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ORIGINAL SCIENTIFIC PAPER

Motor Abilities and Weight Status in Schoolchildren

Elvira Nikšić[1], Nedžad Prazina[1], Almir Kalabušić[2], Amela Bajrektarević[3], Faris Rašidagić[4]

AFFILIATIONS

[1]University of Sarajevo, Faculty of Education, Sarajevo, Bosnia and Herzegovina
[2]Primary School "Fatima Gunić," Sarajevo, Bosnia and Herzegovina
[3]Fitness Center "Pro-Fit Health," Center for Health, Sports Performance and Rehabilitation, Sarajevo, Bosnia and Herzegovina
[4]University of Sarajevo, Faculty of Sport and Physical Education, Sarajevo, Bosnia and Herzegovina

CORRESPONDENCE

E. Nikšić, University of Sarajevo, Faculty of Education, Skenderija 72, 71000 Sarajevo, Bosnia and Herzegovina, *eniksic@pf.unsa.ba*

Abstract

The modern sedentary lifestyle negatively affects children's physical and mental health, contributing to an increased prevalence of overweight and obesity. The aim of this study was to determine differences in motor performance and body composition indicators between fourth- and fifth-grade elementary school students. The research was conducted on a sample of N=628 students (N=314 fourth-grade; N=314 fifth-grade). The results of the t-test showed significant differences in favor of fifth-grade students in the following tests: Flamingo test (IV: 21.29±0.03; V: 30.32±0.05; p<0.001), hand tapping (IV: 20.15±0.03; V: 15.09±0.01; p=0.010), sit-and-reach (IV: 5.48±7.95; V: 11.20±12.17; p<0.001), standing long jump (IV: 134.18±26.40; V: 130.03±23.36; p=0.010), handgrip strength (IV: 15.77±4.71; V: 17.23±4.88; p<0.001), and 10×5 m shuttle run (p<0.001). No significant differences were found in sit-ups (p=0.200) and bent-arm hang (p=0.650). Significant differences in body composition indicators were found in body mass index (BMI) (p<0.001), basal metabolic rate (BMR) (p<0.001), and triceps skinfold thickness (p=0.040), while no significant differences were observed in subscapular skinfold, suprailiac skinfold, and body fat percentage. The results indicate better motor performance and more favorable body composition indicators in fifth-grade students.

Keywords: *physical fitness, anthropometric indicators, body composition, skinfold thickness, basal metabolic rate*

Introduction

Weight status in children is most commonly assessed using anthropometric methods, which include standardized measurements such as body height, body weight, and skinfold thickness (Krebs et al., 2007).

Both undernutrition and overweight represent significant public health concerns, as they adversely affect anthropometric status and increase the risk of various health problems (Kumar & Kelly, 2017; World Health Organization [WHO], 2018).

Childhood obesity has become one of the most serious global health challenges, with a continuous increase in prevalence over recent decades (WHO, 2020). Reduced physical activity and high levels of sedentary behavior are recognized as major contributing factors to this trend (WHO, 2020).

Motor abilities are fundamental components of children's development and are closely associated with their levels of physical activity and participation in sports. Previous research has shown that children with better-developed motor competence are more physically active and demonstrate more favorable body composition profiles (Aaltonen et al., 2015; Barnett et al., 2008).

A large body of research indicates an increasing association between weight status and motor abilities in children. Lopes et al. (2012) reported a significant negative association between BMI and motor abilities in children aged 6–14 years, suggesting that higher BMI is related to poorer motor performance. Similarly, D'Hondt et al. (2013) found that overweight and obese children consistently demonstrate lower motor coordination compared to their normal-weight peers, with differences becoming more pronounced with age. These results are consistent with the developmental model proposed by Stodden et al. (2008), which suggests a bidirectional relationship among motor competence, physical activity, and children's weight status.

However, the literature does not present fully consistent findings. Although numerous studies have shown that overweight and obese children demonstrate poorer performance

in motor tasks (D'Hondt et al., 2013; Lopes et al., 2012), other research suggests that differences in particular motor abilities are not consistently evident and may vary depending on the type of motor task. For example, certain studies report weaker or non-significant associations between BMI and object control skills when controlling for physical activity levels or maturation status (Cattuzzo et al., 2016; Robinson et al., 2015). These inconsistent findings indicate that the association between weight status and motor competence is not straightforward but is shaped by the combined influence of several factors, including age, biological maturation, and the level of engagement in physical activity.

Age and the level of biological maturation are important factors influencing the development of motor competence and changes in weight status. Research indicates that older children generally achieve higher levels of motor competence due to maturation processes and increased exposure to structured physical education (Barnett et al., 2008; Robinson et al., 2015). In addition, Coppens et al. (2024) reported that age-related improvements in motor performance are accompanied by changes in body composition, including BMI and fat distribution, highlighting the interaction between growth and motor development.

Although several studies have examined motor competence and weight status across childhood, research focusing specifically on differences between adjacent school grades remains limited or context-dependent. Existing evidence suggests that transitions between grade levels may be associated with changes in physical activity patterns, school-based physical education exposure, and motor skill development; however, findings are not always consistent across educational systems and populations (Cattuzzo et al., 2016; Robinson et al., 2015). Therefore, further research is needed to clarify how motor abilities and weight status differ between closely related school-age groups within specific educational contexts.

Therefore, the aim of this study was to determine differences in motor abilities and weight status between fourth- and fifth-grade elementary school students.

Material and methods

Sample of participants

Prior to participation in the study, the pupils and their parents were provided with detailed information regarding the study objectives, procedures, and protocol, after which written parental informed consent was obtained. The entire research procedure was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the Ethics Committee of the Faculty of Education, University of Sarajevo (Decision No. 05/2025, dated 21 May 2025).

Sample of variables

Anthropometric measurements

Participants' stature was determined using a Seca stadiometer (Hamburg, Germany), whereas body mass was recorded with a calibrated Seca digital scale (Hamburg, Germany).

Skinfold measurements at the triceps, subscapular, and suprailiac sites were obtained using a Harpenden skinfold caliper (Baty International, West Sussex, United Kingdom).

Body composition characteristics, including basal metabolic rate (BMR) and percentage of body fat (PBF), were evaluated through bioelectrical impedance analysis with the InBody120 analyzer (Biospace Co., Seoul, South Korea).

All anthropometric assessments were performed following the standardized guidelines established by the ISAK Manual (Marfell-Jones et al., 2006).

Motor tests

Motor performance was evaluated using the Eurofit test battery (Council of Europe, 1988). The assessment included tests designed to measure different components of motor competence: the Flamingo balance test (balance), plate tapping (movement speed), sit-and-reach test (flexibility), standing long jump (explosive leg power), handgrip strength test (static strength), sit-up test (trunk strength), bent-arm hang (functional strength), and the 10 × 5 m shuttle run (speed and agility).

Research design

Body mass index (BMI) was determined by dividing body weight in kilograms by the square of body height in meters (kg/m^2). According to the calculated BMI values, participants were assigned to one of four nutritional status groups: underweight, normal weight, overweight, or obesity, following the Centers for Disease Control and Prevention (CDC, 2000) classification (Kuczmarski et al., 2000).

Statistical analysis

Descriptive statistical procedures were applied to summarize the data, including the calculation of means (M), standard deviations (SD), and minimum and maximum values for all measured variables. Differences in anthropometric characteristics and motor abilities between fourth- and fifth-grade students were assessed using the independent samples t-test. Statistical significance was established at $p<0.05$. Data processing and statistical analyses were conducted using SPSS Statistics (IBM Corp., Armonk, NY, USA).

Results

The findings revealed significant differences between the two groups for selected anthropometric variables. Significant group differences were identified for body mass index (BMI) ($p<0.001$), basal metabolic rate (BMR) ($p<0.001$), and triceps skinfold thickness ($p=0.040$). In contrast, the remaining analyzed variables did not demonstrate statistically significant differences between the groups.

Table 1. Differences in Body Mass Index (BMI) and Skinfold Thickness between Fourth and Fifth Grade Elementary School Students – Descriptive Statistics

Variables	Grade	Mean ± SD	t-value	p
BMI (kg/m2)	IV	21.89±3.86	18.180	0.000**
	V	18.58±3.88	15.020	
BMR	IV	1254.32±126.03	15883.610	0.000**
	V	1308.66±142.19	20217.470	
PBF	IV	21.06±5.95	35.410	0.910
	V	21.02±6.53	42.600	
Triceps (mm)	IV	14.97±6.44	41.410	0.040*
	V	14.16±6.32	39.950	
Subscapular (mm)	IV	12.40±7.68	59.040	0.180
	V	11.76±8.13	66.170	
Suprailiac (mm)	IV	15.36±9.42	88.720	0.610
	V	15.65±8.72	76.030	

Note. BMI – Body Mass Index; BMR – Basal Metabolic Rate; PBF – Percentage of Body Fat, Mean – arithmetic mean; SD – standard deviation; p-significance level; ** t-test is statistically significant at a level below 1%, * t-test is statistically significant at a level below 5%.

Table 2 presents the body mass index (BMI) values, providing an overview of the nutritional status distribution of fourth- and fifth-grade elementary school students across different weight-status categories. When observing 4th- and 5th-grade students separately, it can be noticed that obesity and overweight are more prevalent among 4th-grade students than among 5th-grade students. Out of a total of 314 (50.00%) 4th-grade students, 139 belong to the obese category, 21 are overweight, 95 have normal nutritional status, and 59 are undernourished. Out of a total of 314 (50.00%) 5th-grade students, 32 belong to the obese category, 28 are overweight, 109 have normal nutritional status, while 145 are undernourished. A major issue today is not only childhood obesity but also undernourishment, which was highly prevalent among both 4th and 5th-grade students. A higher prevalence of overweight and obesity was observed in fourth-grade students compared to fifth-grade students.

Table 2. Frequency and percentage values of BMI categories among fourth- and fifth-grade elementary school students – Descriptive statistics

Weight status	Percentiles	Grade IV	%	Percentiles	Grade V	%
Obesity	(≥95)	139	44.27	(≥95)	32	10.19
Overweight	(85-95)	21	6.69	(85-95)	28	8.92
Normal weight	(5-85)	95	30.25	(5-85)	109	34.71
Underweight	(<5)	59	18.79	(<5)	145	46.18
Total		314	100.0		314	100.0

The analysis of the data presented in Table 3 indicates that differences in motor abilities exist between fourth- and fifth-grade elementary school students. The t-test revealed significant differences in the flamingo test (balance), hand tapping (movement speed), sit-and-reach (flexibility), standing long jump (explosive leg power), handgrip strength (static strength), and the 10×5 m shuttle run (speed and agility), with fifth-grade students achieving superior performance. Significance at the $p<0.01$ level was observed for the flamingo, sit-and-reach, handgrip strength, and 10×5 m shuttle run tests, whereas the hand tapping and standing long jump tests reached significance at the $p<0.05$ level. Although fifth-grade students also obtained higher scores in the sit-ups (core strength) and bent-arm hang (functional strength) tests, these differences were not statistically significant. Overall, fifth-grade students demonstrated better performance in the majority of the assessed motor ability tests, while no significant differences were found for sit-ups and the bent-arm hang.

Table 3. Differences in motor abilities between boys and girls from 2nd to 5th grade of elementary school – Descriptive statistics, t-test

Variables	Grade	Mean ± SD	t-value	p
Flamingo (sec/stot)	IV	00:21:29±0.03	0.000	0.000**
	V	00:30:32±0.05	0.000	
Hand tapping (sec/stot)	IV	00:20:15±0.03	0.000	0.010*
	V	00:15:09±0.01	0.000	
Sit and reach (cm/mm)	IV	5.48±7.95	63.260	0.000**
	V	11.20±12.17	161.470	
Standing long jump (cm/mm)	IV	134.18±26.40	545.640	0.010*
	V	130.03±23.36	696.760	
Hand grip strength (kg/g)	IV	15.77±4.71	22.200	0.000**
	V	17.23±4.88	23.820	
Sit-ups (number)	IV	17.93±5.84	34.100	0.200
	V	18.35±4.78	22.820	
Pull-up-hold (min/sec/stot)	IV	00:17:54±0.01	0.000	0.650
	V	00:18:22±0.01	0.000	
10x5m shuttle run (sec/stot)	IV	01:07:02±0.16	0.024	0.000**
	V	00:22:07±0.01	0.000	

Note. Mean – arithmetic mean; SD – standard deviation; p-level of significance; * t-test statistically significant at a level below 5%; ** t-test statistically significant at a level below 1%.

Discussion

The main findings of this study indicate that fifth-grade students achieved significantly better results than fourth-grade students in most motor ability tests and demonstrated more favorable weight status indicators. Significant differences were observed in coordination, agility, balance, and explosive strength variables, whereas no significant differences were found in selected measures of muscular endurance and static strength. In addition, fourth-grade students exhibited higher BMI and skinfold values, suggesting less favorable weight status compared with fifth-grade students.

The observed differences in motor abilities are generally consistent with previous research showing that motor competence tends to improve throughout childhood as a result of growth and developmental processes. Barnett et al. (2008) reported that motor competence increases progressively with age and is associated with higher levels of physical activity. Similarly, Lopes et al. (2012) found that older children generally perform better in motor tasks requiring coordination, balance, and agility. Recent international studies have also confirmed the association between age and motor competence. A large European study conducted in ten countries demonstrated that age is a significant predictor of motor competence, with older children achieving higher scores in locomotor and object-control skills (Wälti et al., 2022). Furthermore, a study of Slovak primary school children reported that grade level contributes to differences in basic motor competencies, although the magnitude of these differences may vary according to sex and specific motor domains (Šiška et al., 2024). These findings are further supported by Adolph and Hoch (2020), who emphasized that motor skills represent a fundamental component of child development and influence not only physical functioning but also participation in physical activity and social engagement. Their theoretical perspective suggests that age-related improvements in motor competence may facilitate greater involvement in movement-related activities, thereby contributing to the superior motor performance observed among fifth-grade students in the present study.

The findings of the present study are also in agreement with longitudinal research indicating that motor competence develops progressively across childhood. A recent longitudinal study by den Uil et al. (2024) showed continuous improvements in motor competence between the ages of 4 and 8 years, highlighting the importance of developmental maturation in motor performance. Likewise, longitudinal evidence suggests that children who engage in higher levels of physical activity tend to demonstrate greater improvements in motor competence over time (Estevan et al., 2022).

In addition to differences in motor abilities, significant differences were observed in weight status indicators. Fourth-grade students displayed higher BMI and skinfold values than fifth-grade students. These findings support previous studies demonstrating a negative relationship between excess body

weight and motor performance. D'Hondt et al. (2013) and Lopes et al. (2012) reported that overweight and obese children tend to perform worse in tasks requiring locomotion, balance, agility, and coordination than their normal-weight peers. Similar findings were reported by D'Hondt et al. (2011), who demonstrated a significant inverse relationship between BMI and motor skill performance among children aged 5–10 years. Their results indicated that children with higher BMI values generally achieve lower scores in tasks requiring coordination and movement efficiency. Recent evidence further confirms that BMI and body composition remain important determinants of motor competence in childhood (Coppens et al., 2024; Wälti et al., 2022).

The relationship between motor abilities and weight status observed in this study suggests that these variables are interconnected. Children with lower levels of adiposity may perform movement tasks more efficiently because they have less excess body mass to move during activities involving running, jumping, balancing, and rapid changes of direction. Conversely, children with higher BMI often experience biomechanical and physiological limitations that may negatively affect motor performance. Previous studies have suggested that poor motor competence and unfavorable weight status may influence each other through a reciprocal relationship, whereby lower motor competence reduces participation in physical activity, which subsequently contributes to increased adiposity and further declines in motor performance (Cattuzzo et al., 2016; Hulteen et al., 2023). This interpretation is also consistent with current physical activity recommendations, which emphasize that regular participation in moderate-to-vigorous physical activity is essential for healthy growth, body composition, and motor development during childhood (Bull et al., 2020). Although physical activity levels were not assessed in the present study, the differences observed between grade levels may partly reflect variations in habitual physical activity participation.

From a physiological perspective, the superior performance of fifth-grade students may be explained by age-related maturation of the neuromuscular system. As children grow older, improvements occur in motor unit recruitment, intermuscular coordination, reaction time, movement efficiency, and postural control. These adaptations contribute to better performance in tasks requiring agility, balance, coordination, and explosive movements. In addition, lower body fat levels may facilitate more efficient movement execution by reducing mechanical constraints associated with body-weight-bearing activities.

Although differences between grade levels were observed, caution is required when interpreting their causes. The present study was not designed to examine the effects of teaching methods, teacher specialization, physical activity participation, or other environmental factors. Therefore, it cannot be concluded whether the observed differences are attributable primarily to biological maturation, educational influences, lifestyle factors, or a combination of these variables.

Conclusion

The results of this study indicate that fifth-grade students achieved significantly better results in most motor ability tests and demonstrated more favorable weight status indicators compared with fourth-grade students. Significant differences were particularly evident in measures of coordination, agility, balance, and explosive strength, whereas some strength-related variables did not differ significantly between grades. The findings suggest that grade level is related with both motor competence and weight status during middle childhood. However, because of the cross-sectional nature of the study, it is not possible to determine the specific factors responsible for these differences. Further research is needed to clarify the relative contribution of biological maturation, physical activity participation, and educational factors. Nevertheless, the findings emphasize the importance of monitoring motor development and weight status throughout the primary school years and support the implementation of strategies aimed at promoting healthy growth and physical development in children.

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Conflict of interest
The authors state there is no conflict of interest.

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