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DIFFERENCES IN STRENGTH AND SPEED TESTS AMONG STUDENTS FROM 5TH TO 8TH GRADE

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Abstract: The aim of the research is to determine the differences in certain strength and speed tests among students from the 5th to 8th grade. The sample consisted of four age groups of students (n=60) from the "Vuk Karadžić" primary school in Sočanica. The sample of variables for strength testing included: Standing long jump (MSUD); Vertical jump (MVJ); Throwing a 1 kg medicine ball from a supine position (MBML); Push-ups to failure (MSKL); Sit-ups to failure (MPT); Squats to failure (MCUC); and Dominant hand grip strength (MDIN). The sample of variables for speed testing included: Hand tapping (MTR); Foot tapping (MTN); 20 m sprint from a standing start (MT20); 30 m sprint from a standing start (MT30); and 50 m sprint from a standing start (MT50). All statistical analyses were conducted using IBM SPSS Statistics software (Version 25). The data obtained from the tests were processed using descriptive analysis, normality tests, and one-way analysis of variance (ANOVA). To further determine the differences between the analyzed age categories, Bonferroni post hoc analysis was applied. No statistically significant difference was found in the test for throwing a 1 kg medicine ball from a supine position (MBML, $p > 0.05$), while statistically significant differences were found in all other strength tests (MSUD, MVJ, MSKL, MPT, MCUC, and MDIN, $p < 0.05$). Statistically significant differences were also found in all speed tests (MTR, MTN, MT20, MT30, and MT50, $p < 0.05$) among students from the 5th to 8th grade.

Keywords: strength, speed, students from 5th to 8th grade, differences

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Introduction

Physical growth and development, as part of the complex, multidimensional process in the ontogenesis of children and youth, are determined by changes both in morphological characteristics and motor abilities (Buišić et al., 2013; Kondrič et al., 2022; Smajić et al., 2017). Motor abilities are one of the most frequently studied aspects of anthropological status today. They represent a highly complex and important system that manifests itself through human movement, whether in performing simple everyday activities or in complex situations specific to various physical activities of students (Kerić & Ujsasi, 2014). Numerous studies have established that motor abilities cannot be effectively described using just one dimension; instead, to describe human movement, it is necessary to break them down into multiple quantitative and qualitative motor abilities (Malacko & Popović, 2001; Nićin, 2008; Obradović, 2020). Motor abilities are latent in nature and cannot be measured directly but only indirectly, which means that only motor reactions, or their manifestations, can be measured directly (Latash, 2012; Mekić, 2018). The development of motor abilities is a continuous process influenced by many factors. Through the process of physical exercise, which is conducted in a planned, rational, and organized manner, it is possible to develop certain motor abilities (Kerić & Ujsasi, 2014; Kukolj, 2006). The motor ability that has attracted the most attention from researchers is strength. There are many reasons for this focus on strength. One of the main reasons is that no movement can be performed without some degree of muscular exertion, i.e., the use of strength. Many experts define strength as the ability of an individual to overcome external resistance or to oppose it through muscle exertion (Herodek et al., 2019; Zatsiorsky & Kraemer, 2009). According to the action criterion, strength can be divided into explosive, repetitive, and static strength (Mekić, 2018; Obradović, 2020). Explosive strength is the most genetically determined, accounting for as much as 80% (Kurelić, 1974; Latash, 2012; Herodek et al., 2019). The second motor ability that certainly attracts significant attention is speed. It represents the ability, characteristic, or trait of a person to perform a motor activity, such as movement or motion, at the maximum possible speed, assuming that external resistance is minimal and that the activity does not last long to avoid fatigue (Željaskov, 2004). This motor ability is also genetically determined (Kukolj, 2006; Obradović, 2020). Most authors divide speed at the elementary level into reaction speed, the speed of a single movement, and movement frequency (Mekić, 2018; Herodek et al., 2019). The structure of strength and speed in children significantly differs from that in adults (Gredelj et al., 1975; Voelcker-Rehage, 2008). Numerous studies indicate that during childhood, differences in speed and strength between genders exist, favoring boys who demonstrate better results (Bala, 2003; Katić et al., 2013; Smajić et al., 2018; Zurce et al., 2005). Some studies also suggest that from ages seven to twelve, these differences disappear, after which boys enter a phase of rapid development of all motor

abilities (Latash, 2012; Trajkovski-Višić et al., 2011). Research conducted by Delaš et al. (2008), which measured the motor abilities of students from the fifth to the eighth grade, found that the development of motor abilities is parallel to the increase in age. Similarly, Turek (2006) conducted a study that confirmed the significant influence of biological development on children's motor skills.

Therefore, the aim of this research was to determine the differences in certain strength and speed tests among students from the fifth to eighth grade of primary school.

Method

Sample of Participants

The sample consisted of 60 male students from a primary school, divided into four different age groups. The first group consisted of fifth-grade students, the second group of sixth-grade students, the third group of seventh-grade students, and the fourth group of eighth-grade students. At the time of testing, the students had no health issues or injuries and were not taking any medications. All the benefits and risks of the research were explained to the school principal and the parents of the participants. The study was approved in advance by the school principal and the participants' parents. Each parent provided voluntary written consent before participation. This research was conducted in accordance with all ethical standards outlined in the Helsinki Declaration.

Sample of Variables

The sample of variables for strength testing included: standing long jump (MSUD), vertical jump (MVJ), throwing a 1 kg medicine ball from a supine position (MBML), push-ups to failure (MSKL), sit-ups to failure (MPT), squats to failure (MCUC), and dominant hand dynamometry (MDIN). The sample of variables for speed testing included: hand tapping (MTR), foot tapping (MTN), 20-meter sprint from a standing start (MT20), 30-meter sprint from a standing start (MT30), and 50-meter sprint from a standing start (MT50).

Procedure and Organization of Testing

Strength and speed testing was conducted during physical education classes. The tests were not conducted in a single class but were spread across separate physical education classes. During the testing, the air temperature was comfortable for the participants (20-22°C). The participants wore sports clothing typically used during physical education. Prior to the strength and speed tests, the students performed general and

specific warm-up exercises for 10 minutes. Immediately before strength testing, seven stations were set up, one for each strength test. Each station had one examiner and one recorder who documented the test results in the students' records. The same examiner and recorder remained at the same station throughout the strength tests. For speed testing, five stations were prepared, each with an examiner and recorder who documented the results in the students' records. Test results were read aloud, and the recorder repeated them aloud for verification before entering them into the records. The same examiners and recorders were present at the same test during the speed testing. The participants moved in the same sequence from test to test, with adequate rest periods between tests.

Statistical Processing

The data obtained from the research were processed using descriptive analysis, normality tests, and one-way analysis of variance (ANOVA). After the ANOVA results, Bonferroni post hoc analysis was applied to determine the differences between the analyzed age categories. All statistical analyses were performed using IBM SPSS Statistics software (Version 25).

Results

The results of the basic descriptive statistical analysis of the observed motor abilities are presented in Table 1. The descriptive analysis of the motor abilities (strength and speed) of the students shows expected results for these age groups of participants. Additionally, Table 1 displays the results of the normality test. The Shapiro-Wilk test indicated that there is no statistically significant deviation from a normal distribution of the results.

Table 1. Basic Descriptive Statistics and Shapiro-Wilk Test

Variable		N	Min	Max	S-W
MSUD	5th grade	15	141	160	0.947
	6th grade	15	144	165	0.549
	7th grade	15	150	169	0.176
	8th grade	15	165	175	0.825
MVJ	5th grade	15	20	30	0.341
	6th grade	15	23	37	0.999
	7th grade	15	25	40	0.196
	8th grade	15	27	42	0.287
MBML	5th grade	15	7.7	9.5	0.132
	6th grade	15	8	9.6	0.576
	7th grade	15	8.1	9.6	0.207
	8th grade	15	8	10	0.692

MSKL	5th grade	15	2	5	0.063
	6th grade	15	4	7	0.082
	7th grade	15	7	10	0.061
	8th grade	15	11	14	0.082
MPT	5th grade	15	20	26	0.638
	6th grade	15	25	30	0.692
	7th grade	15	25	32	0.583
	8th grade	15	30	35	0.421
MCUC	5th grade	15	10	13	0.082
	6th grade	15	10	14	0.266
	7th grade	15	11	16	0.445
	8th grade	15	17	21	0.293
MDID	5th grade	15	29.08	31.11	0.224
	6th grade	15	30.47	33.93	0.794
	7th grade	15	33.33	34.41	0.976
	8th grade	15	34.12	36.03	0.511
MTR	5th grade	15	23	30	0.825
	6th grade	15	24	32	0.919
	7th grade	15	25	34	0.766
	8th grade	15	26	35	0.949
MTN	5th grade	15	21	28	0.825
	6th grade	15	22	30	0.919
	7th grade	15	23	32	0.766
	8th grade	15	24	33	0.949
MT20	5th grade	15	4.37	6.4	0.807
	6th grade	15	4.51	6.22	0.215
	7th grade	15	4.71	5.51	0.242
	8th grade	15	3.9	5.7	0.929
MT30	5th grade	15	6.56	9.6	0.801
	6th grade	15	6.81	9.45	0.352
	7th grade	15	6.15	8.85	0.64
	8th grade	15	6	8.55	0.827
MT50	5th grade	15	10.93	16	0.803
	6th grade	15	10.35	15.53	0.314
	7th grade	15	10.25	14.75	0.642
	8th grade	15	9.95	13	0.054

The One-Way Analysis of Variance (ANOVA) and Bonferroni Post Hoc Analysis are presented in Table 2. The table shows the statistical values of the one-way ANOVA test (F and p), which determine the differences between age categories (5th, 6th, 7th, and

8th grade) for the selected motor ability variables: strength (MSUD, MVJ, MBML, MSKL, MPT, MCUC, and MDIN) and speed (MTR, MTN, MT20, MT30, and MT50).

Additionally, Table 2 provides the results of the post hoc analysis for the selected motor ability variables—strength and speed (MSUD, MVJ, MBML, MSKL, MPT, MCUC, MDIN, MTR, MTN, MT20, MT30, and MT50). The table includes the values of the average differences and their significance, showing the differences between each age category compared to all others for each specified variable.

Table 2. ANOVA and Bonferroni Post Hoc Analysis

Varia.	5th grade ^A	6th grade ^B	7th grade ^C	8th grade ^D	F	p
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
MSUD (cm)	149.86±5.22 ^{B,C,D}	156±6.18 ^{A,C,D}	161.73±5.44 ^{A,B,D}	169.60±2.89 ^{A,B,C}	40.9	0.000
MVJ (cm)	25.73±3.23 ^{C,D}	29.53±3.6	31.33±4.6 ^A	32.73±4.54 ^A	8.44	0.000
MBML (dm)	8.41±0.58	8.76±0.49	8.77±0.52	8.94±0.61	2.36	0.081
MSKL (freq.)	3.26±0.88 ^{B,C,D}	5.46±0.91 ^{A,C,D}	8.53±0.99 ^{A,B,D}	12.53±0.91 ^{A,B,C}	281.83	0.000
MPT (freq.)	22.86±1.64 ^{B,C,D}	27.4±1.35 ^{A,D}	28.26±2.18 ^{A,D}	32.3±1.42 ^{A,B,C}	77.7	0.000
MCUC (freq.)	11.6±0.98 ^{C,D}	12.06±1.27 ^{C,D}	13.66±1.54 ^{A,B,D}	19±1.25 ^{A,B,C}	105.4	0.000
MDID (kg)	29.91±0.56 ^{B,C,D}	31.98±0.93 ^{A,C,D}	33.93±0.28 ^{A,B,D}	35.18±0.59 ^{A,B,C}	195.35	0.000
MTR (freq.)	26.26±2.05 ^{C,D}	28.13±2.26	30±2.75 ^A	30.53±2.61 ^A	9.51	0.000
MTN (freq.)	24.26±2.05 ^{C,D}	26.13±2.26	28±2.75 ^A	28.53±2.61 ^A	9.51	0.000
MT20 (s)	5.39±0.61 ^D	5.38±0.58 ^D	5.1±0.26	4.76±0.53 ^{A,B}	4.86	0.004
MT30 (s)	8.1±0.92 ^D	8.11±0.87 ^D	7.63±0.62	7.18±0.78 ^{A,B}	4.527	0.007
MT50 (s)	13.49±1.54 ^D	13.17±1.68 ^D	12.71±1.03	11.69±1.15 ^{A,B}	4.860	0.004

Significant differences were found in nearly all strength tests, including standing long jump, vertical jump, push-ups until failure, sit-ups until failure, squats until failure, and dominant hand grip strength (MSUD, MVJ, MSKL, MPT, MCUC, MDIN at p<0.05). The only exception was the medicine ball throw from a lying position (MBML), which showed no significant difference (p>0.05).

All speed tests, including hand tapping, foot tapping, and running 20 meters, 30 meters, and 50 meters from a standing start (MTR, MTN, MT20, MT30, MT50 at p<0.05), revealed statistically significant differences between students from 5th to 8th grade.

Discussion

An optimal level of motor skills is essential for the adequate growth and development of children. Proper development of these abilities is crucial for achieving optimal anthropometric characteristics. Special attention is given to the development of strength and speed, as they play a significant role among motor skills. These abilities, largely genetically determined, are important for further sports selection. The one-way ANOVA and Bonferroni post hoc analyses indicate statistically significant differences in nearly all strength and speed tests between upper primary school students. The results showed that in the strength test of throwing a 1 kg medicine ball from a lying position (MBML), no significant differences were found between the different grades. However, tests of explosive strength, such as the standing long jump and vertical jump, showed statistically significant differences among older students. As students aged, their performance in these jumps improved, likely due to chronological and biological maturation and morphological characteristics. Similar results were found by Kerić & Ujsasi (2014), who attributed the differences to a higher center of gravity in older students, assuming that taller students are typically older. For repetitive strength tests, such as push-ups until failure, situps until failure, and squats until failure, statistically significant differences were also observed, with better results as the students aged. Research by Durlević et al. (2023), Ghobadi et al. (2013), and others showed nearly identical results in different populations, including handball players, skiers, and judokas. In running tests of 20, 30, and 50 meters from a standing start, significant differences were observed between age groups. Older students ran faster, which can be attributed to morphological characteristics, strength development in the lower limbs, and longer leg bones, enabling longer strides that reduce the frequency of movements during running. Given that many studies have found a link between anthropometric measurements and motor skills, especially during growth and development, it is presumed that differences in motor abilities result from differences in anthropometric measures. The increase in muscle mass in older age groups could have contributed to the significant differences found in almost all strength and speed tests. Additionally, factors such as a larger number of motor units, greater muscle cross-sectional area, and possibly a stronger desire to prove themselves could explain the differences observed in this study. These findings are consistent with previous research by Badrić et al. (2012), Horvat & Vulet (2002), and Vraneković et al. (2003). Based on the results, it can be concluded that the trend in motor skill development generally follows the laws of growth and development. The greatest differences are observed in motor abilities that are more innate, while those influenced by physical training show fewer differences.

Despite the positive results, there are limitations to this study. The first limitation is the small sample size for each age category. Additionally, the results provide insight only into strength and speed differences, without considering gender, which remains a limitation of this study.

Conclusion

The motor skills of elementary school students have frequently been a subject of study in physical education. Many researchers have focused on gender differences, while significantly fewer have studied the differences among higher grades in elementary school. Therefore, the aim of this research was to determine the differences in certain strength and speed tests among students from the 5th to 8th grades. Based on the results, it can be concluded that statistically significant differences were found in strength tests such as standing long jump (MSUD), vertical jump (MVJ), push-ups until failure (MSKL), sit-ups until failure (MPT), squats until failure (MCUC), and dominant hand grip strength (MDIN). However, no statistically significant difference was found in the medicine ball throw from a lying position (MBML). Additionally, in the speed tests—hand tapping (MTR), foot tapping (MTN), 20-meter sprint from a standing start (MT20), 30-meter sprint from a standing start (MT30), and 50-meter sprint from a standing start (MT50)—statistically significant differences were observed.

Considering the limitations of this study, future research could focus on increasing the sample size and including both genders. Since this study examined differences in strength and speed, future research could explore differences in other motor skills as well as differences among athletes from various sports.

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