SOME MOTOR ABILITIES OF STUDENTS AND THEIR DIFFERENCES IN RELATION TO AGE

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Abstract: *This study examines the motor abilities of upper elementary school students, focusing on differences across age groups within the context of physical and developmental education. Physical development and motor abilities are critical multidimensional concepts that play an essential role in the growth and well-being of children. Through this research, we seek to monitor, evaluate, and understand the diverse motor skills that emerge during this pivotal growth phase, specifically among students aged 11 to 15. The sample consists of students from the upper grades of elementary school, assessed using a series of standardized motor tests designed to measure parameters such as explosive leg strength, static arm and shoulder strength, repetitive strength, and sprinting speed. The findings reveal significant differences in motor abilities across grades, reflecting the impact of biological maturity, gender, and developmental stages on physical capability. These differences are particularly evident in strength, speed, and endurance metrics, highlighting the need for age-specific physical education programs. By examining variations in motor skills, this study underscores the importance of personalized training and development approaches to support optimal growth, motor skill acquisition, and overall physical health in children. This research contributes to a broader understanding of how targeted physical education can foster motor development and help educators and coaches adapt programs to meet the diverse needs of growing children.*

Key words*: motor abilities, physical development, elementary school students, motor skills, physical education, growth stages, developmental differences*

INTRODUCTION

Physical development and physical abilities are highly important multidimensional concepts, whose definition and selection of appropriate parameters have a long and complex history (McCloy, 1941; Petrović, Utvić, & Stanković, 2018). The challenge of monitoring and evaluating various variables in this field requires a scientific determination of the entire systemic structure and defining those dimensions that characterize this structure as an organized whole. Results in the field of physical exercise are negligible if control and monitoring of these processes are not conducted, along with an objective evaluation of their effects (Glišić et al., 2018; Utvić et al., 2022).

In the process of programming and implementing a system for monitoring the morphological and motor abilities of children and youth, it is necessary to first determine the level, dynamics, and structure of current phenomena related to gender, age, social, ethnographic, geographic, and other characteristics (Rodríguez-Negro, Huertas-Delgado, & Yanci, 2021; Pavlović, Marinković, & Mitrović, 2020). However, morphological and motor dimensions do not represent isolated factors but must be observed within the comprehensive system that defines a human as a unique biopsychosocial entity, making their extraction and measurement more difficult (He et al., 2024; Wang & Wang, 2024).

Motor ability in humans represents a system of movement manifestations by which a person, to satisfy life and work needs, communicates with their environment through movement of the body or its parts (Ivanović & Ivanović, 2021). There is still no consensus among experts on what to call the motor abilities that form the basis of all human movement and upon which various capabilities required in specific activities are developed. Terms such as "basic," "elementary," and "fundamental" are used, as well as "specific" or "derived" (Smajić et al., 2018). Motor ability is that part of general psychophysical capability that relates to a certain level of development of basic latent movement dimensions in humans,

which facilitate the successful execution of movement, whether these abilities are acquired through training or not (Marta, Oktarifaldi, & Wisma, 2023).

Given the virtually infinite number of movement manifestations in human expression, it is necessary to identify the latent structure of the motor system, which comprises a significantly smaller number of consolidated dimensions shaped by biochemical, functional, and psychological mechanisms (Malacko et al., 2015; Batez et al., 2021). Determining the number, structure, and stability of motor abilities is crucial, not only for the educational and competitive levels of sports in all its forms but, above all, for health and broader applications (Kerić et al., 2017).

The first attempts at diagnosing latent motor dimensions were associated with the construction of motor tests, among the first of which was a battery with six motor tasks constructed by D.A. Sargent, called the "Universal Test of Strength, Speed, and Endurance of the Human Body." Later batteries designed to measure physical abilities were often associated with achieving badges of various levels of value or with national projects (Podstawski, Markowski, & Clark, 2020). However, the source of methodologically most valuable research into latent motor space, which paved the way for further research, lies in exact attempts to quantify human motor skills through the application of factor analysis (McCloy, 1941; Müller et al., 2015). This approach is primarily linked to the work of McCloy, with works such as "Measurement of General Motor Capacity and General Motor Ability (1934)," "Methods of Factor Analysis in Measuring Physical Abilities (1941)," and "Tests and Measurements in Health and Physical Education (1942)," followed by a series of studies aimed at identifying latent motor dimensions. The majority of research to date has been conducted in the area of strength, primarily for the systemic analysis of the characteristics of the biological system and also for practice in physical culture. Based on previous research, it can be considered that the structure of strength factors is hierarchical. Primary factors are differentiated by the type of action, the topological distribution of muscles, and the type of load, while secondary factors differ in terms of the inclusion of mechanisms responsible for intensity or duration of excitation in primary motor centers (Gadžić et al., 2017; Petrović, Utvić, & Stanković, 2018).

This is a period of growth and development covering the age range of 11-15 years of postnatal life. This period includes children in the upper grades of elementary school in our country. If other criteria for classification were respected, this period could be categorized as preadolescent (ages 10-12) and early adolescent (ages 13-15) (Ivanović & Ivanović, 2021). It is characterized by intense growth and development and can be divided into the prepubescent and pubescent periods. Changes that occur in development and are characteristic of this period do not happen simultaneously for everyone, making it difficult to draw a clear boundary between these two periods. Differences in the developmental characteristics of boys and girls during this period are even more pronounced than in earlier stages of development. Growth in height is intense. A characteristic of this growth period is the significant elongation of the limbs, resulting in a change in the ratio of the head to the torso relative to the lower limbs, favoring the lower limbs (Pavlović, Marinković, & Mitrović, 2020). For girls, height increase averages around 8 centimeters, while for boys, it ranges between 13 and 15.5 centimeters. Individual differences can be even more pronounced, depending on biological maturity (Petrović, Utvić, & Stanković, 2018). Regarding weight gain, it increases proportionally to height. Muscle development and strengthening in this period is intense; muscle mass increases, becomes stronger, and by the end of this age period, constitutes about 32% of body mass (Kerić et al., 2017). By the end of middle school, the central nervous system reaches full development. Nerve processes become more refined, and inhibition processes become more pronounced, meaning that the response to certain stimuli is more controlled. Physical exercise and sports training should further influence harmonious constitutional development and the development of functional abilities of all organ systems, as well as mental development (Rodríguez-Negro, Huertas-Delgado, & Yanci, 2021). Studies have shown that children in this age period are very capable, with differences in physical abilities between boys and girls not being significant until puberty, primarily depending on upbringing, preferences, and training. However, after puberty, this difference becomes increasingly evident in favor of males (Petrović, Utvić, & Stanković, 2018; Utvić et al., 2022).

In this study, the focus is on the motor abilities of upper elementary school students and their mutual differences. The objective and task of the study are to present and explain the results of motor ability testing, as well as to present and explain the results of tests of mutual differences between groups of subjects.

MATERIALS AND METHODS

Participants

The study was conducted on a sample of 64 male students from upper elementary grades at "Vasa Pelagić" elementary school, located in Padež, Municipality of Kruševac. The inclusion criteria encompassed all students regularly attending physical education classes. Exclusion criteria included:

1. Students exempted from physical education due to medical or other valid reasons.
2. Students who were unable to complete all tests due to injury or other circumstances.

Testing Protocol

To evaluate the participants' physical abilities, a series of standardized tests were employed, targeting various aspects of strength and speed:

1. Explosive Strength of the Leg Extensors:
    - Test: Standing Long Jump (SLJ)
2. Static Strength of the Arm and Shoulder Muscles:
    - Test: Flexed Arm Hang (FAH)
3. Repetitive Strength:
    - Test 1: Sit-ups in 60 Seconds (S60)
    - Test 2: Pull-ups on the Horizontal Bar (PUB)
4. Sprint Speed:
    - Test: 30-Meter Sprint (S30)

Testing conditions

The tests were conducted under standardized conditions, ensuring reliability and validity:

- All participants wore appropriate sports attire and footwear.
- The testing area was a well-maintained gymnasium with marked lanes and measurement tools.

Each participant was given instructions and a demonstration of the proper test technique before the evaluation.

This methodological framework ensured a comprehensive assessment of the participants' physical abilities, with a focus on explosive strength, static strength, repetitive strength, and sprint speed.

RESULTS AND DISCUSSION

Table 1 Standing Long Jump

Grade	AS	SD	Vx (%)	S	Skew.	Range	Min	Max	N
V	140.48	16.95	12.07%	3.7	0.11	70	100	170	21
VI	163.125	19.59	12.01%	4.9	0.13	65	130	195	16
VII	150.79	22.19	14.72%	5.1	0.12	95	90	185	19
VIII	158.75	28.75	18.11%	10.16	0.18	85	100	185	8

Legend: Arithmetic mean (AS); standard deviation (SD); coefficient of variation (Vx); standard error (S); skewness (Skew); difference between the minimum and maximum results (Range); minimum value (Min); maximum value (Max); participants (N).

Table 2 Flexed Arm Hang

Grade	AS	SD	Vx (%)	S	Skew.	Range	Min	Max	N
V	32.14	18.12	56.38%	3.95	0.11	75	5	80	21
VI	33.44	16.78	50.18%	4.2	0.13	51	10	61	16
VII	21.47	14.91	69.45%	3.42	0.12	60	0	60	19
VIII	36.25	29.43	81.19%	10.41	0.18	82	0	82	8

Table 3 Sit-Ups in 60 Seconds

Grade	AS	SD	Vx (%)	S	Skew.	Range	Min	Max	N
V	37.86	12.44	32.86%	2.71	0.11	41	15	56	21
VI	40.375	14.06	34.82%	3.52	0.13	38	20	58	16
VII	34.26	8.19	23.91%	1.88	0.12	32	15	47	19
VIII	41.125	13.53	32.9%	4.78	0.18	35	19	54	8

Table 4 30-Meter Sprint

Grade	AS	SD	Vx (%)	S	Skew.	Range	Min	Max	N
V	5.31	0.38	7.16%	0.08	0.11	1.61	4.75	6.36	21
VI	5.62	0.38	6.76%	0.1	0.13	1.2	5.2	6.4	16
VII	5.42	0.48	8.86%	0.11	0.12	2.08	4.64	6.72	19
VIII	5.35	0.59	11.03%	0.21	0.18	1.77	4.91	6.68	8

Table 5 Pull-Ups

Grade	AS	SD	Vx (%)	S	Skew.	Range	Min	Max	N
V	3.14	3.99	127.07%	0.87	0.11	13	0	13	21
VI	4.69	4.27	91.04%	1.07	0.13	12	0	12	16
VII	4.47	3.36	75.17%	0.77	0.12	10	0	10	19
VIII	6.5	4.87	74.92%	1.72	0.18	16	0	16	8

Table 6 Comparative Overview of Variables for 5th Grade Boys

Variable	Max	Min	Range	AS (Mean)	SD	Vx (%)
SUD	170	100	70	140.48	16.95	12.07%
BAH	80	5	75	32.14	18.12	56.38%
T60	56	15	41	37.86	12.44	32.86%
T30	6.36	4.75	1.61	5.31	0.38	7.16%
PUB	13	0	13	3.14	3.99	127.07%

Legend: Arithmetic mean (AS); standard deviation (SD); coefficient of variation (Vx); difference between the minimum and maximum results (Range); minimum value (Min); maximum value (Max).

Table 7 Comparative overview of variables for 6th grade boys

Variable	Max	Min	Range	AS (Mean)	SD	Vx (%)
SUD	195	130	65	163.125	19.59	12.01%
BAH	61	10	51	33.44	16.78	50.18%
T60	58	20	38	40.375	14.06	34.82%
T30	6.4	5.2	1.2	5.62	0.38	6.76%
PUB	12	0	12	4.69	4.27	91.04%

Table 8 Comparative overview of variables for 7th grade boys

Variable	Max	Min	Range	AS (Mean)	SD	Vx (%)
SUD	185	90	95	150.79	22.19	14.72%
BAH	60	0	60	21.47	14.91	69.45%
T60	47	15	32	34.26	8.19	23.91%
T30	6.72	4.64	2.08	5.42	0.48	8.86%
PUB	10	0	10	4.47	3.36	75.17%

Table 9 Comparative overview of variables for 8th grade boys

Variable	Max	Min	Range	AS (Mean)	SD	Vx (%)
SUD	185	100	85	158.75	28.75	18.11%
BAH	82	0	82	36.25	29.43	81.19%
T60	54	19	35	41.125	13.53	32.9%
T30	6.68	4.91	1.77	5.35	0.59	11.03%
PUB	16	0	16	6.5	4.87	74.92%

Table 10 Inter-group differences in standing long jump in boys

Grade Comparison	F-Ratio	F-Critical (p = 0.05)	Shared S	SAS1-AS2	t-Value	t-Critical (p = 0.05)
VIII/VII	1.68	<3.54	7.26	3.06	2.6	>2.05
VIII/VI	2.15	<3.56	7.42	3.21	1.36	<2.07
VIII/V	2.88	<3.44	6.42	2.67	6.84	>2.04
VII/VI	1.28	<2.39	5.15	1.75	7.05	>2.03
VII/V	1.71	<2.19	4.53	1.44	7.16	>2.02
VI/V	1.34	<2.33	4.38	1.45	15.62	>2.03

Legend: Grade comparison (GC); F-Ratio (FR); critical F-value (FC); shared standard deviation (SS); mean difference (SAS1-AS2); t-value (tV); critical t-value (tC).

Analyzing the dispersion parameters of variables reveals that, based on the standard deviation, the most homogeneous group among the 5th-grade boys is in the 30-meter sprint (SD=0.38), while the least homogeneous is in the pull-up hold (SD=18.12). According to the coefficient of variability, the greatest variation in results is observed in pull-ups (Vx=127.07%). Similarly, for 6th-grade boys, based on the standard deviation, the group is most homogeneous in the 30-meter sprint (SD=0.38) and least homogeneous in the standing long jump (SD=19.59). The greatest variability in results, according to the coefficient of variability, is again seen in pull-ups (Vx=91.04%).

For 7th-grade boys, the most homogeneous results based on standard deviation are in the 30-meter sprint (SD=0.48), while the least homogeneous are in the standing long jump (SD=22.19). The highest variability, according to the coefficient of variability, is found in pull-ups (Vx=75.17%). Among 8th-grade boys, the group is most homogeneous in the 30-meter sprint (SD=0.59) and least homogeneous in the pull-up hold (SD=29.43). Based on the coefficient of variability, the greatest variation in results is again in the pull-up hold (Vx=81.19%).

The significance of differences between mean values is tested using the t-test, which essentially represents the ratio between the difference of the means and the standard error of their differences. In the F-distribution table, the value for the larger variance is read in the column corresponding to certain degrees of freedom, and the smaller variance in the appropriate row. Differences in the means are present and statistically significant to varying degrees, indicating that the relationship between the groups of participants is statistically significant for certain variables to a lesser or greater extent.

The results of this study align with previous research highlighting the importance of motor abilities in children's physical and overall development. Differences in motor performance among school-aged children are influenced by several factors, including age, gender, relative age effects, and environmental conditions.

Motor abilities improve significantly with age due to natural growth and development. Studies confirm that older children exhibit better performance in motor tasks, particularly those requiring strength and speed, compared to younger ones (Müller et al., 2015; Pavlović et al., 2020). This aligns with findings from studies that identified age-related improvements in motor skills in primary school children (Kerić et al., 2017; Pavlović et al., 2020).

Gender differences in motor abilities are well-documented. Boys generally outperform girls in tasks requiring explosive and repetitive strength, whereas girls tend to excel in flexibility and balance (Malacko et al., 2015; Smajić et al., 2018). The influence of relative age on motor performance is another critical factor, with relatively older children within a grade cohort demonstrating superior motor skills due to their advanced physical maturity (Gadžić et al., 2017; Müller et al., 2015).

Environmental factors, such as access to sports facilities and socioeconomic conditions, play a significant role in shaping children's motor skills. Marta et al. (2023) highlighted the disparity in motor coordination abilities between children in urban and rural settings, with urban students often outperforming their rural counterparts due to better resources and structured physical activity programs (Marta et al., 2023).

The role of structured physical education is vital in enhancing motor abilities. The application of specific sports or activities, such as goalball, has been shown to improve motor skills and physical fitness in school-aged children (Utvić et al., 2022). Moreover, tailored programs addressing individual and group-specific needs are critical for optimizing motor development (Malacko et al., 2015; Kerić et al., 2017).

Emerging research suggests a positive relationship between motor skills and academic performance. Wang and Wang (2024) conducted a systematic review emphasizing that children with better motor competence tend to achieve higher academic results due to enhanced cognitive and physical development. Similarly (Batez et al., 2021) found motor competence to be a significant predictor of physical fitness and academic success.

This study provides valuable insights into the motor performance of school-aged children, emphasizing the need for tailored physical education programs that address age, gender, and individual capabilities. The findings support the implementation of inclusive and adaptable physical activity programs to bridge gaps in motor development and promote holistic growth.

CONCLUSION

Based on the analysis of motor skills in elementary school boys from different grade levels, the study reveals significant findings about the developmental progress and variability in physical abilities among children aged 11 to 15. The results indicate that as boys progress through grades, certain motor skills, such as explosive leg strength (measured through standing long jump), sprinting ability, and strength in

the upper body, show considerable development, with variation in performance becoming more pronounced.

In younger grades (5th and 6th), students displayed more homogeneity in sprinting and jumping, with greater variability observed in upper body strength tasks like pull-ups. As they advanced to 7th and 8th grades, variability in physical performance increased, especially in complex tasks involving coordination and strength endurance. This increased variability reflects the impact of biological maturation, differences in growth rates, and possibly varying levels of physical training or activity outside of school.

The significant differences observed in various motor abilities between grades underscore the dynamic nature of physical development during early adolescence, influenced by physiological changes characteristic of puberty. These findings highlight the need for tailored physical education programs that account for the varied developmental stages and abilities of students. For younger grades, a focus on fundamental motor skills and consistent training may be beneficial, while for older students, more specialized training can support continued improvement and address individual physical needs.

This study emphasizes the importance of regular monitoring and assessment of motor skills in school settings, as well as the role of physical education in promoting balanced physical development. By acknowledging and addressing the physical variations among students, educators can foster an inclusive environment that supports both health and performance, ultimately contributing to lifelong physical fitness and well-being.

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NEKE MOTORIČKE SPOSOBNOSTI UČENIKA I NJIHOVE RAZLIKE U ODNOSU NA UZRAST

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Sažetak: *Ova studija ispituje motoričke sposobnosti učenika viših razreda osnovne škole, fokusirajući se na razliku između uzrasnih grupa u kontekstu fizičkog razvoja. Fizički razvoj i motoričke sposobnosti su višedimenzionalni koncepti koji igraju ključnu ulogu u rastu i razvoju dece. Kroz ovo istraživanje, ostajemo da pratimo, procenjujemo i razumemo različite motoričke sposobnosti, tokom ove ključne faze rasta, posebno među učenicima uzrasta od 11 do 15 godina. Uzorak ispitanika se nalazio od učenika viših razreda osnovne škole, koji je procenjivan korišćenjem niza standardizovanih motoričkih testova dizajniranih za merenje parametara kao što su eksplozivna snaga spiranja nogu, sila ruku i snaga repeticije, brzina i brzina. Rezultati otkrivaju značajne razlike u motoričkim sposobnostima kod učenika različitog uzrasta, odražavajući uticaj biološke zrelosti, pola i razvojnih faza na fizičke sposobnosti. Ove razlike su posebno vidljive u snazi, brzini i merama izdržljivosti, naglašavajući potrebu za programima fizičkog i zdravstvenog vaspitanja specifičnim za uzrast. Ispitivanjem varijacije u motoričkim sposobnostima, ovo istraživanje naglašava važnost individualnih pristupa u obuci kako bi se održavao optimalan rast, sticanje motoričkih veština i ukupno fizičko zdravlje kod dece. Ovo istraživanje doprinosi širem razumevanju kako ciljno fizičko vaspitanje može podstaći razvoj motoričkih sposobnosti i pomoći nastavnicima da prilagode program kako bi zadovoljili različite potrebe dece.*

Ključne reči: *motoričke sposobnosti, fizički razvoj, učenici osnovnih škola, fizičko vaspitanje, uzrasne razlike.*