with obesity during the COVID-19 pandemic in Germany. *PloS One*, 17(4), e0267601. <https://doi.org/10.1371/journal.pone.0267601>

#### Abstract

The aim of this analysis was to assess the effectiveness of a juvenile outpatient weight management program during the coronavirus pandemic in Germany, which was implemented digitally during the initial lockdown and thereafter under strict hygiene rules (e.g., adapted exercise sessions). Changes in body mass index standard deviation scores (BMI-SDS), physical fitness, media consumption, health-related quality of life (HRQOL), and social self-concept of 28 children and adolescents were compared to data of 30 participants before the pandemic. Adjusted mean changes from baseline to follow-up in BMI-SDS ( $M = -0.07 \pm 0.30$ ), relative physical fitness ( $M = 0.0 \pm 0.3$  W/kg), media use ( $M = 0.5 \pm 2.6$  hours/day), HRQOL ( $M = -1.6 \pm 15.3$ ), and social self-concept ( $M = -3.8 \pm 13.2$ ) during the pandemic were not significantly different from those of the pre-pandemic participants (all  $p > 0.05$ ). Therefore, the results suggest that an adjusted approach to weight management, which combined digital and adapted in-person components to meet hygiene requirements during the pandemic, was as effective as the pre-pandemic program. It could thus be a potential

solution to ensure continuity of care for vulnerable children with obesity during the pandemic and the associated restrictions.

## **Summary**

**Background:** With the observed lifestyle changes resulting from nationwide restrictions to prevent the spread of COVID-10, a growing number of researchers predict a significant increase in childhood obesity (Rundle et al., 2020). In addition, obesity is a risk factor for a more severe and complicated course of COVID-19 and children already affected by obesity were more vulnerable for weight gain during the pandemic lockdown (Woo Baidal et al., 2020; Woolford et al., 2021). Therefore, appropriate weight management strategies were and are critical in children and adolescents with obesity. However, outpatient weight management programs had to be discontinued or implemented in digital or modified form during the pandemic. The CHILT III program, for example, switched to digital delivery through individual video calls/ group sessions with the start of pandemic restrictions in Germany in March 2020 until the end of the cycle in July 2020. In August 2020, the new cycle began in person under strict hygiene regulations.

**Objective:** The objective of this brief analysis was to evaluate the effectiveness of the modified CHILT III program during the COVID-19 pandemic period by comparing data during and before the pandemic.

**Methods:** Mean changes from baseline to follow-up in BMI-SDS, physical fitness (W/kg), media consumption (hours/day), HRQOL, and social self-concept during the pandemic period (2019-2021) were compared to pre-pandemic outcomes using analysis of covariance with gender, age, and the respective baseline value as

covariates. The final study sample consisted of 58 children participating in the CHILT III program between 2017 and 2021.

*Results and Discussion:* According to the results, there was no significant difference in the effectiveness of the CHILT III program before and during the pandemic. In particular, with regard to BMI-SDS reduction and stabilization of fitness levels, implementation of the modified program under strict sanitary conditions can thus be considered a successful approach to provide uninterrupted support and prevent the risk of worsening health inequalities after the COVID-19 pandemic. Nevertheless, in line with earlier research, the findings also indicate a small (albeit not significant) decrease in HRQOL and social self-concept and a marginal increase in media use. High levels of screen time during the pandemic have been shown to have negative effects on psychosocial well-being and are associated to physical inactivity (Muñiz-Velázquez et al., 2021). Therefore, while telehealth may increase accessibility, flexibility and individual care, the use of digital media in weight management settings should especially target social interaction and exercise. Wherever possible, while adhering to hygiene regulations, maintaining shared sports activities (e.g., outdoors) in combination with digital content can be essential for promoting psychosocial and physical well-being in times of social distancing.

## **6. Summarized Discussion**

### **6.1 Methodological limitations**

Despite all efforts, this dissertation is naturally not free of limitations. In contrast to study 3, studies 1, 2, and 4 were based on CHILT III data, so similar limitations in methodology and data collection must be considered.

#### **6.1.1 Study I, II, IV**

##### *6.1.1.1 CHILT III Database*

Study 1,2 and 4 are limited to a single weight management program in Cologne and the conclusions drawn may not be applicable in different settings/ countries. The long period over which the data were collected (2003-2021) must also be taken into account, as it could be related to changes in the conditions and/or framework for the implementation of the program and data collection. For example, changes in personnel over time may have resulted in differences in the measurements. There may also have been differences between the two intervention sites (German Sport University Cologne and Cologne-Meschenich) in study design and patient characteristics such as household income or sociocultural factors.

In addition, selection/participation bias cannot be discarded because the data were collected from a group of individuals who were seeking treatment, so participants may have characteristics that distinguish them from other groups (e.g., motivation, psychological distress). Another limitation is that there was not sufficient data in the investigated parameters (i.e., HRQOL, self-concept, follow-up data at t3) in the control group or in participants who dropped out of the study, so intention-to-treat analysis was not applicable. There are also no data on the reasons for dropouts, especially after the

intervention ended. The sample was also too small to use in a representative study in follow-up years at time points t4, t5, and t6, so the author is aware of possible criticisms of the term "long-term" in the analysis of BMI-SDS reductions from Study 2.

Concerning the statistical analyses (all of which were performed using the most recent version of SPSS), results must be interpreted with caution because of a high variability in the sample and the small sample size in study 4 which focused on only two CHILT III cycles during the pandemic. In studies 1 and 2, backward stepwise multiple linear regression analyses were employed. On one hand this method leads to a lower variance resolution, a smaller adjusted  $R^2$  and potentially unadjusted final predictors compared to more conventional regression analysis, but on the other hand it has the advantage of clearly revealing which variables actually have a significant association with the dependent variable (Collins et al., 2015).

Furthermore, several factors relevant to obesity were not included in the studies due to incomplete data which would have resulted in too large a reduction in sample size. These included dietary habits, school type, single parenthood, and parental BMI. We refrained from using data imputation to deal with missing data "because by definition the missing data are unknown and it can therefore not be assessed if the observed data can predict the unknown data" (Jakobsen et al., 2017). In "When and how should multiple imputation be used for handling missing data in randomised clinical trials – a practical guide with flowcharts", Jakobsen et al. (2017) recommend using observed data only in case the mechanisms that cause the missing data are unclear or depend neither on observed data nor on the missing data.

International reviewers of the above publications have criticized that the selection of literature on which the methodology for data collection is based is not up to date. However, the selected tools are recommended by the AGA and therefore continue to

be widely used in Germany, improving the screening, monitoring, and comparing of German multidisciplinary weight management programs.

#### *6.1.1.2 Anthropometric Measurements*

Incorrect placement of the stadiometer bars, a non-upright posture, or lack of heel contact with the back wall may have resulted in inaccurate height measurements. Inaccuracies may have occurred in the measurement of body weight if the scale was not tared, if it was placed on uneven ground, or if the children were wearing other clothing such as tights under their sportswear.

Comparisons of BMI-SDS with other international studies are difficult due to the use of different BMI-SDS cut-off values and reference groups. Many international studies therefore use international growth charts from the International Obesity Task Force (Rankin et al., 2016) or the Centers for Disease Control which recommends using the following definitions for overweight and obesity for children and adolescents between 2 and 20 years: Overweight: BMI  $\geq$  85th < 95th percentile; Obesity: BMI  $\geq$  95th percentile (S. Kumar & Kelly, 2017). In the 2013 KiGGS study of the Robert Koch Institute, only minor differences were found between the older German reference data of Kromeyer-Hauschild et al. (2001) and the KiGGS percentiles (Rosario et al., 2011). However, the authors found major differences from the German growth curves and the curves of the Centers for Disease Control, the WHO standard for 0- to under-5-year-olds and the WHO references for older children and adolescents ("WHO Child Growth Standards Based on Length/height, Weight and Age," 2006).

In addition, Cole et al. (2005) showed that BMI-SDS is sensitive to changes in the middle of the adiposity range but insensitive to changes at the extremes. Nevertheless,

the use of BMI-SDS based on the percentile charts of Kromeyer-Hauschild et al. is recommended as a national reference because, compared with BMI, it allows sex- and age-specific differentiation, it is suitable for screening and monitoring growth in children in Germany, and is easy to use (Rosario et al., 2011). In addition, the AGA recommends the use of complementary diagnostic methods for a comprehensive assessment of individual health risks (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter, 2019).

In the first study, body fat percentage based on measures of skinfold thickness using a body fat caliper was thus included into the analysis. However, using skinfold-thickness equations such as Slaughter skinfold-thickness equations for assessment of body fat percentage has been criticized because results may vary systematically in important subgroups: Truesdale et al. (2016) reported differential bias by sex, race/ethnicity, weight status, and age. Similarly, Slaughter's equations have been found to overestimate body fatness in children with obesity (Freedman et al., 2013). According to the authors, it has thus no advantage over BMI-SDS in identifying children who are at increased risk for cardiovascular diseases. Lastly, measurement of skinfold thickness strongly depends on the experience of the examiner and the correct measuring point (Kromeyer-Hauschild et al., 2001). Although bioimpedance analysis was also performed in CHILT III to assess body composition, the inclusion of calipometry measurements was preferred over bioimpedance analysis in study 1 because more skinfold thickness data were available.

#### *6.1.1.3 Bicycle Ergometry*

Bicycle ergometry is referred to as the gold standard for cardiopulmonary exercise testing (Hollmann et al., 2006), but it is also viewed critically in childhood and

adolescence. The criticisms include children's limited ability to concentrate and the early local fatigue of the child's leg muscles, so that the maximum metabolic workload may not be achieved (Kupfer, 2010; Trappe, 2000). In addition, a variety of different exercise protocols exist for bicycle ergometry, making comparison difficult. The Working Group on Exercise Testing of the German Society for Pediatric Cardiology and the Society for Pediatric Sports Medicine, for example, recommend a weight-based protocol with load levels of 0.5 W/kg body weight and increase in load every 2 or 3 minutes (Lawrenz et al., 2019). According to Lawrenz et al. (2019), however, the disadvantage of this protocol is that children with overweight or obesity are more heavily loaded and less favorably evaluated in relation to their muscle mass than normal-weight children and that comparative values exist only from a collective of healthy children and adolescents. Finally, it can be criticized that we used the term physical fitness to report the results of bicycle ergometry. Physical fitness is a broad term which may include cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition (Ortega, Ruiz, et al., 2018). Therefore, we have adjusted it in study 2 and used "cardiovascular endurance" instead.

#### *6.1.1.4 Questionnaires to assess Lifestyle Patterns and Demographics*

While questionnaires have the advantage of low costs and low time and personnel expenditure, they also have disadvantages. For example, it is not possible to check who filled in the questionnaire and whether this person was able to give the relevant answer adequately or whether the question was understood correctly. In terms of understanding, it is possible that parents with a higher level of schooling and without a migration background provided more reliable information. The return rate of the questionnaires was to be increased by asking the parents to fill in the questionnaires

on site. Biases due to self-report, social desirability or social expectations also may play a role: It can be assumed that the data on physical activity might be biased upward, and the times of media consumption were biased downward.

It is possible that parents may have misjudged their children's level of physical activity and media use and had difficulty in accurately indicating the number of minutes. Irregular movement patterns of children with many short activity sequences also might make the subjective recording of a total activity time span difficult. A large amount of missing data on the child's physical activity (e.g., in study 1  $n = 79$  of 241 [32.8%]) and media use (e.g., in study 1  $n = 51$  of 241 [21.2%]) indicates that less educated, less interested, or less committed parents maybe did not provide any information. Precise data on the validity of the parent responses are not available. Additionally, Ortega, Cadenas-Sanchez, et al. (2018) advise against mixing the concepts of inactivity with sedentariness, since a person can be simultaneously active (if they meet the minimum guidelines for physical activity per week) and sedentary (if they spend a lot of time in sedentary behavior).

While the questionnaire has the advantage of being able to collect additional information on the type and the intensity of physical activity compared to objective measures of physical activity, no distinction was made between the types and intensities in our studies. Since the questionnaire was filled out retrospectively, the information could be imprecise. Furthermore, it is possible that the survey was subject to seasonal fluctuations, as people may exercise less and sit more in winter than in summer (Silva et al., 2011).

In Germany, the Winkler index is often used to depict the social-economic status of the household on several levels, with education, income, and the occupation of the parents as key dimensions (Schenk et al., 2008). However, income was not included in our

questionnaire because the risk of misreporting, dropouts and missing data was too high. Information on occupation was requested but not used in the analyses because of missing data and because women might have been at a disadvantage compared to men due to their frequently interrupted employment history. In contrast, parental education level has been repeatedly shown in studies to be one of the strongest determinants of children's weight and health status and an appropriate proxy for socioeconomic status (Lange et al., 2010; Vrijkotte et al., 2020).

To adequately reflect the migration background, Schenk et al. (2008) recommend a differentiation of the migrant population into important subgroups, e.g., by uni- or bilateral migration background, by country of origin, or by length of stay. The authors criticize different definitions of the migrant population and related terms in the scientific literature such as "race," "ethnicity," "nationality," or "migrant." We have thus referred to "migration background" (yes/no) in our studies. Although our questionnaire asked about the child's country of birth, nationality, and length of residence in Germany, due to a lack of information the language spoken at home often had to be used to determine migration background.

#### *6.1.1.5 GW-LQ-KJ*

The GW-LQ-KJ was developed specifically for obese children and adolescents and asks about limitations in daily life due to weight and the demands associated with weight loss (Warschburger et al., 2005). Thus, it is a disease-specific quality-of-life measurement tool that has been shown to be reliable and valid for this group (Hoffmann & Warschburger, 2015; Warschburger et al., 2004). However, this of course makes it so specialized that cross-cultural comparisons (with non-overweight populations) are difficult. Other methods to assess the quality of life of children, such

as the KIDSCREEN-52 (e.g., in Ottova et al., 2012), the KINDL-R (e.g., in Krause et al., 2014), or the Pediatric Quality of Life Inventory (e.g., in Schwimmer et al., 2003), can also specifically map individual subdomains of the multidimensional concept of quality of life, whereas the GW-LQ-KJ cannot. To foster comparability with other HRQOL questionnaires (compare Buttitta et al., 2014; Griffiths et al., 2010), the results of the GW-LQ-KJ, ranging from 1-5, were recorded to fall within a range of 0-100 in this work.

#### *6.1.1.6 FSK-K*

Studies 1, 2, and 4 used the FSK-K, a German version of the Harter Self-Perception Profile for Children (SPPC), an internationally recognized and widely used instrument for assessing self-esteem or self-concept. The SPPC's discriminant validity has been questioned due to high correlations between the individual subdomains and the question format has been criticized (Arens & Morin, 2017). The latter refers to the design of the questionnaire with one statement on the left and one on the right, where the child has to decide which statement is "really" or "sort of" true for him. This system might be too complex and difficult to understand. At CHILT III, the FSK-K was sometimes filled out by the parents who might have misjudged the child's self-perception. Furthermore, it has been criticized that the global self-worth domain is qualitatively different from the other domain-specific self-concept scales (scholastic, social, physical and behavioral, Arens & Morin, 2017).

In this dissertation, the domains were derived according to Harter's (2012) SPPC manual and correspond to other international versions of the SPPC (Christison & Khan, 2012; Wong et al., 2009). Nevertheless, it should be mentioned that the FSK-K consists of only 30 items and not 36 like the other versions of the SPPC, omitting the domain

“athletic competence”. There is a second German version of the SPPC (Asendorpf & Aken, 2002) that uses different translations of the subdomains, making national comparisons (and, in the context of childhood obesity; the search for a reference group for healthy weight) difficult: Asendorpf and Aken (2002) distinguished between cognitive competence, sports competence, peer acceptance, physical appearance, and global self-worth. Finally, unfortunately, there is no German version of the Self-Perception Profile for Adolescents that allows for age-specific differentiation.

### **6.1.2 Study III**

Study 3 examined provider and family/participant surveys of weight management programs in Germany during the 2020 COVID-19 pandemic. One of the main limitations of the third as well as the first study is the cross-sectional design, which precludes any causal conclusions and cause-and-effect inferences. The results of study 3 could further be influenced by response bias, particularly nonresponse bias, because in this study the number of responses from weight management providers was approximately 50% and there was little feedback from affected families. Nonresponse bias reduced interpretability and generalizability of the quantitative results of the family survey in particular. In comparison, qualitative analyses are not designed to be generalizable or all-inclusive. Although qualitative data are very subjective, they have the advantage of giving in-depth information to generate an overview concerning the problem of interest and of the social context through the interviewee's perspective. They are criticized as unreliable, as they might be biased by the expectations and perception of the researcher, but they also have the advantage of a dynamic, context-sensitive research process (Golafshani, 2015). Especially in

view of the uncertainties of the unprecedented COVID-19-related challenges, this research design proved suitable.

The technical equipment of providers and participants may have improved, and digital implementation have become more proficient as the pandemic has progressed. Thus, rapid scientific evidence on the consequences of COVID-19 pandemic restrictions related to multidisciplinary management of childhood obesity was urgently needed. Therefore, although the results reflect only Germany during that time and a rather small, selective sample, they provide detailed, quickly needed insight into the perspectives of health care providers and patients/families during this time. Objective data on weight gain or other physical parameters were not gathered or included in study 3. Study 4, a brief report, therefore built on the findings of study 3 and analyzed objective data on BMI-SDS and actual psychosocial and physical health outcomes of an exemplary German weight management program, which, in contrast, were not the focus of study 3.

## **6.2 Main Findings, Implications and Discussion**

With the goal of contributing to advances in multidisciplinary childhood obesity management, predictors of psychosocial health and BMI-SDS reduction as well as program adjustments during the COVID-19 pandemic were analyzed in this dissertation. The main findings elaborated below are the role of physical fitness and lessons learned from the pandemic, including implications for treatment and research.

### *6.2.1.1 The Underappreciated Role of Physical Fitness*

The individual, family-level and macro-level dynamics relevant to the development of childhood obesity and associated physical and psychosocial aspects of health are complex. Multiple determinants, such as sociodemographic factors, parenting skills, or family health-related habits, may influence the mechanisms underlying the development of obesity (see [Chapter 2.2](#)). At the same time, these variables may impact obesity treatment outcomes as the factors relevant for a child's psychosocial and physical health might also influence program adherence and long-term weight loss maintenance (see [Chapter 2.4.3](#)).

On this basis, emphasizing the crucial role of physical fitness is among the most important findings of this dissertation. While there is scientific consensus on the positive relationship between physical fitness and physical health including a lower BMI (e.g., Rauner et al., 2013), this work adds that fitness also plays an important role in the interactive structure of psychosocial health and childhood obesity and identifies fitness as a possible predictor of long-term BMI-SDS reduction.

Study 1 investigated inhibitory and promotive factors of psychosocial health of children and adolescents with obesity. In addition to BMI-SDS, age, immigrant background, and

parental education, physical fitness proved to be a major determinant of psychosocial health among CHILT III participants. More precisely, high levels of relative physical fitness, objectively measured using bicycle ergometry, remained as the single predictor in the final linear regression models explaining HRQOL as well as self-perceived social and scholastic self-concept. In contrast, self-reported physical activity predicted only one sub-domain of self-concept, namely self-perceived physical appearance.

Building on the findings and limitations of the first study, study 2 examined predictors of BMI-SDS reduction longitudinally. Again, physical fitness was found to play an important role in the context of childhood obesity: Both in the short-term as well as longer-term, physical fitness was positively correlated to reductions in BMI-SDS. Similar results were found for selected aspects of psychosocial health, also showing significant positive associations with changes in BMI-SDS (compare [Chapter 2.4.3.1](#)).

In sum, higher levels of physical fitness may be positively associated to psychosocial health on the one hand and BMI-SDS reductions on the other. This finding is particularly relevant for the therapeutic setting: To date, to the best of our knowledge, this is the first work to identify physical fitness as an important predictor of (long-term) weight loss. While it is important for a deeper understanding of the complexity of childhood obesity to explore predictors of weight loss, i.e., individual or family characteristics such as sex, age, or parental education, “these factors offer no starting point for intervention, as neither the adolescents' gender nor BMI at admission can be an intervention target” (Reinelt et al., 2020). In contrast, providing evidence-based research on program-level factors such as fitness improvements that can be specifically addressed in multidisciplinary obesity treatment approaches is critical.

Our results show that promoting physical fitness can contribute to holistic and long-term health outcomes and may even be more effective than focusing on weight loss or

physical activity alone. Consistent with this, Perez-Sousa et al. (2018) showed that the negative effects of overweight or obesity on HRQOL in children are mitigated by physical fitness. Ortega, Ruiz, et al. (2018) even refer to the "fit-but-fat" paradox, highlighting the relevance of physical fitness to obesity-related cardiometabolic risk factors. Improving physical fitness should thus become a priority in multidisciplinary weight management programs and a targeted outcome parameter in addition to BMI-SDS reductions. The fact that this is already a main success criterion at CHILT III should be positively emphasized at this point.

In particular, in view of the vicious circle between aspects of psychosocial health and weight development, the promotion of physical fitness could show promising results, being associated both with HRQOL and self-concept (study 1) and with the reduction of BMI-SDS in our sample (study 2). For example, improved physical fitness can reduce concomitant physical conditions that impede physical engagement (Ortega, Ruiz, et al., 2018) and increase motivation to participate in physical and social activities (Riiser et al., 2014) and. In this way, barriers and deficiencies can be eliminated or reduced, paving the way for a long-term commitment to healthier living. In line with this, Reddon et al. (2017), for instance, found physical fitness to be a mediator in the relationship between physical activity levels and global self-worth.

Because improved physical fitness might lead to increased physical activity and a reduction in BMI-SDS, it potentially also has an impact on body satisfaction and self-perceived physical appearance (Padilla-Moledo et al., 2012). Higher physical self-concept scores, in turn, are positively associated with longer-term BMI-SDS reduction, according to study 2. Therefore, in addition to existing strategies to improve psychosocial health in multidisciplinary weight management programs – such as learning to cope with weight-related teasing, improving body image or promoting self-

efficacy in a playful environment, (Helfert & Warschburger, 2013; Warschburger et al., 2016) – the value of physical fitness for both physical and psychosocial health should be recognized to a much greater extent and be included in program designs accordingly.

#### *6.2.1.2 Lessons learned from the COVID-19 Pandemic*

The COVID-19 pandemic and the measures required to contain its spread have had a significant impact on our overall lifestyle. Children, especially those who are overweight, have been hit particularly hard by these restrictions. Daily life became more isolated, anxiety and worry increased while exercise time was reduced, and weight management programs had to be closed at times or adapted as quickly as possible (Androutsos et al., 2021; Dicker et al., 2020; Violant-Holz et al., 2020). Concerningly, each of the factors mentioned represent risk factors for the (further) development of obesity (Rundle et al., 2020).

The results of study 3 showed that the weight management programs in Germany for children and adolescents were able to adapt quickly to the new challenges and that the participating families accepted these adaptations well. In all areas of the multidisciplinary programs (nutrition, exercise, medical/ psychological / general counseling) face-to-face program components were combined with written and virtual information materials via email, messengers etc., videocalls/ -conferences and phone calls. Study 4 further indicated that these necessary program adjustments did not negatively affect the positive short-term effect of the 11-month CHILT III program on BMI-SDS reduction and physical fitness stabilization from baseline to end.

Study 3 and 4, while not free of limitations, were much needed in the context of the rapidly spreading COVID-19 pandemic. These early results suggested that a combined approach to weight management for children and adolescents including digital and modified in-person components was both effective and perceived positively, i.e., potentially ensuring continuity of care even in times of social distancing. It can be concluded that the new incorporation of digital sessions into therapeutic treatments improved accessibility, flexibility, and individualized care.

Digital sessions have the advantage of promoting sustainability because they can be recorded and repeated to better internalize the knowledge or to make them available to additional family members. If high-quality, targeted digital exercise videos are created within multidisciplinary weight management settings, they also have the potential to provide sports opportunities away from shame-filled environments.

However, strategies are needed for socially disadvantaged families who may face a lack of technical equipment and limited housing space. Children and families should be guided in using and implementing the digital sessions. While digital content enables more flexibility, mandatory schedules and binding commitments should also be added or intensified as important program content, as consistent routines may help children to regulate weight-related behaviors (Neshteruk et al., 2021).

With regard to psychosocial aspects of health, it is furthermore essential to limit the use of digital media in weight management settings to aspects of individual medical and psychological counseling, social interaction, and exercise (Minsky et al., 2021). Otherwise, promoting screen-based media may increase the risk of social isolation, physical inactivity, and obesity (Robinson et al., 2017).

Nevertheless, it has to be noted that evidence on the relationship between digital media and psychosocial well-being is mixed, e.g., indicating differences between different types of media (Wulff & Wagner, 2018). Study 4 found small (albeit insignificant) increases in media use during the pandemic and concomitant decreases in HRQOL and social self-concept. But although other studies also suggest an association between increased screen time and decreased happiness (Muñiz-Velázquez et al., 2021; Neill et al., 2021; Pandya & Lodha, 2021), the small sample size in study 4 does not allow for generalization and causal interpretation. At the same time, little is known about the associations between long-term weight loss maintenance and media use. While study 2 of this dissertation suggested a positive relationship (presumably due to increased comparison with others and suffering; and thus motivation to change), further longitudinal studies with larger samples are needed to better understand the dynamics between media use, psychosocial well-being and weight development.

As research on media use related to childhood obesity and weight management is still developing, the role of objective parameters of physical activity and sedentary behavior becomes even more apparent. Using physical fitness as a proxy for physical activity may help to better capture the role of physical inactivity and sedentary behavior for psychosocial health and weight management success than self-reported media use, which in this dissertation aggregated different types of screen behaviors. Especially during times of social distancing and isolation, moreover, the role of physical fitness could be crucial for mental health and the enjoyment of exercise (possibly jointly with others and in the fresh air).

### 6.2.1.3 Outlook

From the findings of this cumulative work as well as the methodological limitations, further implications for research and therapeutic practice emerge. First of all, it would be interesting to investigate the role of family characteristics (e.g., single parenthood, physical activity patterns of the parents) for the dynamics between psychosocial health and childhood obesity in more detail. Although, as noted above, these do not provide a direct starting point for treatment strategies, they are nevertheless important to deepen the understanding on the mechanisms underlying different dimensions of health and the development of obesity. Moreover, the evidence regarding socio-economic and socio-cultural aspects in relation to the HRQOL children with obesity and to long-term weight loss remains heterogeneous and scarce.

Future research should furthermore deal with the identification of successful intervention components not only for long-term weight loss but also for psychosocial health promotion of children with obesity. In this regard, preliminary exploratory analyses of CHILT III data suggest sex differences in program-level predictors of psychosocial health, but further research is warranted to identify successful individualized program components which may contribute to psychosocial health improvements. As self-esteem between boys and girls with obesity is found to differ (Mäkinen et al., 2012), program-level predictors that could be examined in an age- and sex- specific study could include participation rate in the aftercare program, reasons for drop-out or group composition.

Theory-driven research is needed to better understand the motivation for change and the direction of the relationship between psychosocial distress and weight loss. Although research is unlikely to answer the “chicken-or-egg question” with regard to

the origins of psychosocial suffering and obesity, it may help to identify children who are more at risk than others.

There is also a need for long-term studies that objectively measure and examine the effect of the COVID-19 pandemic and associated constraints on children's health and weight development to uncover significant causalities. Since both weight management programs and society as a whole have adapted quickly to the changing circumstances, a more precise differentiation between different phases of the pandemic would be interesting.

Finally, the role of different types of digital media in childhood obesity should receive more scientific attention. Questions that still need to be answered here could be, for example, "Was increased media consumption during the COVID-19 pandemic associated to weight development and psychosocial health of children with obesity?" or "What role does the steadily increasing media consumption of children and adolescents play in attempts to lose weight sustainably?".

## 7. Conclusion

Multidisciplinary weight management programs are essential to help children with obesity and their families at an early stage by promoting a healthy lifestyle and including multiple aspects of health such as diet, exercise, and behavior change. Achieving sustainable weight loss and behavior change is critical to prevent children with obesity from becoming adults with obesity and having serious health problems. Thus, constant research and continuous development of existing weight management approaches at the cutting edge of science are required to achieve long-term and lasting program effectiveness.

In this context, this dissertation, the core of which is the analysis of data from CHILT III, an outpatient multidisciplinary weight management program for children and adolescents, aimed to

- seek predictors of psychosocial health and long-term BMI-SDS reduction with consideration of the predictive potential of physical fitness
- analyze the impact and implementation of weight management approaches during COVID-19 pandemic-related challenges.

From the analyses, effective approaches for therapeutic interventions and program adaptations can be derived based on a deeper understanding of the interplay between physical and psychosocial aspects of health in the context of childhood obesity and weight management.

Key findings from this cumulative work include an appreciation of the relevance of physical fitness in multidisciplinary weight management. Physical fitness has been found to play an integral part in HRQOL and self-concept of children and adolescents with obesity. At the same time, physical fitness also represents an important predictor

of BMI-SDS reductions both at the end of the 11-month CHILT III program and one year later at follow-up. In line with previous findings on the mediating role of physical fitness in the obesity-HRQOL-relationship (Perez-Sousa et al., 2018), this dissertation therefore highlights the importance of promoting physical fitness in multidisciplinary weight management to achieve holistic and sustainable positive health outcomes.

Furthermore, this work has drawn lessons for the implementation of weight management programs from the challenges and adaptations during the COVID-19 pandemic that may still have relevance after pandemic times. For example, it was shown that a combined approach for juvenile weight management of both conventional face-to-face components and newly elaborated digital units was effective and feasible and was well received by providers and participants. While digitizing the content of weight management programs brings advantages in terms of customization and accessibility, it is also important to note that the increased use of digital media is not all benefits. Because some forms of digital media may be adversely associated with psychosocial health and physical activity (Muñiz-Velázquez et al., 2021), specific distinction and use for therapeutic purposes, exercise, and social exchange, as well as training of participants must be undertaken.

Research cannot yet present a golden solution to address the global public health issue of childhood obesity. Neither does this work presume to have fully illuminated the complexity of the interrelationships between obesity, physical and psychosocial health and other relevant determinants, but it hopes to a) have contributed to raising awareness of the need for and importance of continuous development, research, and constant care both for those affected and for the relief of the health sector and to b) have provided concrete evidence-based guidance at the program level for the further development of current weight management programs.

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## 9. Appendix

### 9.1 Original CHILT III Questionnaire (German)



Deutsche  
Sporthochschule Köln  
German Sport University Cologne

Children's Health Interventional Trial (CHILT)

Zeitpunkt: t1

#### Familienfragebogen

Datum: \_\_\_\_\_

Vor- und Nachname des untersuchten Kindes:

\_\_\_\_\_

Vor- und Nachname der Erziehungsberechtigten:

\_\_\_\_\_

Wer hat den Fragebogen ausgefüllt:

- |                                   |  |
|-----------------------------------|--|
| <input type="checkbox"/> Mutter   | <input type="checkbox"/> Vater                 |
| <input type="checkbox"/> Kind     | <input type="checkbox"/> Geschwister           |
| <input type="checkbox"/> Betreuer | <input type="checkbox"/> Andere Person.: _____ |

#### Zum Kind

##### Allgemein

Geschlecht: ☐ männlich ☐ weiblich

Geburtsdatum: \_\_\_\_\_

Geburtsgewicht: \_\_\_\_\_ g

Geburtslänge: \_\_\_\_\_ cm

Schwangerschaftswochen: \_\_\_\_\_ SSW

Gewichtszunahme i. d. Schwangerschaft: \_\_\_\_\_ kg

Stillen (Dauer): \_\_\_\_\_ Wochen

In welchem Land ist Ihr Kind geboren? \_\_\_\_\_

Welche Nationalität besitzt Ihr Kind? \_\_\_\_\_

Wie lange lebt Ihr Kind in Deutschland: seit \_\_\_\_\_ (z.B. August 2001)

Welche Sprache wird zu Hause überwiegend gesprochen? \_\_\_\_\_

Welche Schulklasse besucht Ihr Kind? \_\_\_\_\_ Schultyp: \_\_\_\_\_



Children's Health Interventional Trial (CHILT)

Anamnese

Erkrankungen, Allergien, Medikamente

Liegen bei Ihrem Kind Erkrankungen/Allergien vor? ☐ Nein ☐ Ja

Erkrankungen (z.B. auch Allergien) und regelmäßige Medikamenteneinnahme bei Ihrem Kind:

Erkrankungen	Seit ... (Monat/Jahr) z.B. 08/2010	Medikamente

Wurden bisher krankengymnastische / ergotherapeutische Maßnahmen bei Ihrem Kind unternommen?

☐ Nein ☐ Ja

Maßnahmen	Grund	Wann (Monat/Jahr)

Rauchen

Raucht Ihr Kind aktuell? ☐ Nein ☐ Ja, seit \_\_\_\_\_ (Monat/Jahr)

Wenn Ja, wie häufig raucht Ihr Kind? ☐ täglich An \_\_\_\_\_ Tagen in der Woche

Wie viele Zigaretten raucht Ihr Kind? \_\_\_\_\_ am Tag und \_\_\_\_\_ in der Woche



### Körperliche Aktivität

#### Bewegung außerhalb der Schule

##### Wie kommt Ihr Kind normalerweise zur Schule?

☐ Zu Fuß ☐ Fahrrad ☐ Auto ☐ Bus ☐ Sonstiges \_\_\_\_\_

##### Wohnt Ihr Kind so nah an der Schule, dass es zu Fuß zur Schule kommen könnte?

☐ Nein ☐ Ja Wie groß ist die Entfernung zur Schule? \_\_\_\_\_ km

##### Wie viele Minuten am Tag bewegt sich Ihr Kind außerhalb der Schule?

\_\_\_\_\_ Min.

##### Kommt Ihr Kind dabei außer Atem oder ins Schwitzen?

☐ Nein ☐ Ja

Wenn Ja, für wie viele Minuten etwa? \_\_\_\_\_ Min.

##### Wie oft bewegt sich Ihr Kind in der Woche außerhalb der Schule?

☐ Jeden Tag ☐ An 4 bis 6 Tagen ☐ An 1 bis 3 Tagen ☐ fast nie

##### Wie viele Minuten bewegt sich Ihr Kind in der Woche außerhalb der Schule?

\_\_\_\_\_ Min.

#### Sportliche Aktivität

##### Hat ihr Kind vor Beginn des CHILT-Programms am „Nachsorgeprogramm“ teilgenommen?

☐ Nein ☐ Ja

Wenn ja, wie lange? \_\_\_\_\_ Monate

##### Ist Ihr Kind sportlich aktiv?

☐ Nein ☐ Ja



Children's Health Interventional Trial (CHILT)

**Wenn Nein, warum nicht?**

(Bitte nennen Sie die 3 wichtigsten Gründe)

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

**Welche Sportart(en) betreibt Ihr Kind zurzeit regelmäßig?**

	Montag bis Freitag		Samstag und Sonntag		Im Verein
	Häufigkeit Mo - Fr	Gesamtzeit Std. + Min.	Häufigkeit Sa + So	Gesamtzeit Std. + Min.	
<b>Beispiel: Fußball</b>	<u>2</u>	<u>1</u> Std. <u>30</u> Min.	<u>1</u>	Std. <u>30</u> Min.	<input checked="" type="checkbox"/>
	_____	Std. _____ Min.	_____	Std. _____ Min.	<input type="checkbox"/>
	_____	Std. _____ Min.	_____	Std. _____ Min.	<input type="checkbox"/>
	_____	Std. _____ Min.	_____	Std. _____ Min.	<input type="checkbox"/>

**Welche Sportart(en) betreibt Ihr Kind nicht regelmäßig (d.h. nicht wöchentlich)?**

	Montag bis Sonntag		Im Verein
	Häufigkeit pro Monat	Gesamtzeit Std. + Min.	
<b>Beispiel: Fußball</b>	<u>2</u>	<u>1</u> Std. <u>30</u> Min.	<input type="checkbox"/>
	_____	Std. _____ Min.	<input type="checkbox"/>
	_____	Std. _____ Min.	<input type="checkbox"/>
	_____	Std. _____ Min.	<input type="checkbox"/>



## Children's Health Interventional Trial (CHILT)

### Sitzende Tätigkeiten

**Wie viele Stunden verbringt Ihr Kind durchschnittlich mit sitzender Tätigkeit an einem Tag von Montag bis Freitag? (z.B. im Auto, auf dem Sofa, vor dem Fernseher, ...)**

Ergänzen Sie bitte falls nötig die Tabelle.

#### Schule

Schulweg (inaktiv)	_____ Std.
Unterricht	_____ Std.
Computer	_____ Std.
Hausaufgaben	_____ Std.
_____	_____ Std.
_____	_____ Std.

#### Zu Hause

Hausaufgaben/Lernen	_____ Std.
Computer/Konsole	_____ Std.
Fernsehen	_____ Std.
Malen/Basteln/Lesen	_____ Std.
_____	_____ Std.
_____	_____ Std.

**Wie viele Stunden verbringt Ihr Kind durchschnittlich mit sitzender Tätigkeit an einem Wochenende (Samstag und Sonntag)? Ergänzen Sie falls nötig die Tabelle.**

#### Zu Hause

Hausaufgaben/Lernen	_____ Std.
Computer/Konsole	_____ Std.
Fernsehen	_____ Std.
Malen/Basteln/Lesen	_____ Std.
_____	_____ Std.
_____	_____ Std.
_____	_____ Std.

### Medienzeit

Wie viele Minuten am Tag schaut Ihr Kind Fernsehen? \_\_\_\_\_ Min.

Wie viele Minuten am Tag spielt Ihr Kind mit einer Spielekonsole? \_\_\_\_\_ Min.

Wie viele Minuten am Tag ist Ihr Kind am Computer/im Internet? \_\_\_\_\_ Min.

Wie viele Minuten am Tag hört Ihr Kind Musik? \_\_\_\_\_ Min.

Wie viele Minuten am Tag verbringt Ihr Kind mit dem Handy? \_\_\_\_\_ Min.





### Children's Health Interventional Trial (CHILT)

#### Wie ist Ihr höchster beruflicher Abschluss?

- |   |  |
|---|--|
| <input type="checkbox"/> Gewerbliche oder landwirtschaftliche Lehre | <input type="checkbox"/> Fachhochschule, Ingenieurschule                           |
| <input type="checkbox"/> Kaufmännische oder sonstige Lehre          | <input type="checkbox"/> Universität, Hochschule                                   |
| <input type="checkbox"/> Berufsfachschule, Handelsschule            | <input type="checkbox"/> Schule des Gesundheitswesens                              |
| <input type="checkbox"/> Beamtenausbildung                          | <input type="checkbox"/> Fachschule (z.B. Meister- Technikerschule)                |
| <input type="checkbox"/> Sonstiger Ausbildungsabschluss             | <input type="checkbox"/> Nichts davon, ich habe (noch) keinen Ausbildungsabschluss |

#### Sind Sie aktuell berufstätig?

- ☐ Voll berufstätig als \_\_\_\_\_
- ☐ Teilweise berufstätig als \_\_\_\_\_
- ☐ In Berufsausbildung als Auszubildende (Lehre)
- ☐ In sonstiger Berufsausbildung (z.B. Fachschule)
- ☐ Arbeitslos Seit wann? \_\_\_\_\_ (Monat/Jahr) z.B. 08/2010

#### Anamnese

##### Erkrankungen, Allergien, Medikamente

Liegen bei Ihnen Erkrankungen/Allergien vor? ☐ Nein ☐ Ja

#### Erkrankungen (z.B. auch Allergien) und regelmäßige Medikamenteneinnahme bei Ihnen:

Erkrankungen	Seit ... (Monat/Jahr) z.B. 08/2010	Medikamente
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____



## Children's Health Interventional Trial (CHILT)

### Rauchen

**Rauchen Sie aktuell?** ☐ Nein ☐ Ja, seit \_\_\_\_\_ (Monat/Jahr)

**Wenn Ja, wie häufig rauchen Sie?** ☐ täglich An \_\_\_\_\_ Tagen in der Woche

**Wie viele Zigaretten rauchen Sie?** \_\_\_\_\_ am Tag und \_\_\_\_\_ in der Woche

**Wenn Nein, haben Sie früher geraucht?** ☐ Nein ☐ Ja

**Wenn Ja, wie viele Jahre haben Sie geraucht?** \_\_\_\_\_

**Wie viele Zigaretten pro Tag?** \_\_\_\_\_

**In welchem Alter haben Sie aufgehört zu rauchen?** \_\_\_\_\_

### Familienanamnese

**Liegen in Ihrer Familie Krankheiten wie z. B. Herzinfarkt, Schlaganfall, Zuckerkrankheit, Bluthochdruck, Krebs usw. vor?**

(Bitte Verwandtschaft aus Ihrer Sicht angeben, z. B. Ihre Mutter)

☐ Nein ☐ Ja

Wenn ja, welche? \_\_\_\_\_ seit \_\_\_\_\_ (Jahr)

Wer ist daran erkrankt? \_\_\_\_\_

Wenn ja, welche? \_\_\_\_\_ seit \_\_\_\_\_ (Jahr)

Wer ist daran erkrankt? \_\_\_\_\_

### Körperliche Aktivität

#### Bewegung im Beruf

Bei aktueller Arbeitslosigkeit springen Sie bitte zu „Bewegung in der Freizeit“

**Wie gestaltet sich Ihre berufliche Tätigkeit hauptsächlich?**

- ☐ Ausschließlich sitzende Tätigkeiten (z.B. Bürotätigkeit, ...)
- ☐ Überwiegend sitzende Tätigkeiten (z.B. Kraftfahrer, Laborant, ...)
- ☐ Mäßige Bewegung (z.B. Hausfrau, Verkäufer, ...)
- ☐ Intensive Bewegung (z.B. Fensterputzer, Postzusteller, ...)

**Wie kommen Sie zur Arbeit?**

☐ Zu Fuß ☐ Fahrrad ☐ Auto ☐ Bus ☐ Sonstiges \_\_\_\_\_

**Wohnen Sie so nah bei der Arbeit, dass Sie zu Fuß zur Arbeit kommen könnten?**

☐ Nein ☐ Ja Wie groß ist die Entfernung zur Arbeit? \_\_\_\_\_ km



## Children's Health Interventional Trial (CHILT)

### Bewegung in der Freizeit

An wie vielen Tagen in der Woche gehen Sie zurzeit zu Fuß oder fahren mit dem Rad, um von einem Ort zum anderen zu gelangen (inkl. Ihres Arbeitsweges)?

\_\_\_\_\_ Tage in der Woche, für jeweils etwa \_\_\_\_\_ Minuten pro Tag

An wie vielen Tagen pro Woche verrichten Sie aktuell körperliche Aktivitäten, zum Beispiel das Tragen von Lasten oder Arbeiten im Haus, Hof oder im Garten und Ähnliches?

\_\_\_\_\_ Tage in der Woche, für jeweils etwa \_\_\_\_\_ Minuten pro Tag

### Sportliche Aktivität

Welche Sportart(en) betreiben Sie zurzeit regelmäßig?

	Montag bis Freitag		Samstag und Sonntag		Im Verein
	Häufigkeit Mo - Fr	Gesamtzeit Std. + Min.	Häufigkeit Sa + So	Gesamtzeit Std. + Min.	
<b>Beispiel: Fußball</b>	<u>2</u>	<u>1</u> Std. <u>30</u> Min.	<u>1</u>	<u>1</u> Std. <u>30</u> Min.	<input checked="" type="checkbox"/>
	_____	_____ Std. _____ Min.	_____	_____ Std. _____ Min.	<input type="checkbox"/>
	_____	_____ Std. _____ Min.	_____	_____ Std. _____ Min.	<input type="checkbox"/>
	_____	_____ Std. _____ Min.	_____	_____ Std. _____ Min.	<input type="checkbox"/>

Welche Sportart(en) betreiben Sie nicht regelmäßig?

	Montag bis Sonntag		Im Verein
	Häufigkeit pro Monat	Gesamtzeit Std. + Min.	
<b>Beispiel: Fußball</b>	<u>2</u>	<u>1</u> Std. <u>30</u> Min.	<input type="checkbox"/>
	_____	_____ Std. _____ Min.	<input type="checkbox"/>
	_____	_____ Std. _____ Min.	<input type="checkbox"/>
	_____	_____ Std. _____ Min.	<input type="checkbox"/>



**Children's Health Interventional Trial (CHILT)**

**Ich treibe keinen Sport, weil ...**

- ☐ ich keine Zeit habe.
- ☐ ich keine Lust habe.
- ☐ ich gesundheitliche Gründe habe.

*Ich habe sonstige Gründe:*

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*Weitere Anmerkungen, z. B. frühere Sportarten ...*

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**Fühlen Sie sich in Ihren körperlichen Funktionen eingeschränkt?** ☐ Nein ☐ Ja

*Wenn Ja, inwiefern:*

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**Sitzende Tätigkeiten**

**Wie viele Stunden verbringen Sie durchschnittlich mit sitzender Tätigkeit an einem Tag von Montag bis Freitag? (z.B. im Auto, auf dem Sofa, vor dem Fernseher, ...)**

Ergänzen Sie falls nötig die Tabelle.

**Beruf**

Bildschirmarbeit (z.B. PC)	_____ Std.
Büroarbeit (ohne PC)	_____ Std.
Autofahren/Nahverkehr	_____ Std.
Kasse	_____ Std.
_____	_____ Std.
_____	_____ Std.

**Privat**

PC/Tablet/Handy	_____ Std.
TV	_____ Std.
Lesen/Schreiben	_____ Std.
Autofahren	_____ Std.
_____	_____ Std.
_____	_____ Std.



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German Sport University Cologne

Children's Health Interventional Trial (CHILT)

**Wie viele Stunden verbringen Sie durchschnittlich mit sitzender Tätigkeit am Wochenende (Samstag und Sonntag)? Ergänzen Sie falls nötig die Tabelle.**

**Beruf**

Bildschirmarbeit (z.B. PC)	_____ Std.
Büroarbeit (ohne PC)	_____ Std.
Autofahren/Nahverkehr	_____ Std.
Kasse	_____ Std.
_____	_____ Std.
_____	_____ Std.

**Privat**

PC/Tablet/Handy	_____ Std.
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Lesen/Schreiben	_____ Std.
Autofahren	_____ Std.
_____	_____ Std.
_____	_____ Std.





### Children's Health Interventional Trial (CHILT)

#### Wie ist Ihr höchster beruflicher Abschluss?

- |   |  |
|---|--|
| <input type="checkbox"/> Gewerbliche oder landwirtschaftliche Lehre | <input type="checkbox"/> Fachhochschule, Ingenieurschule                           |
| <input type="checkbox"/> Kaufmännische oder sonstige Lehre          | <input type="checkbox"/> Universität, Hochschule                                   |
| <input type="checkbox"/> Berufsfachschule, Handelsschule            | <input type="checkbox"/> Schule des Gesundheitswesens                              |
| <input type="checkbox"/> Beamtenausbildung                          | <input type="checkbox"/> Fachschule (z.B. Meister- Technikerschule)                |
| <input type="checkbox"/> Sonstiger Ausbildungsabschluss             | <input type="checkbox"/> Nichts davon, ich habe (noch) keinen Ausbildungsabschluss |

#### Sind Sie aktuell berufstätig?

- ☐ Voll berufstätig als \_\_\_\_\_
- ☐ Teilweise berufstätig als \_\_\_\_\_
- ☐ In Berufsausbildung als Auszubildender (Lehre)
- ☐ In sonstiger Berufsausbildung (z.B. Fachschule)
- ☐ Arbeitslos Seit wann? \_\_\_\_\_ (Monat/Jahr) z.B. 08/2010

#### Anamnese

##### Erkrankungen, Allergien, Medikamente

Liegen bei Ihnen Erkrankungen/Allergien vor? ☐ Nein ☐ Ja

#### Erkrankungen (z.B. auch Allergien) und regelmäßige Medikamenteneinnahme bei Ihnen:

Erkrankungen	Seit ... (Monat/Jahr) z.B. 08/2010	Medikamente
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____



## Children's Health Interventional Trial (CHILT)

### Rauchen

**Rauchen Sie aktuell?** ☐ Nein ☐ Ja, seit \_\_\_\_\_ (Monat/Jahr)

**Wenn Ja, wie häufig rauchen Sie?** ☐ täglich An \_\_\_\_\_ Tagen in der Woche

**Wie viele Zigaretten rauchen Sie?** \_\_\_\_\_ am Tag und \_\_\_\_\_ in der Woche

**Wenn Nein, haben Sie früher geraucht?** ☐ Nein ☐ Ja

**Wenn Ja, wie viele Jahre haben Sie geraucht?** \_\_\_\_\_

**Wie viele Zigaretten pro Tag?** \_\_\_\_\_

**In welchem Alter haben Sie aufgehört zu rauchen?** \_\_\_\_\_

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*(Bitte Verwandtschaft aus Ihrer Sicht angeben, z. B. Ihre Mutter)*

☐ Nein ☐ Ja

Wenn Ja, welche? \_\_\_\_\_ seit \_\_\_\_\_ (Jahr)

Wer ist daran erkrankt? \_\_\_\_\_

Wenn Ja, welche? \_\_\_\_\_ seit \_\_\_\_\_ (Jahr)

Wer ist daran erkrankt? \_\_\_\_\_

### Körperliche Aktivität

#### Bewegung im Beruf

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- ☐ Überwiegend sitzende Tätigkeiten (z.B. Kraftfahrer, Laborant, ...)
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☐ Zu Fuß ☐ Fahrrad ☐ Auto ☐ Bus ☐ Sonstiges \_\_\_\_\_

**Wohnen Sie so nah bei der Arbeit, dass Sie zu Fuß zur Arbeit kommen könnten?**

☐ Nein ☐ Ja Wie groß ist die Entfernung zur Arbeit? \_\_\_\_\_ km



## Children's Health Interventional Trial (CHILT)

### Bewegung in der Freizeit

An wie vielen Tagen in der Woche gehen Sie zurzeit zu Fuß oder fahren mit dem Rad, um von einem Ort zum anderen zu gelangen (inkl. Ihres Arbeitsweges)?

\_\_\_\_\_ Tage in der Woche, für jeweils etwa \_\_\_\_\_ Minuten pro Tag

An wie vielen Tagen pro Woche verrichten Sie aktuell körperliche Aktivitäten, zum Beispiel das Tragen von Lasten oder Arbeiten im Haus, Hof oder im Garten und Ähnliches?

\_\_\_\_\_ Tage in der Woche, für jeweils etwa \_\_\_\_\_ Minuten pro Tag

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Welche Sportart(en) betreiben Sie zurzeit regelmäßig?

	Montag bis Freitag		Samstag und Sonntag		Im Verein
	Häufigkeit Mo - Fr	Gesamtzeit Std. + Min.	Häufigkeit Sa + So	Gesamtzeit Std. + Min.	
<b>Beispiel: Fußball</b>	<u>  2  </u>	<u>  1  </u> Std. <u> 30 </u> Min.	<u>  1  </u>	<u>      </u> Std. <u> 30 </u> Min.	<input checked="" type="checkbox"/>
	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<input type="checkbox"/>
	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<input type="checkbox"/>
	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<input type="checkbox"/>

Welche Sportart(en) betreiben Sie nicht regelmäßig?

	Montag bis Sonntag		Im Verein
	Häufigkeit pro Monat	Gesamtzeit Std. + Min.	
<b>Beispiel: Fußball</b>	<u>  2  </u>	<u>  1  </u> Std. <u> 30 </u> Min.	<input type="checkbox"/>
	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<input type="checkbox"/>
	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<input type="checkbox"/>
	<u>      </u>	<u>      </u> Std. <u>      </u> Min.	<input type="checkbox"/>



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## Children's Health Interventional Trial (CHILT)

### Ich treibe keinen Sport, weil ...

- ☐ ich keine Zeit habe.
- ☐ ich keine Lust habe.
- ☐ ich gesundheitliche Gründe habe.

Ich habe sonstige Gründe:

---

---

Weitere Anmerkungen, z. B. frühere Sportarten ...

---

---

Fühlen Sie sich in Ihren körperlichen Funktionen eingeschränkt? ☐ Nein ☐ Ja

Wenn Ja, inwiefern:

---

---

### Sitzende Tätigkeiten

Wie viele Stunden verbringen Sie durchschnittlich mit sitzender Tätigkeit an einem Tag von Montag bis Freitag? (z.B. im Auto, auf dem Sofa, vor dem Fernseher, ...)

Ergänzen Sie falls nötig die Tabelle.

#### Beruf

Bildschirmarbeit (z.B. PC)	_____ Std.
Büroarbeit (ohne PC)	_____ Std.
Autofahren/Nahverkehr	_____ Std.
Kasse	_____ Std.
_____	_____ Std.
_____	_____ Std.

#### Privat

PC/Tablet/Handy	_____ Std.
TV	_____ Std.
Lesen/Schreiben	_____ Std.
Autofahren	_____ Std.
_____	_____ Std.
_____	_____ Std.



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Children's Health Interventional Trial (CHILT)

**Wie viele Stunden verbringen Sie durchschnittlich mit sitzender Tätigkeit am  
Wochenende (Samstag und Sonntag)?** Ergänzen Sie falls nötig die Tabelle.

**Beruf**

Bildschirmarbeit (z.B. PC)	_____ Std.
Büroarbeit (ohne PC)	_____ Std.
Autofahren/Nahverkehr	_____ Std.
Kasse	_____ Std.
_____	_____ Std.
_____	_____ Std.

**Privat**

PC/Tablet/Handy	_____ Std.
TV	_____ Std.
Lesen/Schreiben	_____ Std.
Autofahren	_____ Std.
_____	_____ Std.
_____	_____ Std.

**Vielen Dank für Ihre Unterstützung!**

**T1**

Bitte dieses Kästchen freilassen

APV ☐

DB ☐

Datum: \_\_\_\_\_

## 9.2 Original GW-LW-KJ, Version B (German)

### Fragebogen zur Lebensqualität, Version B

Copyright 2004

Ident.-Nr.     Inst.-Nr.     Gruppen-Nr.     Teilnehmer-Nr.     Anfangsbuchstaben Vorname, Nachname

Zeitpunkt der Erhebung PB<sup>1</sup> T1 ☐ PE<sup>2</sup> T2 ☐ PE + 1 Jahr T3 ☐ PE + 3 Jahre T4 ☐ PE + 5 Jahre T5 ☐

<sup>1</sup> PB = Programm-Beginn, <sup>2</sup> PE = Programm-Ende

Wir möchten gern von dir erfahren, wie es dir in den letzten zwei Wochen ergangen ist.

In den letzten zwei Wochen ...	Immer	Oft	Manchmal	Selten	Nie
1. ... ist es mir passiert, dass man mich wegen meines Gewichts nicht mochte.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. ... musste ich mich zwingen, an Gewicht zu verlieren.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. ... konnte ich mich nur richtig wohl fühlen, wenn ich so viel gegessen hatte, wie ich wollte.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. ... war ich wegen meines Gewichts lieber allein als mit anderen zusammen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. ... fand ich mein Aussehen ganz okay, wenn ich mich mit anderen verglichen habe.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. ... habe ich mich gesund gefühlt.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. ... hat mich mein Gewicht beim Schulsport gestört.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. ... habe ich wegen meines Gewichts nur schwer Freunde gefunden.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. ... wurde ich wegen meines Gewichts von anderen gehänselt.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. ... hatte ich das Gefühl, wegen meines Gewichts angestarrt zu werden.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. ... bin ich wegen meines Gewichts ungern ins Schwimmbad gegangen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Vielen Dank für deine Mitarbeit!

## 9.3 Original FSK-K (German)

### FSK-K

Ident.-Nr.     Inst.-Nr.     Gruppen-Nr.    Teilnehmer-Nr.   Anfangsbuchstaben Vorname, Nachname

Zeitpunkt  
der Erhebung

PB<sup>1</sup>  
T1 ☐

PE<sup>2</sup>  
T2 ☐

PE + 1 Jahr  
T3 ☐

PE + 3 Jahre  
T4 ☐

PE + 5 Jahre  
T5 ☐

<sup>1</sup> PB = Programm-Beginn, <sup>2</sup> PE = Programm-Ende

Bei diesem Fragebogen interessiert uns, welche Erfahrungen du normalerweise machst. Es gibt keine richtigen und falschen Antworten, sondern es geht um deine ganz persönlichen Erfahrungen. Alle Fragen bestehen aus zwei Aussagen wie z. B.

	Stimmt genau für mich	Stimmt ein bisschen für mich	stimmt ein bisschen für mich	Stimmt genau für mich	
1. Ich gehe gerne in die Schule	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich gehe nicht gerne in die Schule.

Überlege bitte zuerst, welche der beiden Seiten am ehesten auf dich zutrifft.

Im Beispiel: Wenn du eher gerne in die Schule gehst die **linke Seite**, wenn du eher nicht gerne in die Schule gehst, die **rechte Seite**. Auf der Seite, für die du dich entschieden hast, kannst du dann ankreuzen, ob das **genau** oder nur **ein bisschen** für dich stimmt.

Zum Beispiel: Wenn du also jeden Tag immer wieder gerne in die Schule gehst, würdest du auf der linken Seite unter „Ich gehe gerne in die Schule“ ankreuzen, „stimmt genau für mich“. Bitte mache bei jeder Frage also **nur ein Kreuz**!

	Stimmt genau für mich	Stimmt ein bisschen für mich	Stimmt ein bisschen für mich	Stimmt genau für mich	
1. Ich finde, dass ich sehr gut bin in dem, was in der Schule von mir verlangt wird,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich befürchte, dass ich das nicht kann, was in der Schule von mir verlangt wird.
2. Ich finde, dass es schwer ist, Freunde zu finden,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich finde es ganz einfach, Freunde zu finden.
3. Ich bin froh über mein Aussehen,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin nicht froh über mein Aussehen.
4. Ich finde es oft nicht gut, wie ich mich verhalte,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich mag es normalerweise, wie ich mich verhalte.
5. Ich bin oft unzufrieden mit mir selbst,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin meistens zufrieden mit mir selbst.

## FSK-K

	Stimmt genau für mich	Stimmt ein bisschen für mich	Stimmt ein bisschen für mich	Stimmt genau für mich	
6. Ich halte mich für genauso schlau wie andere Kinder in meinem Alter,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin da nicht so sicher, ob ich so schlau bin wie andere Kinder in meinem Alter.
7. Ich habe eine Menge Freunde,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich habe nicht sehr viele Freunde.
8. Ich bin zufrieden mit meinem Gewicht und meiner Größe,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin nicht zufrieden mit meinem Gewicht und meiner Größe.
9. Ich finde meistens richtig, was ich tue,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich finde es oft nicht richtig was ich tue.
10. Ich finde es nicht gut wie ich lebe,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich finde es gut wie ich lebe.
11. Ich bin ziemlich langsam bei den Hausaufgaben,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich kann meine Hausaufgaben schnell machen.
12. Mich kann man wirklich mögen,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... mich zu mögen fällt anderen irgendwie schwer.
13. Ich möchte, dass mein Körper anders ist,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich mag meinen Körper so wie er ist.
14. Ich weiß meistens, wie ich mich gegenüber anderen verhalten soll,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich weiß oft nicht genau, wie ich mich anderen gegenüber verhalten soll.
15. Ich bin mir sicher, dass ich einen guten Charakter habe,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin mir nicht so sicher, ob ich einen guten Charakter habe.
16. Ich vergesse oft, was ich gelernt habe,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich kann mich leicht an Sachen erinnern, die ich gelernt habe.
17. Ich tue alles mit anderen Kindern zusammen,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich tue vieles gern alleine.
18. Ich würde gerne anders aussehen,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich mag mich so wie ich aussehe.

## FSK-K

	Stimmt genau für mich	Stimmt ein bisschen für mich	Stimmt ein bisschen für mich	Stimmt genau für mich	
19. Ich bekomme oft Schwierigkeiten wegen dem, was ich tue,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bekomme normalerweise keine Schwierigkeiten wegen dem, was ich tue.
20. Ich will gern so bleiben wie ich bin,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich wäre gern jemand anderes.
21. Ich bin sehr gut im Unterricht,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... Ich bin nicht so gut im Unterricht.
22. Ich hätte es gerne, dass mehr Kinder mich mögen,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin mir ziemlich sicher, dass die meisten anderen mich mögen.
23. Ich mag mein Gesicht und meine Haare so, wie sie sind,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich hätte es lieber, dass an meinem Gesicht oder meinen Haaren etwas anders aussieht.
24. Ich habe oft Angst, das Falsche zu tun,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin mir meistens sicher, das Richtige zu tun.
25. Ich mag mich so wie ich bin,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich wäre oft viel lieber anders, als ich bin.
26. Mir fällt es schwer, auf Fragen in der Schule eine Antwort zu finden,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... mir fallen fast immer Antworten ein.
27. Ich bin bei anderen Kindern in meinem Alter beliebt,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin nicht sehr beliebt.
28. Ich finde, dass ich mit meinem guten Aussehen auf andere Eindruck mache,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich finde, dass mein Aussehen bei anderen nicht so gut ankommt.
29. Ich weiß meistens genau, was ich tun muss, wenn ich ein Problem habe,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich weiß oft nicht was ich machen soll, wenn ich ein Problem habe.
30. Ich bin oft unzufrieden mit der Art, wie ich eine Sache anpacke,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... ich bin meistens zufrieden damit, wie ich eine Sache anpacke.

Vielen Dank, dass du dir die Mühe gemacht hast, den Fragebogen so sorgfältig auszufüllen!