Original Article

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Gross motor coordination and physical fitness in overweight and obese primary school children compared with normal weight peers

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Abstract: The epidemic of childhood obesity, the decline in the level of motor competence and health-related fitness, and simultaneously the increase in physical inactivity have been the subject of global professional and scientific discourse in the last two decades. This study is focused on the analysis of the level of gross motor coordination and physical fitness in primary school children in terms of their weight status. Data were collected from 219 primary school children (50.68% girls) with an average age of 9.48 years (SD = 0.47 years). Gross motor coordination was assessed with the KTK test. The children's physical fitness was assessed using six items of the Eurofit test. The body mass index (BMI) of the participants was assessed based on the international childhood BMI cut-offs suggested by the International Obesity Task Force (IOTF). Differences in the examined motor indicators between overweight/obese children and normal weight children were evaluated using independent samples t-test. Pearson correlations were performed to explore the associations between motor coordination indicators and BMI. The results of this study revealed overweight or obesity in more than one fifth of the participants (25.2% of girls and 21.3% of boys). Our study provides evidence that excessive body weight is negatively reflected both in gross motor coordination and in a worse physical fitness profile of children. Weak to moderate inverse correlations ($-0.17 \le r \le -0.39$) were found between most of the gross motor coordination, physical fitness parameters and BMI, for both sexes. Considering the role of gross motor coordination and health-related fitness in the mechanism of shaping children's active lifestyle, early detection and intervention is necessary, especially in children with excessive body weight.

Keywords: childhood obesity; motor development; motor competence

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INTRODUCTION

Childhood overweight and obesity remains a major public health problem worldwide. Based on meta-analyses, Ng et al [1] confirm that the prevalence of overweight in children and adolescents (2-19 years) increased by almost 50% between 1980 and 2013. In 2013, more than 22.6% of girls and 23.8% of boys from economically developed regions of the world were classified as overweight or obese.

Based on recent data from 33 countries in the European Region, 29% of children aged 7-9 years are overweight (including obese) according to World Health Organization (WHO) standards. The prevalence is higher in boys (31%) than in girls (28%). The overall incidence of obesity in 7-9 year old children was 12%, 14% for boys and 10% for girls [2]. In addition to the direct impact of childhood obesity on a child's physical and mental health, school performance and quality of life, unhealthy body weight in early life can increase the risk of obesity and noncommunicable diseases in later life and adulthood [2]. Freedman et al [3] state that up to 77% of overweight children remain obese into adulthood. Overweight children and adolescents are 6.2 times more likely to be overweight in adulthood than children and adolescents of healthy weight [4].

Based on the theoretical model presented by Stodden et al [5], overweight and obesity can be supported by the cumulative effect of low levels of motor competence leading to a reduction in an individual's motor opportunities, reduced physical fitness and reduced self-assessment of one's own motor competence. Robinson et al [6] emphasise that an adequate level of physical fitness and motor competence provides the so-called protective effect in relation to the decrease in physical activity and unhealthy increase in body weight during ontogenesis.

In recent decades, a decline in the level of motor skills in primary school children has been reported [7,8]. Similarly, Giuriato et al [9], using the Körperkoordinations Test für Kinder (KTK) test battery, document a lower level of gross motor coordination in contemporary children compared to the reference data of the KTK battery presented by Kiphard and Schiling [10,11]. This decline has been shown to be global and largely driven by the increasing prevalence of sedentary behaviour in children [12].

As reported by Stodden et al [5], health-related fitness may play a mediating role in the relationship between physical activity and motor competence. Children who do not have adequate levels of motor competence will not continue to be physically active in later childhood and therefore will not further increase or maintain health-related physical fitness. Ortega et al [13] consider physical fitness to be a reliable summative indicator of health. However, based on a meta-analytic approach, Tomkinson et al [14] report that over two decades (1980-2000) there was a significant decline in cardiorespiratory fitness in children and adolescents aged 6-19 years of 0.43% of the mean value per year. Tomkinson et al [15] estimate that 78% of boys and 83% of girls (9-17 years) meet the new international criterion-referenced standards of 42 and 35 mL/kg/min, respectively, for healthy cardiorespiratory fitness, with the percentage meeting the standards decreasing with age.

Research in recent years has documented a negative association between weight status or adiposity and gross motor coordination in children on a cross-sectional basis [16-21] and in longitudinal studies [22,23]. Similarly, many studies confirm the negative impact of overweight on physical fitness in children [24-28]. Barnett et al [29] emphasise that excess body weight is an obstacle to the development of motor skills, especially if the individual is already obese in early childhood.

In this context, Slotte et al [30] state that despite the increasing interest in childhood obesity and its relationship with health-related fitness and gross motor coordination in recent years, the relationship between weight status and various motor measures has not been comprehensively investigated. This may be related to the variability of the diagnostic tools used and the aspects of motor competence measured.

Cattuzzo et al [31] emphasise that although physical fitness and gross motor coordination are theoretically distinct constructs, they are closely related. Their development is linked not only directly through neuromuscular functions, but also indirectly through the individual's participation in physical activity. Chovanová, Majherová and Bendíková [32], Utesch et al. [33] state that both motor constructs mentioned should be part of the diagnosis of motor competence in the child population, as together they can provide more complex and detailed information about motor performance.

However, many previous studies have used diagnostic tools that did not define which domain of motor performance they were operationalising or did not represent a clearly defined construct. Therefore, in the present study, two test batteries are used simultaneously to represent two different theoretical constructs - gross motor coordination and physical fitness. On the other hand, gross motor coordination and physical fitness should not be considered as separate constructs. Rather, they should be seen as simultaneous goals for developing functional abilities in children that will enable them to participate successfully in many types of health-promoting physical activities.

In light of the above, the aim of this study is to assess differences in levels of gross motor coordination and physical fitness in primary school children according to their weight status. The study hypothesises that obese or overweight children will have significantly lower levels of both physical fitness and gross motor coordination than their normal weight peers.

MATERIAL AND METHODS

Participants

Children from 11 urban primary schools in the Presov region participated in the cross-sectional study. The children were recruited as a convenience sample. Out of the total planned number of children (n = 253), 233 informed consents were obtained from the parents or legal representatives of the participating children (92.09% response rate). Finally, the research sample consisted of a total of 219 children (111 girls, 50.68%; 108 boys, 49.32%; total normal weight n = 168; overweight n = 51; girls n = 111: normal weight n = 83, overweight n = 28; boys n = 108: normal weight n = 85, overweight n = 23) with a mean age of 9.48 ± 0.47 years who completed all measurements and whose data were included in the subsequent statistical analyses.

The children's participation in the research was voluntary, and the data collected were processed anonymously. All participants regularly attended two hours of physical education per week and were free of serious health problems. The study was approved by the Ethics Committee of the University of Presov (No. ECUP102023PO/21 September 2023) in accordance with the Declaration of Helsinki.

Anthropometric measurements

All anthropometric measurements were taken by the participants in light sports clothing and barefoot. Height was measured using a portable stadiometer with an accuracy of 0.1 cm (Harpeden, Holtain Ltd, Crymych, United Kingdom). Body weight was measured using a digital scale (Omron HN-286, Omron, Kyoto, Japan) with an accuracy of 0.5 kg. Based on these measurements, the participants' body mass index (BMI, [kg/m2]) was calculated. The widely used international cut-offs for childhood BMI proposed by the International Obesity Task Force (IOTF) [34] were used to divide the children into two BMI groups: normal weight and overweight. The cut-offs used to identify overweight were 19.38 kg/m2 (9.5 years) for girls and 19.43 kg/m2 (9.5 years) for boys. A Holtain skinfold caliper (Holtain Ltd., Crymych, United Kingdom) was used to measure five skinfolds (triceps, biceps, subscapular, supraspinal, medial calf) to an accuracy of 0.1 mm according to the protocol described by Adam et al [35].

Gross motor coordination assessment

The assessment of gross motor coordination was conducted using the Körperkoordinations test für Kinder (KTK) [10,11], a test that has been standardised for children between the ages of 5 and 14 years. The test-retest reliability coefficient for the raw score on the total test battery was reported to be 0.97. The coefficients for individual test items ranged from 0.80 to 0.96 [10,11]. The KTK test comprises four items: (1) walking backwards: walking backwards on a balance beam of decreasing widths (6 cm, 4.5 cm, 3 cm); (2) hopping for height: one-legged hopping over a foam obstacle with increasing height in consecutive steps of 5 cm; (3) jumping sideways: two-legged jumping from side to side over a beam as fast as possible for 15 seconds; (4) moving sideways: moving sideways on wooden boards for 20 seconds.

The raw scores of each test item were converted into standardised scores, adjusted for age and sex, using normative data tables in the KTK manual. The sum of the standardized scores for each test item provides the motor quotient (MQ). The KTK MQ, adjusted for age and gender, permits the assessment of gross motor coordination in the following categories: The following categories are used to describe the level of motor coordination: impaired (KTK MQ 56-70; ≤ 2nd percentile), poor (KTK MQ 71-85; 3rd-16th percentile), normal (KTK MQ 86-115; 17th-84th percentile), good (KTK MQ 116-130; 85th-98th percentile, or high (KTK MQ 131-145; ≥99th percentile) [10,11].

Physical fitness assessment

The physical fitness of children was evaluated using six items from the Eurofit test [35], which included the sit-and-reach test (flexibility), the standing broad jump test (lower body muscular power), the sit-ups test (abdominal muscular endurance), the bent arm hang test (upper body muscular endurance), the 10×5 m agility shuttle run test (running speed-agility), and the 20 m shuttle run test (cardiorespiratory endurance, CRF). The level of cardiorespiratory fitness (20 m shuttle run) was assessed in accordance with recently published reference data for individual components of physical fitness [36]. Motor testing was conducted during physical and sports education lessons in the gymnasiums of participating schools.

Statistical analysis

All analyses were conducted using SPSS Statistics (v20.0, IBM, Chicago, IL, USA), and the data are presented as mean ± standard deviation. The level of significance was set at $p < 0.05$. The normality test by Shapiro-Wilk was employed to ascertain the normality of the data distribution. Additionally, the Levene's test was employed to assess the equality of variances. An independent samples t-test was employed to assess the differences in anthropometric and motor measures between the normal weight and excessive weight groups. Pearson's correlation coefficients (r) were employed to investigate the relations between BMI and KTK/Eurofit motor parameters. The strength of the Pearson's correlation coefficients is defined as weak (≤ ± 0.10), moderate (≥ ± 0.30), and strong (≥ ± 0.50) [37]. The effect size was evaluated using Cohen's d. The values of $d = 0.2$, $d = 0.5$ and $d = 0.8$ were interpreted as representing small, medium and large effects, respectively [37,38].

RESULTS

A total of 219 children were examined, of whom 51 (23.3%) were identified as having excessive body weight (overweight/obesity). Of these, 25.2% were girls and 21.3% were boys. The prevalence of obesity was 5.4% among girls and 6.5% among boys. Table 1 presents the basic anthropometric characteristics of the BMI groups, which were created based on the BMI cut-off points [34]. The results indicate a significantly less favourable level in children with obesity/overweight compared to normal weight children in all examined somatic indicators.

The results of the independent samples t-test indicated that overweight children exhibited statistically significant lower scores than their normal weight peers in all examined items of the KTK test [10,11], with effect sizes ranging from 0.35 (jumping sideways) to 0.86 (walking backwards) (see Table 2). Normal weight girls demonstrated a significantly higher raw score than their overweight peers in two out of four test items of the KTK test, as well as in the overall evaluation expressed on the basis of the KTK MQ. The exceptions were observed in the jumping sideways ($t(109) = 1.77$, $p = 0.080$) and moving sideways ($t(109) = 1.87$, $p = 0.064$) tasks. According to the established norms [10,11], the mean level of the KTK MQ in overweight girls was only slightly above the threshold value (KTK MQ = 85), which indicates poor motor coordination. Similar to girls, normal weight boys also achieved higher levels than overweight/obese boys in all investigated motor indicators (medium to large effect sizes), with the exception of jumping sideways ($t(106) = 1.62$, $p = 0.107$) and moving sideways ($t(106) = 1.77$, $p = 0.079$).

The results demonstrate that a total of 41.2% of overweight/obese children exhibit a deficit in gross motor coordination, as indicated by a KTK MQ score of ≤85. Conversely, 9.5% of children with a normal BMI are below the level of normal gross motor coordination. A significant proportion of girls with overweight or obesity (46.4%) and normal weight girls (12.05%) demonstrate poor or impaired gross motor coordination. The KTK MQ is below the normal level (≤ 85) in 34.8% of boys with excessive body weight and 7.06% of normal weight boys.

The results of the comparison of BMI groups in terms of physical fitness are presented in Table 3. Normal weight boys achieved significantly higher scores than their peers with excessive body weight in almost all examined motor indicators, with medium to large effect sizes. The exceptions are the test items sit-and-reach ($t(106) = 0.16$, $p = 0.873$) and sit-ups ($t(106) = 0.66$, $p = 0.514$). The situation is identical in the group of girls; however, significant differences between BMI groups were not confirmed in the item bent arm hang ($t(109) = 1.89$, $p = 0.060$).

Table 4 presents the Pearson's correlations between gross motor coordination measures and BMI. Significant inverse correlations between walking backwards, hopping for height, and the KTK MQ and BMI were confirmed in both girls and boys, as well as in the overall sample. These correlations ranged from weak to moderate, with values between -0.17 and -0.39.

Table 1. Descriptive statistics and results of statistical significance between groups

Indicator	Gender	Normal weight M ± SD	Overweight M ± SD	t	p	d
Age (years)	Total	9.48 ± 0.50	9.59 ± 0.49	-1.40	0.162	0.32
	Girls	9.47 ± 0.50	9.61 ± 0.48	-1.25	0.213	0.35
	Boys	9.48 ± 0.50	9.57 ± 0.51	-0.70	0.485	0.26
Body weight (kg)	Total	30.68 ± 5.11	45.45 ± 7.94	-12.52	**< 0.001**	2.21
	Girls	30.60 ± 5.40	44.63 ± 8.53	-8.17	**< 0.001**	1.97
	Boys	30.77 ± 4.83	46.46 ± 7.21	-9.85	**< 0.001**	2.56
Body height (cm)	Total	138.71 ± 7.33	143.39 ± 8.38	-3.60	**0.001**	0.59
	Girls	138.22 ± 7.49	142.45 ± 9.94	-2.06	**0.046**	0.48
	Boys	139.19 ± 7.19	144.54 ± 5.97	-3.28	**0.001**	0.81
Sum of 5 skinfolds (mm)	Total	41.07 ± 8.85	57.47 ± 11.51	-9.37	**< 0.001**	1.60
	Girls	42.67 ± 8.79	57.39 ± 9.57	-7.49	**< 0.001**	1.60
	Boys	39.44 ± 8.66	57.57 ± 13.74	-5.99	**< 0.001**	1.58
BMI (kg·m^{-2})	Total	15.87 ± 1.71	21.94 ± 2.03	-21.25	**< 0.001**	3.23
	Girls	15.93 ± 1.77	21.79 ± 1.79	-15.11	**< 0.001**	3.29
	Boys	15.81 ± 1.66	22.14 ± 2.03	-12.30	**<0.001**	3.41

M - mean; SD - standard deviation; t - results of t-test; p - significance level; d – effect size Cohen's, bold - statistically significant

Table 2. Descriptive statistics and BMI groups differences of KTK parameters (raw scores)

KTK items	Gender	Normal weight M ± SD	Overweight M ± SD	t	p	d
Walking backwards (steps)	Total	54.34 ± 10.55	43.39 ± 14.62	5.90	**< 0.001**	0.86
	Girls	53.40 ± 11.09	42.71 ± 13.82	4.13	**< 0.001**	0.85
	Boys	55.26 ± 9.98	44.22 ± 15.81	3.18	**0.004**	0.84
Hopping for height (points)	Total	62.23 ± 11.22	55.04 ± 14.36	3.28	**0.002**	0.58
	Girls	59.45 ± 11.16	53.93 ± 13.26	2.16	**0.033**	0.45
	Boys	64.94 ± 10.65	56.39 ± 15.79	2.45	**0.021**	0.64
Jumping sideways (jumps)	Total	61.17 ± 9.82	57.20 ± 12.82	2.04	**0.045**	0.35
	Girls	61.64 ± 8.86	57.93 ± 11.61	1.77	**0.080**	0.36
	Boys	60.72 ±10.71	56.30 ± 14.36	1.62	0.107	0.35
Moving sideways (transfers)	Total	45.49 ± 8.77	41.82 ± 9.53	2.56	**0.011**	0.40
	Girls	45.65 ± 7.49	42.07 ± 8.50	1.87	0.064	0.45
	Boys	45.73 ± 9.90	41.52 ± 10.85	1.77	0.079	0.41
KTK motor quotient (MQ)	Total	103.12 ± 12.20	91.55 ± 17.07	4.50	**< 0.001**	0.78
	Girls	99.61 ± 12.52	88.89 ± 15.60	3.68	**< 0.001**	0.76
	Boys	106.54 ±10.91	94.78 ± 18.53	2.91	**0.007**	0.77

KTK - Körperkoordinations test für Kinder; M - mean; SD - standard deviation; t - results of t-test; p - significance level; d – effect size Cohen's; bold - statistically significant

Table 3. Descriptive statistics and BMI groups differences of Eurofit parameters

Eurofit test	Gender	Normal weight M ± SD	Overweight M ± SD	t	p	d
Sit-and-reach (cm)	Total	21.19 ± 5.90	21.71 ± 6.60	-0.54	0.593	0.83
	Girls	22.21 ± 5.47	23.14 ± 6.67	-0.74	0.462	0.15
	Boys	20.19 ± 6.15	19.96 ± 6.22	0.16	0.873	0.04
Standing broad jump (cm)	Total	136.87 ± 20.69	125.29 ± 17.12	3.63	**< 0.001**	0.61
	Girls	131.20 ± 18.74	120.14 ± 16.76	2.77	**0.007**	0.62
	Boys	142.40 ± 21.11	131.57 ± 15.70	2.29	**0.024**	0.58
Sit-ups (n)	Total	18.97 ± 4.70	17.94 ± 5.27	1.33	0.184	0.21
	Girls	18.59 ± 3.60	17.46 ± 5.95	0.94	0.352	0.23
	Boys	19.34 ± 5.55	18.52 ± 4.37	0.66	0.514	0.16
Bent arm hang (s)	Total	17.12 ± 12.73	10.00 ± 9.46	3.68	**< 0.001**	0.64
	Girls	14.05 ± 9.56	10.03 ± 9.53	1.89	**0.060**	0.26
	Boys	20.11 ± 14.66	9.96 ± 8.88	4.16	**< 0.001**	0.84
10×5 m shuttle run (s)	Total	23.04 ± 2.12	24.46 ± 2.28	-4.14	**< 0.001**	0.65
	Girls	23.26 ± 1.82	24.87 ± 2.29	-3.78	**< 0.001**	0.78
	Boys	22.82 ± 2.36	23.97 ± 2.22	-2.10	**0.038**	0.50
20 m shuttle run (s)	Total	26.48 ± 8.87	20.67 ± 8.32	4.16	**< 0.001**	0.68
	Girls	23.98 ± 7.22	19.46 ± 7.74	2.81	**0.006**	0.60
	Boys	28.92 ± 9.65	22.13 ± 8.92	3.04	**0.003**	0.73

M - mean; SD - standard deviation; t - results of t-test; p - significance level; d – effect size Cohen's; bold - statistically significant

Table 4. Pearson correlations (*r*) between BMI and KTK parameters

Test	Motor measures	BMI		
		Total	Girls	Boys
KTK	Walking backwards	−0.35**	−0.32**	−0.39**
	Hopping for height	−0.24**	−0.21*	−0.27**
	Jumping sideways	−0.11	−0.09	−0.14
	Moving sideways	−0.17*	−0.16	−0.17
	KTK MQ	−0.35**	−0.32**	−0.38**
Eurofit	Sit-and-reach	0.13	0.08	0.18
	Standing broad jump	−0.23**	−0.24*	−0.23*
	Sit-ups	−0.19**	−0.16	−0.12
	Bent arm hang	−0.31**	−0.27**	−0.34**
	10×5 m shuttle run	−.023**	−0.32**	0.16
	20 m shuttle run	−0.31**	−0.28**	−0.34**

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

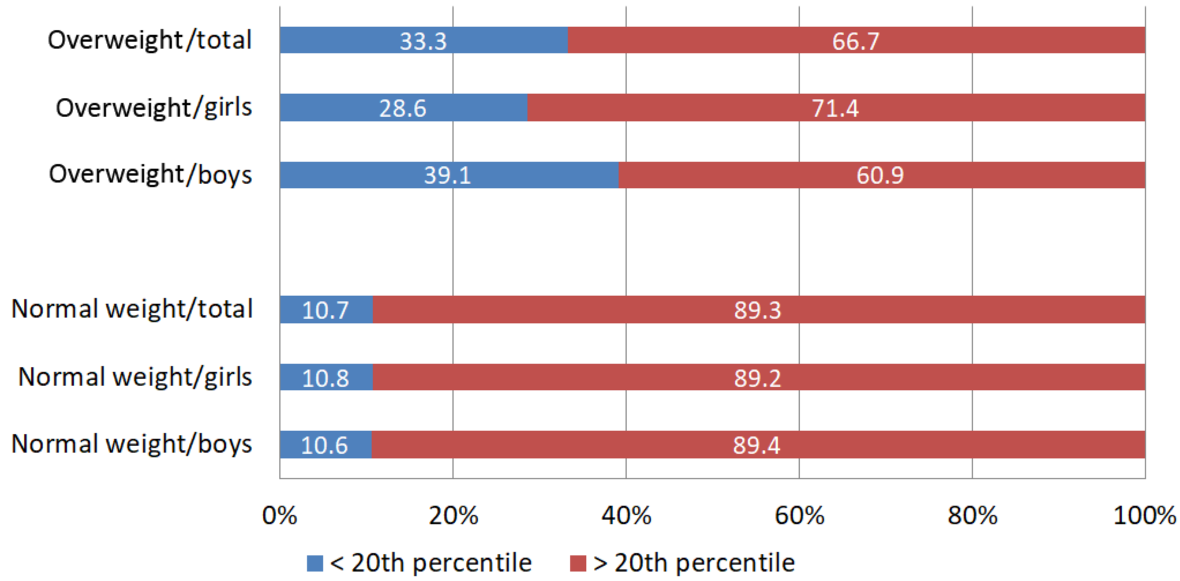

Figure 1. The percentage of cardiorespiratory fitness (CRF) level according to BMI groups (20 m shuttle run).

The correlations between physical fitness items and the BMI in the joint group of girls and boys (see Table 4) demonstrate a significant inverse relationship between BMI and all examined motor indicators, with the exception of sit-and-reach ($r = 0.13$, $p = 0.052$). In boys, a significant inverse relationship between BMI and three out of six physical fitness items was demonstrated, with the strength of the relationship varying from weak to moderate. These items were the standing broad jump, bent arm hang and 20 m shuttle run.

The results of the 20 m shuttle run test (CRF) were compared with the most recent European fitness reference values for children and adolescents, as outlined in reference 36. As illustrated in Figure 1, approximately one-third of overweight children and 10.7% of normal-weight children are below the 20th percentile in cardiorespiratory fitness, which indicates a very low/poor level [15]. A significantly higher proportion of overweight and obese boys (39.1%) and girls (28.5%) are below the level of the 20th percentile of cardiorespiratory fitness compared to their normal weight counterparts.

DISCUSSION

The results of the research indicate that an excessive body weight is negatively reflected in the level of motor competence in both girls and boys. In the study sample, more than one fifth of the children were found to be overweight or obese (25.2% of girls and 21.3% of boys). This prevalence is consistent with global findings [1], although it is slightly lower than reference European data [2], particularly in boys, where it was detected at a level of 31%.

The results of this study corroborate the negative correlation between obesity/overweight and motor competence in children, a relationship that has been consistently documented in recent research findings [31,39-42]. Moreover, as reported by D'Hondt et al. [17], the strength of this negative relationship increases with age. Similarly, Battaglia et al. [43] report a significantly lower level of gross motor coordination in children with overweight and obesity compared to their peers with normal weight aged 6 to 13 years, with the exception of 6- to 7-year-old boys. Conversely, in early childhood (3 to 5 years), there is no significant difference in gross motor coordination, locomotor, and object control skills in relation to the weight status of children [44].

As stated by Hardy et al. [45], overweight or obese children tend to exhibit diminished performance, particularly in locomotor activities. This is partially attributable to biomechanical factors related to higher body weight. Excessive body weight affects body geometry and increases the weight of individual body segments, which can increase the difficulty of movements that place high demands on body stability. Furthermore, Lima et al. [46] concur with the aforementioned findings, indicating that overweight or obese children tend to experience difficulties in weight-bearing tasks, which can impede the development of motor competencies. Conversely, in the jumping sideways test item, which assumes quick sideways jumps, no significant differences were confirmed between BMI groups when separately comparing girls and boys in our study. Additionally, no significant correlation was observed between BMI and jumping sideways in girls ($r = -0.09$, $p = 0.371$) or in boys ($r = -0.14$, $p = 0.145$). It is challenging to provide a clear rationale for this outcome at this level of analysis. However, it can be postulated that children at this age are capable of compensating for the effects of excessive body weight, and this may not yet be reflected in their motor performance at this age.

Further research findings indicate that 40% of overweight children and almost 10% of normal weight children exhibited a deficit in gross motor coordination, as indicated by a KTK MQ score of ≤85. Concurrently, over 33% of overweight or obese children and almost 11% of normal weight children exhibited suboptimal cardiorespiratory fitness (CRF). Conversely, the mean level of cardiorespiratory fitness in normal weight children in this study does not exceed the moderate level (40-60th percentile) [15]. Similarly, a longitudinal study by Henrique et al. [47] demonstrated that children with higher gross motor coordination exhibited lower BMI, subcutaneous fat, and higher physical fitness scores than those with consistently low motor coordination. Similarly, D'Hondt et al. [17] report that less than 20% of healthy-weight children were identified as being motor impaired, while that proportion was 43.3% and 70.8% in children with overweight and obesity, respectively. Furthermore, Ružbarská [21] indicates that almost 60% of children (aged 8 years) with excessive body weight exhibit deficits in gross motor coordination.

Armstrong et al. [24] and Dumith et al. [27] have reported that children with a healthy body weight demonstrate an overall better physical fitness profile compared to their overweight and obese peers, with the exception of the sit-and-reach test. The results of this study also demonstrate a significantly lower level of physical fitness in children with excessive body weight compared to children with normal weight, with the exception of the sit-and-reach and sit-ups test items. As reported by Castro-Piñero et al. [48], children with a healthy body weight demonstrated significantly higher performance than their overweight and obese peers in the lower-body explosive strength tests and in the push-ups test in boys and the bent-arm hang test in both boys and girls. Similarly, López-Gil et al. [28] report in their recent study that children with normal weight achieved better results for health-related physical fitness and physical activity than those with excessive weight. As reported by Dumith et al. [27], the differences between BMI groups are more pronounced in boys than in girls. Furthermore, cardiorespiratory fitness has the strongest association with BMI status.

Pombo et al. [49] postulate that the cardiorespiratory fitness deficit in children may be attributable to their inadequate level of locomotor skills. Laukkanen et al. [50] posit that research indicates that there are different sex-specific mechanisms at play in the interaction between BMI and motor development in childhood. This necessitates the implementation of distinct intervention strategies for girls and boys with regard to the promotion of motor development, physical activity, and obesity prevention.

Gross motor coordination and health-related physical fitness are distinct yet interrelated motor constructs. The parallel development of these constructs is of significant importance in the context of physical education at the primary level of education, as it allows children to successfully participate in various motor contexts that are developmentally appropriate and bring both short-term and long-term health benefits. Nevertheless, it is of particular importance to implement intervention strategies to enhance motor competence in the population of children with excessive body weight, as this demographic is at risk of entering a vicious cycle of low gross motor coordination, physical fitness, physical inactivity, and obesity.

It is important to note that this study is subject to several limitations that should be taken into account when interpreting the research results. Firstly, it should be noted that this was a cross-sectional study, which precludes the possibility of determining the directionality and causality of the relationships identified. Secondly, BMI is a widely accepted proxy measure for detecting obesity in the paediatric population. However, it has limitations for assessing body composition, as it does not differentiate between fat mass (adipose tissue) and lean mass. In their meta-analysis, Javed et al. [51] report that BMI calculation had 73% sensitivity in determining adiposity. Conversely, the application of internationally established BMI cut-offs provides a reliable measure of adiposity for monitoring weight at the population level [34]. Nevertheless, further research employing more accurate obesity detection methods and a longitudinal approach is necessary to elucidate the relationship between adiposity and motor competencies in childhood.

In light of the role of gross motor coordination and physical fitness in the mechanism of shaping the trajectory of an individual's lifelong physical activity, it is also necessary to investigate other factors that can determine the interrelationships between motor competence, physical fitness, and weight status. These include physical activity, self-assessment of one's own motor competence, socioeconomic status, and more.

CONCLUSION

The findings of this study demonstrate that excessive body weight has a detrimental impact on both the level of gross motor coordination and physical fitness, both in girls and boys. Moreover, the findings of the study indicate a higher prevalence of motor impairments, coupled with a higher incidence of very low cardiorespiratory fitness in children with overweight or obesity.

Conversely, the findings indicate that the impact of excessive weight on gross motor coordination and physical fitness is not uniform. It can be presumed that children at this age are still capable of compensating for the negative effects of excess body weight on their motor performance.

In conclusion, it is of paramount importance to delineate the precise theoretical construct that has been identified when analysing the relationship between weight status and motor performance. This allows for more precise identification of the negative impact of excessive body weight in the childhood population.

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