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EXPLOSIVE LEG POWER AND FLEXIBILITY IN SCHOOL CHILDREN AGED 6–8 YEARS

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Abstract: *This pilot study has been carried out on a sample of 51 participants – children aged 6–8 years, pupils in grades 1 and 2 at Elementary School Dimkata Angelov-Gaberot in Vatasha, Kavadarci, Republic of North Macedonia. The main objectives were: 1) to assess explosive leg power and flexibility of lower back and hamstring muscles; 2) to compare these parameters by age and sex. Measurement of anthropometric characteristics (height, weight and BMI) and assessment of explosive leg power and flexibility of lower back and hamstring muscles were performed in the school. In order to examine whether data have a normal distribution, skewness and kurtosis values and Kolmogorov–Smirnov test were used. Basic mathematical and appropriate statistical methods were used to calculate descriptive statistical parameters. Student's t-test was applied to test the difference between groups formed based on age and sex. Boys in grades 1 and 2 showed better results than girls in standing long jump (SLJ) test, while girls in Grade 1 performed better in flexibility test (FT). Second graders who have been involved in Physical Education classes longer than first graders, have shown better results in SLJ test than first graders. The reason for this outcome is that second graders have practiced more and have a better performance technique that influenced the jump distance.*

Keywords: *explosive leg power, flexibility, school children.*

INTRODUCTION

Motor development, motor abilities, and physical fitness level in children are a potent biomarker of health from an early age (Ortega et al. 2008). In order to assess motor abilities and physical fitness in young children at schools and sports clubs, practical and easy-to-perform tests are necessary (Latorre-Román et al. 2017).

Explosive strength (power) is defined as the ability to perform a maximum effort in a minimum amount of time (Singh et al. 2017). A commonly used tool to assess explosive leg power is standing long jump (SLJ). It is not a specific skill test, but it is practical, time-saving, and does not require any addi-

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tional equipment (Moresi et al. 2018). However, body dimensions may affect performance significantly when SLJ is used for assessment of leg muscle power in children, since taller individuals may jump longer than shorter ones with the same leg muscle power (Chamari et al. 2008). The most important factors that affect this outcome are the higher centre of mass and the longer leg length in taller children, which increase the trajectory of the centre of mass and the SLJ performance respectively (Benefice, Malina 1996). Consequently, during their growth and development, children may improve SLJ performance simply because height and leg length are increased (Veligekas et al. 2012).

Flexibility is typically characterized by the maximum range of motion in a joint or series of joints (McHugh et al. 1998). Nowadays, different kinds of tests are used to assess flexibility, especially hamstring muscle extensibility. The choice of a proper test should be based on its functionality and validity (López-Miñarro 2010). Although angular tests have the advantage of being the "gold standard" criterion of measuring flexibility, their use seems to be limited in several settings, especially when applied to school children, due to the necessity of sophisticated instruments, qualified technicians, and time constraints (Castro-Piñero et al. 2009). Unlike the angular tests, linear tests have a simple procedure. They are easy to administer, require minimal skills training for their application, and the equipment necessary to perform them is very affordable, so they could potentially be a useful alternative to estimate flexibility (Mayorga-Vega et al. 2014).

Therefore, the main objectives of this pilot study were: 1) to assess the explosive leg power and flexibility of the lower back and hamstring muscles in school children aged 6–8 years; 2) to compare these parameters by gender; 3) to compare these parameters by age.

METHODOLOGY

Participants

The present pilot study has been carried out on a sample of 51 participants – 6–8-year-old pupils in grades 1 and 2 at the at Elementary School Dimkata Angelov-Gaberot in Vatasha, Kavadarci, Republic of North Macedonia.

Instruments

In order to achieve the particular aim of the study, we first measured some anthropometric characteristics (height, weight and BMI) of the children. They were measured barefoot while wearing light clothes, according to the WHO manual (WHO 2007).

Height: Measured using a wall-mounted stadiometer (SECA SE206).

Weight: A calibrated digital scale was used (TANITA TBF 300).

BMI: Calculated from height and weight as follows: $\frac{Weight\ (kg)}{Height\ (m)^2}$ (WHO, 2007).

Then, we assessed explosive leg power and flexibility in the children by applying:

- SLJ in cm (Jovanovski 1998);
- Flexibility test (FT) in cm (Jovanovski 1998).

Data analysis

Skewness and kurtosis values and the Kolmogorov–Smirnov test were used in order to examine whether the data have a normal distribution. Basic mathematical and appropriate statistical methods were used in order to calculate descriptive statistical parameters. The Student's t-test was applied in order to verify if there is a statistically significant difference between boys and girls in both grades. For that purpose, we used Microsoft Office Excel 2010.

RESULTS AND DISSCUSION

According to the data presented in Table 1, the results of boys in Grade 1 have a normal distribution, with a normal asymmetry considered when values for skewness range between -1,00 and 1,00 (Zeqiri et al. 2020), and when kurtosis values are in an acceptable range from -3 to 3 as proposed by

Kallner (2013). An exception is the skewness value for BMI (1,32), which is above the accepted range and therefore indicates a right-skewed distribution. It means that most of the boys have a BMI that is lower than the arithmetic mean value for BMI (17,15).

Table 1. *Descriptive statistical parameters of boys in Grade 1*

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Weight (kg)	15	20,00	36,00	27,40	5,22	0,28	-1,43	p > .20
Height (cm)	15	115,00	138,00	126,20	6,81	-0,01	-0,96	p > .20
BMI*	15	13,82	23,41	17,15	2,78	1,32	1,47	p > .20
Standing long jump (cm)	15	70,00	140,00	111,40	19,66	-0,63	0,03	p > .20
Flexibility test (cm)*	15	30,00	59,00	43,93	8,75	-0,18	-0,99	p > .20

*Variable with an opposite metric orientation

Table 2. *Descriptive statistical parameters of girls in Grade 1*

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Weight (kg)	12	18,00	36,00	24,33	4,85	1,05	2,28	p > .20
Height (cm)	12	114,00	134,00	122,67	6,15	0,24	-0,61	p > .20
BMI*	12	13,61	23,04	16,10	2,61	1,86	4,19	p > .20
Standing long jump (cm)	12	70,00	130,00	96,67	16,96	0,10	0,41	p > .20
Flexibility test (cm)*	12	28,00	47,00	38,08	5,53	-0,36	-0,18	p > .20

*Variable with an opposite metric orientation

Based on the data in Table 2, the results of girls in Grade 1 have a normal distribution. Exceptions are the skewness value for weight (1,05) and the skewness and kurtosis values for BMI: (1,86) and (4,19) respectively, which are above the acceptable range (Kallner 2013; Zeqiri et al. 2020). This means that most of the girls are "lighter" than 24,33 kg, which is the arithmetic mean, and have a BMI lower than 16,10. Ad for the kurtosis value for BMI, if we take into consideration the SD (2,61) in addition to it (Kallner, 2013), we may conclude that this seems acceptable.

Table 3. *Descriptive statistical parameters of boys in Grade 2*

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Weight (kg)	11	21,00	42,00	26,18	6,60	1,71	2,48	p > .20
Height (cm)	11	118,00	152,00	127,45	9,93	1,58	3,15	p > .20
BMI*	11	13,44	18,66	15,90	1,82	0,14	-1,34	p > .20
Standing long jump (cm)	11	90,00	150,00	128,73	17,86	-0,75	0,86	p > .20
Flexibility test (cm)*	11	34,00	60,00	44,55	7,85	0,76	-0,12	p > .20

*Variable with an opposite metric orientation

According to what is presented in Table 3, the results of boys in Grade 2 have a normal distribution, except for the skewness value for weight (1,71) and the skewness and kurtosis values for height:

(1,58) and (3,15) respectively, which are above the acceptable range (Kallner 2013; Zeqiri et al. 2020). This means that most of the boys are "lighter" than 26,18 kg, and shorter than 127,45 cm. And for the kurtosis value for height, if we take into consideration the SD (9,93) in addition to it (Kallner 2013), we may conclude that this seems acceptable.

Table 4. *Descriptive statistical parameters of girls in Grade 2*

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Weight (kg)	13	20,00	36,00	27,77	4,78	0,00	-0,73	p > .20
Height (cm)	13	124,00	138,00	130,69	4,70	0,11	-1,02	p > .20
BMI*	13	13,01	20,35	16,21	2,42	0,47	-0,73	p > .20
Standing long jump (cm)	13	90,00	140,00	110,46	13,34	0,63	0,74	p > .20
Flexibility test (cm)*	13	38,00	59,00	44,00	6,79	1,17	0,38	p > .20

*Variable with an opposite metric orientation

Based on what is presented in Table 4, the results of girls in Grade 2 have a normal distribution, with a normal asymmetry considered when values for skewness range between -1,00 to 1,00 (Zeqiri et al. 2020), and when kurtosis values are in an acceptable range from -3 to 3 as proposed by Kallner (2013). The only exception here is the skewness value for FT (1,17), which is above the accepted range and therefore indicates a right-skewed distribution. It means that most of the girls have a lower result than 44,00 cm which is the arithmetic mean. Since FT is a variable with an opposite metric orientation, this points to better flexibility in most of the girls.

Table 5. *Arithmetic mean, t-test and p-value for boys and girls in Grade 1*

Grade 1				
	Boys	Girls	T-Test	P-Value
Weight (kg)	27,40	24,33	2,06	0,13
Height (cm)	126,00	123,00	2,06	0,17
BMI*	17,15	16,10		
Standing long jump (cm)	111,40	96,67	2,06	0,05
Flexibility test (cm)*	43,93	38,08	2,06	0,05

*Variable with an opposite metric orientation

Based on Table 5, we can conclude that there is a statistically significant difference between boys and girls in Grade 1 in terms of SLJ (cm) and FT (cm), and no statistical differences in weight (kg) and height (cm). Boys are better than girls in SLJ test, while girls have demonstrated better results in FT (Figure 1).

We assume that the better results of the boys in SLJ test are result of a larger body dimension, since taller individuals may jump longer than shorter ones (Chamari et al. 2008). With regard to flexibility, our results are in line with what was previously reported (Valdivia et al. 2009).

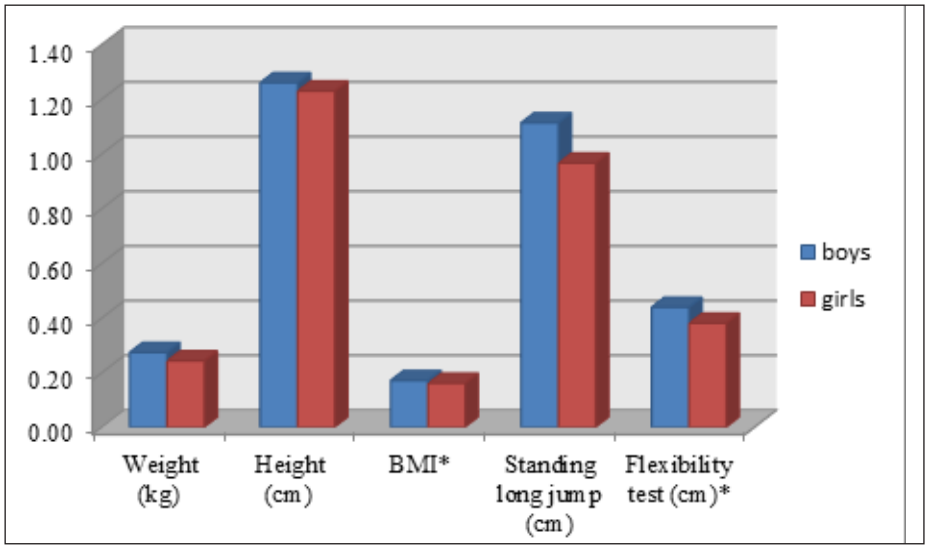
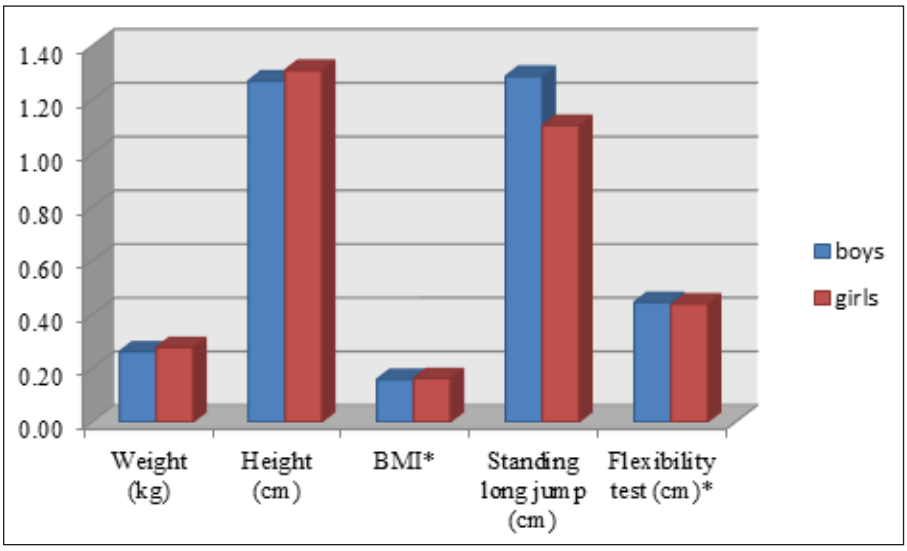


Table 6. *Arithmetic mean, t-test and p-value for boys and girls in Grade 2*

Grade 2				
	Boys	Girls	T-Test	P-Value
Weight (kg)	26,18	27,77	2,10	0,52
Height (cm)	127,00	130,69	2,14	0,34
BMI*	15,90	16,21		
Standing long jump (cm)	128,73	110,46	2,10	0,01
Flexibility test (cm)*	44,55	44,00	2,09	0,86

*Variable with an opposite metric orientation

According to Table 6, there is a statistically significant difference between boys and girls in Grade 2 in terms of SLJ test, but there is no such difference between them in weight (kg), height (cm) and FT (cm). Boys in second grade have demonstrated better results in the SLJ test than girls (Figure 2). As we discussed earlier, this outcome is more likely to be due to chance in our sample, since children at this age are prepubescent and, according to what has previously been reported in literature, they did not show statistically significant differences in terms of strength (Alves et al. 2018). In line with this, gender may affect SLJ performance, with boys performing better than girls, but this occurs only during puberty and not in early childhood (Veligekas et al. 2012).



* Variable with an opposite metric orientation

Figure 2. *Weight, height, BMI, SLJ and FT in boys and girls in Grade 2*

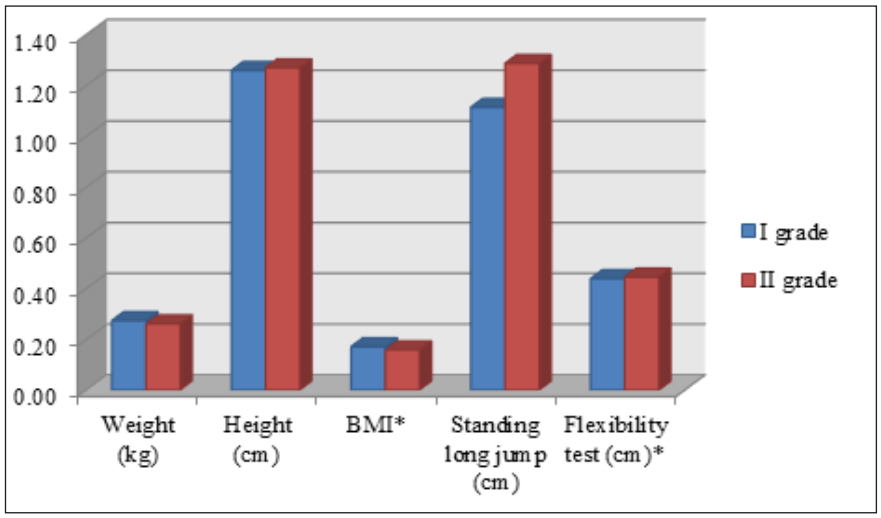
Table 7. *Arithmetic mean, t-test and p-value for boys in grades 1 and 2*

Boys				
	Grade 1	Grade 2	T-Test	P-Value
Weight (kg)	27,40	26,18	2,09	0,62
Height (cm)	126,00	127,00	2,11	0,72
BMI*	17,15	15,90		
Standing long jump (cm)	111,40	128,73	2,07	0,03
Flexibility test (cm)*	43,93	44,55	2,07	0,85

*Variable with an opposite metric orientation

Table 7 shows that there is a statistically significant difference between boys in grades 1 and 2 in favour of second graders in terms of the SLJ test, and that there is no such difference between them in weight (kg), height (cm) and FT (cm).

Other important factors that may influence SLJ performance in children are skill and technique. Skill in children is influenced by neuromuscular maturation, but it also depends on practice (Benefice, Malina 1996). Therefore, second graders who have been involved in Physical Education classes longer than first graders, have performed better in the SLJ test (Figure 3). This test requires coordination of movements and good timing. Thus, children who have practiced more and have a better technique may have an advantage (Veligekas et al. 2012).



*Variable with an opposite metric orientation

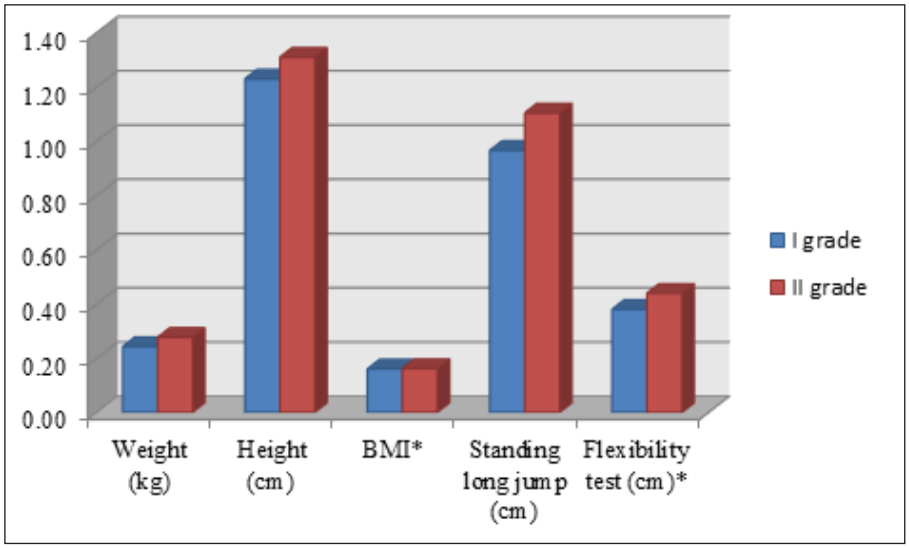
Figure 3. *Weight, height, BMI, SLJ and FT in boys in grades 1 and 2*

Table 8. *Arithmetic mean, t-test and p-value for girls in grades 1 and 2*

Girls				
	Grade 1	Grade 2	T-Test	P-Value
Weight (kg)	24,33	27,77	2,07	0,09
Height (cm)	123,00	131,00	2,08	0,00
BMI*	16,10	16,21		
Standing long jump (cm)	96,67	110,46	2,08	0,04
Flexibility test (cm)*	38,08	44,00	2,07	0,03

*Variable with an opposite metric orientation

According to what is presented in Table 8, there is a statistically significant difference between girls in grades 1 and 2 in height (cm) and SLJ (cm) in favour of the second graders, and in FT (cm) in favour of the first graders (Figure 4). There is no such difference between them in weight (kg). As we discussed earlier, this difference in the SLJ test might be due to a better performance technique in second grade girls which might influence the jump (Veligekas et al. 2012). As for the difference in height (cm) and flexibility (cm), we should consider that this is a pilot study where the sample group was very small, so this outcome might be due to chance.



*Variable with an opposite metric orientation

Figure 4. *Weight, height, BMI, SLJ and FT in girls in grades 1 and 2*

CONCLUSION

Boys in grades 1 and 2 have demonstrated better results than girls in the standing long jump (SLJ) test, while girls in Grade 1 have performed better in the flexibility test (FT). Second graders who have been involved in Physical Education classes longer than first graders, have shown better results in the SLJ test than first graders because they have practised more and have a better performance technique that might influence the jump distance.

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