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Research Article

Body Weight and Motor Competence in 6- To 8-Year-Old Children

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Abstract

Objective: The development of motor competence during childhood has important implications for future health and well-being. The present study examined the association of overweight and obesity with motor competence in 6- to 8-year-old school children.

Methods: In a cross-sectional study 18 elementary schools in the federal state of Tyrol, Austria were randomly selected for participation. Motor competence was assessed in 857 (422 boys; 435 girls), children between March and December 2017 using the German Motor Test. Body weight and height were measured following standard procedures with children in sports clothes and being barefoot. Participants were categorized into four weight groups based on the German BMI reference system: group I (anorexic/underweight), group II (normal weight), group III (overweight) and group IV (obese). Differences across weight categories (underweight, normal weight, overweight, obese) were determined via ANOVA, using Bonferroni adjustment for post-hoc analyses.

Results: Out of the 857 school children 9.0% were overweight and 6.1% were obese. The prevalence of overweight and obesity increased from 5.7% in the 6-year old participants to 10.6% in the 8-year-old participants ($p= 0.004$). Motor competence of children with normal body weight or underweight was significantly higher than that of their peers with overweight or obesity ($p< 0.001$). Further, children with obesity displayed significantly lower motor competence scores than children with overweight ($p< 0.001$).

Conclusion: Motor competence is an important contributor to a healthy development in children. Comprehensive, preventive efforts, therefore, should emphasize motor development, particularly in elementary school, when targeting an active lifestyle and healthy body weight.

INTRODUCTION

The importance of motor competence and physical activity (PA) for health and the development of children and adolescents has been well documented [1-3]. Further, motor competence has been shown to be an important contributor to various preventive efforts [4,5]. In the last several decades, PA patterns, however, have changed drastically in many industrialized countries, with a majority of youth no longer meeting current PA recommendations of least 60 minutes of daily moderate-to-vigorous PA [6-10]. In addition to low PA, sedentary behaviors such as watching TV, surfing the internet and playing computer games have become increasingly popular leisure choices among children and adolescents [11-13]. These behavioral changes may also have contributed to a decline in physical fitness and motor competence in children and adolescents [14,15], while the prevalence of overweight and obesity has increased [16-18]. Even though recent studies have shown that overweight/obesity rates have plateaued in several regions [19,20], there has been a continuous worldwide increase in overweight/obesity levels [21]. Of particular concern is the increasing number children and adolescents with overweight or obesity, which is exceeding 40% in some European countries [10].

Fat tissue, however, does not only serve for energy storage, it also functions as endocrine organ. Excess body fat, therefore, has been associated with metabolic disruptions and increased risk for various chronic diseases already in youth. [23]. In addition to the association with physical health parameters, excess body fat has been shown to affect psycho-social health of children and adolescents, such as stigmatization and isolation [24]. Overweight and obesity during childhood as also been associated with excess body weight during adulthood along with the associated health risks. A Danish study [25], for example showed an increased risk for coronary heart disease with excess body weight. In fact there appeared to be a direct linear association between body weight during childhood and the risk for coronary heart disease during adulthood [25,26]. Even in the absence of adult obesity, children

and adolescents with excess body weight have been shown to have an increased chronic disease risk during adulthood [27].

Further excess body weight has been associated with an impairment of motor development and various national and international studies have shown an inverse association between body weight and physical fitness [15,22,28]. Childhood, and particularly elementary-school-age, is a vulnerable period for the development of motor competence and future PA habits [29]. Most studies, however, relied on data from the USA, Australia and Scandinavia and there exists limited data on this association in Austrian children. The present study therefore examines the association between body weight and motor competence in first- and second-grade elementary school children in Austria. It was hypothesized that increased body weight would be associated with lower motor competence and that the strength of this association increases with age.

METHODS

Motor competence and body weight was measured in first and second grade students during the school-year 2016/17. A total of 20 out of the 376 elementary schools in Tyrol, Austria were randomly selected for participation and contacted for participation. Two schools refused to participate and from the remaining 18 schools 22 first-grade classes and 21 second-grade classes agreed to participate. The study protocol was approved by the Institutional Review Board of the University of Innsbruck (Approval Number: 16/2017), the School Board of Tyrol, Austria and the principals of the participating schools. Parents received information about the study by mail and provided written informed consent. Students provided oral consent at the time of data collection.

Physical assessments were taken in a single session during regular school time in the gymnasiums of the elementary schools. Body weight and height were measured with children wearing gym clothes and being barefoot. Specifically, body weight was measured with an electronic scale (SECA 803®, Seca, Germany) to the nearest 0,1 kg and height was measured with a mobile stadiometer (SECA® 217, Seca, Germany) to the nearest 0.1 cm. Body mass index (BMI) was calculated (kg/m^2) and converted to BMI percentiles (BMIPCT) using German reference values [30]. Children with a BMIPCT between 10 and 90 were considered normal weight. Children with BMIPCT between 90 and 97 were considered overweight and children with BMIPCT above 97 were considered obese. Children with a BMIPCT under 3 were classified as anorexic and children with a BMIPCT between 3 and 10 were classified as underweight. Due to the small number of anorexic children (n=3), underweight and anorexic children were pooled in one group (underweight).

Motor competence was assessed with the German motor test (Deutscher Motorik Test 6-18, DMT6-18) [31]. The DMT6-18 is a standardized and previously validated test that assesses cardiorespiratory endurance, muscular endurance, muscular strength, power, speed, agility, balance and flexibility. It consists of 8 test items (6-minute run, pushups, sit ups, standing long-jump, 20m-sprint, sideways jumping, backwards balance and stand and reach test). Raw performance scores of each test are converted to sex- and age-normalized scores, which facilitates comparison across age groups. The average of these scores is subsequently calculated as indicator for overall motor performance [31]. After anthropometric measurements and a standardized warm-up children started the test battery with the 20m-sprint and ended with the 6-minute run. Other tests were performed in random order.

DATA ANALYSIS

Mean and standard deviations are shown for interval-scaled data and frequencies are displayed in tables and figures. Motor competence data was checked for normal distribution via the Kolmogorov-Smirnov test and homogeneity of variance was assessed via the Levene Test. Differences across weight categories (underweight, normal weight, overweight, obese) were determined via ANOVA with Bonferroni adjustment being used for post-hoc analyses for 3 separate age categories. All statistical analyses were performed with SPSS 24.0 and a significance level of $p < 0.05$.

RESULTS

A total of 857 children (49.2% male) provided valid data. Average age was 6.9 ± 0.8 years with a mean BMI of 16.5 ± 2.3. There were no significant sex differences in BMI and age. Anthropometric characteristics are shown in Table (1). Out of the 422 boys 9.2% (n= 39) were considered overweight and 6.6 (n=28) were considered obese. In the girls 8.7% (n=38) and 5.5% (n=24) were considered overweight and obese, respectively (Table 2). The prevalence of obesity increased from 5.7% in the 6-year old participants to 10.6% in the 8-year-old participants, which indicates a significant increase (p= 0.004).

The average motor competence score of 96.1 ± 4.7 of participants with obesity was significantly lower compared to all other weight groups (p<0.001) (Figure 1). Additionally, an average motor competence score of 101.0 ± 5.2 in participants with overweight was significantly lower than that of normal weight (105.3 ± 6.0; p<0.001) and underweight (104.4 ± 6.5; p= 0.031). No significant difference in motor competence scores were observed between the normal weight and underweight group.

Analyses by age group further revealed that motor

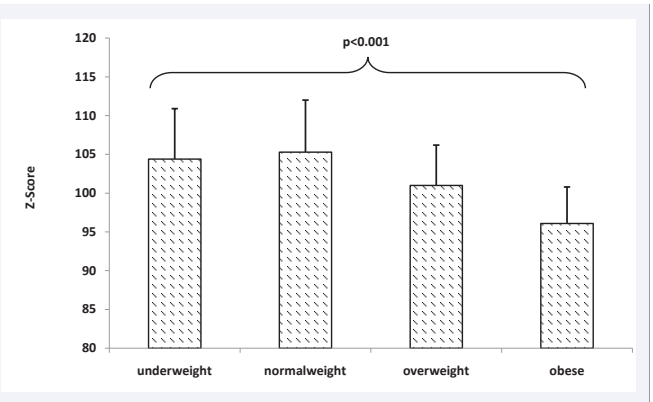

Figure 1 Age and sex-normalized motor competence scores by weight group. Values are number of means ± standard deviation.

Table 1: Anthropometric characteristics for boys and girls by age group. Values are Mean ± SD.

Age Group (years)	Girls				Boys			
	n	Height (cm)	Weight (kg)	BMI	n	Height (cm)	Weight (kg)	BMI
6	168	121.7 ± 6.2	24.0 ± 4.3	16.1 ± 1.9	131	121.7 ± 6.0	24.0 ± 4.7	16.1 ± 1.9
7	155	126.2 ± 5.9	25.9 ± 5.0	16.2 ± 2.1	176	126.8 ± 6.4	26.2 ± 4.2	16.2 ± 1.8
8	112	129.6 ± 6.0	29.2 ± 6.3	17.3 ± 2.9	115	130.7 ± 5.7	29.3 ± 5.8	17.1 ± 2.7

Table 2: Prevalence of underweight, normal weight, overweight and obesity by sex and age.

Age Group (years)	Girls				Boys			
	under-weight* n (%)	normal-weight n (%)	over-weight n (%)	obese n (%)	under-weight* n (%)	normal-weight n (%)	over-weight n (%)	obese n (%)
6	6 (3.6)	142 (84.5)	12 (7.1)	8 (4.8)	6 (4.6)	105 (80.2)	11 (8.4)	9 (6.9)
7	6 (3.8)	134 (86.5)	12 (7.7)	3 (1.9)	7 (3.9)	148 (84.1)	13 (7.4)	8 (4.5)
8	4 (3.6)	81 (72.3)	14 (12.5)	13 (11.6)	3 (2.6)	86 (74.8)	15 (13.0)	11 (9.6)
Total	16 (3.7)	357 (82.1)	38 (8.7)	24 (5.5)	16 (3.8)	339 (80.3)	39 (9.2)	28 (6.6)

*anorexic participants (n=3) were pooled with the underweight group

competence scores of 6-year-old underweight (104.3 ± 4.7) and normal weight participants (104.6 ± 5.7) were significantly higher compared to their peers with overweight or obesity (99.5 ± 4.9 and 96.5 ± 5.2, respectively; $p<0.001$). At this age there was no significant difference in motor competence between participants with overweight and obesity. In the 7- and 8-year-old participants, children with obesity displayed significantly lower motor competence scores than all their peers, including those with overweight ($p<0.001$).

DISCUSSION

This study including 857 Austrian elementary school children between 6 and 8 years of age showed a prevalence of 9% and 6% of overweight and obesity, respectively. This is comparable to other studies in European children [32]. As has been shown in previous studies, there was an inverse association between body weight and motor competence [15,22,33-36].Children with overweight or obesity showed consistently lower motor competence than their normal weight and underweight peers. Considering separate age groups it could further be shown that the discrepancy in motor competence between participants with overweight and obesity increased with increasing age. There was no significant difference in motor competence between participants with overweight and obesity at the age of 6, while 7- and 8-year-old children with obesity displayed significantly lower motor competence than their peers with overweight. It can, therefore, be speculated that that the influence of body weight on motor competence increases as children get older. A similar trend has been shown in preschool children as well [22]. Of additional concern is the increasing prevalence of obesity with increasing age. Taken together, these results emphasize the importance of early preventive measures against excess body weight. As body weight has been shown to track from childhood throughout adolescence into adulthood, adipose children are more likely to become an overweight adults, which increases their risk for various adverse health outcomes, including cardiovascular and metabolic diseases [37].

Despite the limited evidence on the association between excess body weight and chronic disease in children compared to adults [38], increased fat mass has been associated with increased morbidity during childhood [39]. Further, excess body fat during childhood has been associated with increased risk for cardiovascular disease and metabolic problems, including type II diabetes, in adulthood [25,26,40-42]. Even if adults managed to have a normal body weight, there was still a higher chronic disease risk when they were obese during childhood [27]. Particularly metabolic problems, including diabetes type II, and hypertension are commonly associated with adiposity [40,41]. Excess weight gain in children is also associated with emotional and psycho-social problems that increase the risk for isolation of these children. These problems may further lead to detrimental behaviors such as high sedentary leisure-time choices (i.e. high media consumption) and unhealthy dietary choices that are maintained into adulthood [42-44]. Higher motor competence, on the other hand, can facilitate participation in various forms of PA, which is an important component for sustainable weight management.

Some limitations of the present study, however, should be considered when interpreting the results. There was no data on other correlates of body weight and motor competence, such as socio-economic background or overall PA. The cross-sectional nature of the study further does not allow establishing a causal relationship between body weight and motor competence, which is most likely bi-directional in nature. Generalization may also be limited as only children from predominantly rural areas in Western Austria participated in the study. The measurement of body weight and height (rather than self- or parental report) along with the utilization of a widely used and validated test battery for the assessment of motor competence [30] as well as the large sample size, on the other hand, should be considered a strength of this study. Given the limited data in Austrian children, the present study provides potentially valuable data for the development of intervention strategies targeting body weight and motor competence in elementary school children.

In conclusion, the results of the present study show that body weight is a strong correlate of motor competence in elementary school children and that the strength of the association increases with age. Accordingly, elementary school years appear to be critical in the promotion of motor competence by facilitating active leisure time choices and sports participation, particularly in children with excess body weight.

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