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Primary School Children: Contribution of Nutritional Status in Explanation of Their Explosive and Repetitive Strength

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Abstract: *Recent studies have attested the fact that now days children are living a sedentary life, which causes an excessive increase in body weight, thus negatively affecting their health and motor skills. Furthermore, studies up to this point have proven that there are differences in the motor skills of pupils with different nutritional status.*
The aim of this research was to determine impact of nutritional status on motor skills of primary school children also to determine whether there are differences in motor abilities with respect to gender. The research was conducted on a sample of 239 pupils (128 girls and 111 boys) of the fourth grade. The variable sample consisted of 2 anthropometric variables (body weight and body height) and 6 variables for estimating explosive and repetitive strength. The obtained results of this research have shown that for boys there are negative correlation between their BMI and tests: long jump, high jump, squats and sit-ups. For the sample of girls, the BMI positively correlates with test throwing a medicine ball and negatively with test sit-ups. Furthermore, boys achieve better results in motor tests than girls.
Keywords: *body mass index, children, motor performance, elementary education*

INTRODUCTION

Excess body weight can be explained as an excess of body mass for a person's height, while obesity is considered the phenomenon of excessive accumulation of body fat in the body (Zavrsnik, 2004). Nowadays, overweight and obese children of younger school age are becoming more and more common. That is the reason why the overweight and obesity of children is becoming a serious public health problem. Previous researches support the fact that obesity in childhood can have negative effects on overall motor development (Morano, Colella, & Caroli, 2011). Moreover, most of the research conducted so far has shown that excess body weight and obesity negatively affect the level of motor skills in children of younger school age, and that there are differences in the motor skills of children with different nutritional status (Prskalo, Badrić & Bogović, 2015). Various factors such as physical activity, fitness level, and motor competence can influence the appearance of obesity in children (Bryant, Duncan, and Birch, 2014). It is establish that low level of physical activity is correlated with higher BMI in children (Janssen and LeBlanc 2010). Also children who are overweighed and obese are disadvantaged in antigravity motor skills (Barnett et. all, 2016; Prskalo, Badrić and Kunješić 2015). Increased body mass index causes reduced motor abilities in primary age school children. During the performing physical activities obese children feel tired more quickly than children with normal body weight, and that children are unable to persist doing activities for longer period of time and they become slower in doing physical activities (Ishud, & Romadona, 2020). In general, the result of the study conducted by Wibowo, Budiman and Sumarno (2020) shows that male children are better than female children in fine and gross motor skill mastery.

The main goal of this research was to determine whether the nutritional status assessed through the body mass index of younger school-aged children correlates with their motor skills (explosive and repetitive strength). The secondary goal was to determine whether there are statistically significant differences in the motor status of children with regard to their gender and nutritional status. In accordance with the set goals, the following hypotheses were set:

1. The body mass index (BMI) of children correlates negatively and statistically significantly with the results on tests for evaluating repetitive and explosive strength. It is expected that male and female students with a higher BMI will achieve worse results on tests for assessing explosive and repetitive strength.

2. There are statistically significant differences between male and female students in tests for assessing explosive and repetitive strength. Male students are expected to achieve better results than female students in all tests.

METHODS

Study participants

The research was conducted on a sample of 239 4th grade students of elementary schools in Zadar County, Croatia. In the total sample 128 were girls (normal weighted 90 and over-weighted or obese 38) 111 were boys (normal weighted 66 and over-weighted or obese 45). The research was approved in advance by the Faculty Council of the Department of Teacher and Preschool Teacher Education of the University of Zadar, Croatia. Parents gave their written consist to allow researchers to test their children. Also, the research was anonymous and voluntary.

Variables

The survey consisted of three parts. The first part was aimed at collecting socio-demographic data on gender, age, and elementary school grade. The second part of the research was related to the collection of information on the level of nutritional status and included measures of the students' body height and body weight. Taking into account the values of children's body mass and body height, their body mass index was calculated as weight divided by height squared (kg/m2). Overweight was defined according to the definitions of the WHO (2006). The third part was focused on measuring 6 variables for estimating explosive and repetitive strength: long jump, high jump, throwing a medicine ball (all three assessing explosive strength), and squat, sit up, spine (all three assessing repetitive strength).

Statistical analysis

The collected data were processed by the program Statistic for Windows 13.0 (StatSoft). Basic descriptive indicators were calculated: arithmetic mean and standard deviation. The normality of the distribution was tested by the Kolmogorov-Smirnov test. T test was used to establish differences in motor abilities of primary school children with the regard of their gender. A series of simple regression analyzes were used to determine the contribution of children's nutritional status in explaining their explosive and repetitive strength.

RESULTS AND DISCUSSION

From the results presented in Table 1, it is evident that boys achieve better results in all variables assessing explosive strength and in two variables assessing repetitive strength compared to girls (Table 1). In the test that evaluates the repetitive strength of the lower extremities (squats), no statistically significant difference was obtained with regard to the children's gender ($t=-1.42$; $p=0.16$). Furthermore in this research, boys and girls in primary education do not differ statistically significantly in terms of body mass index ($t= -1.92$; $p=0.06$). The greatest variation of results for both boys and girls was obtained for all three variables that assess repetitive strength. The results of the Kolmogorov Smirnov test indicate that only one variable that assesses the explosive power of the upper extremities (Max D= 0.12; K-S $p<0.05$) and just for the sample of girls specify a statistically significant deviation from the normal distribution of results, therefore parametric statistics (regression analysis and t test for independent samples) was being applied in the statistical processing of the data.

In this research, the results obtained on the tests: long jump, high jump, and sit-ups are better compared to the results obtained for the same tests in the research conducted by Lončar (2011). In addition to the above, in the same study, no differences were found in the motor skills of fourth-grade students with regard to gender. On contrary, gender differences of the results assessing motor abilities in favour of boys, were obtained in the results of the research conducted by Cetinić and Petrić (2010). Additionally, in this study, boys achieved better results in test long jump than the normative values for population of Croatian fourth grade male pupils, while girls achieved slightly worse results compared to the previously mentioned normative values (Findak, Metikoš, and Mraković, M., 1992). Similary to the results from this research, concerning the gender differences in motor abilities, Pejčić, Malacko and Tomljenović (2008) indicated that male pupils compared to female achieve better results in tests of explosive and static strength, coordination and aerobic endurance if they have reduced body weight values and a reduced proportion of fat tissue, and vice versa.

Table 1. *Descriptive parameters of Body mass index and variables assessing explosive and repetitive strength for boys (N=111) and girls (N=128) and differences in those variables concerning gender (t test results)*

Variable	Gender	Mean	SD	max D	K-S	t test	p
BMI	Male	19.42	3.16	0.13	p < .05*	-1.92	0.06
	Female	18.58	3.50	0.15	p < .01*		
LONG JUP	Male	1.54	0.24	0.06	p > .20	-7.04	0.00*
	Female	1.33	0.22	0.08	p > .20		
HIGH JUMP	Male	25.14	4.68	0.08	p > .20	-4,57	0.00*
	Female	22.53	4.13	0.10	p < .15		
THROWING A BALL	Male	5.47	1.17	0.11	p < .20	-6,38	0.00*
	Female	4.55	1.06	0.12	p < .05*		
SQUATS	Male	42.20	8.58	0.08	p > .20	-1,42	0.16
	Female	40.83	6.29	0.10	p < .15		
SIT-USP	Male	34.77	8.31	0.09	p > .20	-4,73	0.00*
	Female	29.73	8.10	0.10	p < .20		
SPINES	Male	37.08	7.77	0.08	p > .20	-3,98	0.00*
	Female	33.44	6.39	0.10	p < .20		

Legend: *N- number of examinees; SD- standard deviation; Max D- maximum deviation; K-S - Kolmogorov Simirnov test of normality; **- statistically significant difference; *- statistically significant deviation from the normal distribution of results (level of significance= p<0,05 and p<0,01); BMI- body mass index*

For the sample of boys (Table 2), the body mass index correlates negatively and statistically significantly with two tests for assessing explosive strength (long jump β=-0.35 and high jump β=-0.41) and with two tests for assessing repetitive strength (squats β=-0.19 and sit-ups β=-0.24). For the sample of girls, the body mass index positively and statistically significantly correlates with one test for evaluating explosive strength (throwing a medicine ball β=0.26) and negatively and statistically significantly correlates with one test for evaluating repetitive strength (sit-ups β=-0.20). The body mass index for boys contributes to the explanation of the variables of long jump (R^2=0.35), high jump (R^2=0.41), squats (R^2=0.19), and sit-ups (R^2=0.24), and for girls' body mass index contributes to the explanation of the variables of long jump (R^2=0.32), throwing a medicine ball (R^2=0.26), and sit-ups (R^2=0.20) (Table 2).

In the research of D'Hondt et al. (2014) children's BMI at baseline predicted and explained 37.6% of the variance in gross motor coordination with age (D'Hondt, Deforche, Gentier, Verstuyf, Vaeyens, Bourdeaudhuij, et al., 2014). Webster, Sur, Stevens, & Robinson (2021) established that different components of body composition (i.e., fat free mass) were associated with different aspects of fundamental motor skills competency. Also, they argued that „excess body fat may be a morphological constraint to proficient locomotor performance when transporting the body through space ".

Table 2. *Results of a series of simple regression analyzes of the contribution of body mass index as predictor variable in explaining explosive and repetitive strength as criterion variables of primary girls and boys*

	EXPLOSIVE STRENGHT								
VARIABLE	LONG JUMP			HIGH JUMP			THROWING A BALL		
	β	SE β	p	β	SE β	p	β	SE β	p
BMI_M	-0.35	0.09	0.00*	-0.41	21.47	0.00*	0.16	0.09	0.09
	Mult. R= 0.35 St. Err.= 22.64 F=15.26 p< 0.00*			Mult. R= 0.41 St. Err.=4.3 F=21.47 p< 0.00*			Mult. R= 0.16 St. Err.= 115.68 F=2.89 p< 0.09		

	β	SE β	p	β	SE β	p	β	SE β	p
	-0.32	0.08	0.00*	-0.09	0.09	0.32	0.26	0.09	0.09
BMI_F	Mult. R=0.32 St. Err.=20.65 F=14.63 p< 0,00*			Mult. R= 0.09 St. Err.= 4.13 F=0.99 p< 0.32			Mult. R= 0.26 St. Err.= 103.10 F=9.27 p< 0.00*		
	REPETITIVE STRENGHT								
VARIABLE	**SQUATS**			**SIT-UPS**			**SPINES**		
	β	SE β	p	β	SE β	p	β	SE β	p
	-0.19	0.09	0.04	-0.24	0.09	0.01	-0.12	0.1	0.22
BMI_M	Mult. R=0.19 St. Err.=8.46 F=4.27 p<0.04**			Mult. R=0. 24 St. Err.=8.11 F=6.65 p<0.01*			Mult. R=0. 12 St. Err.=7.75 F=1.5 p<0.22		
	β	SE β	p	β	SE β	p	β	SE β	p
	-0.17	0.09	0.06	-0.20	0.09	0.02	-0.11	0.09	0.20
BMI_F	Mult. R=0. 17 St. Err.=6.22 F=3.78 p<0.06			Mult. R=0. 20 St. Err.=7.95 F=5.70 p<0.02*			Mult. R=0. 11 St. Err.=6.37 F=1.66 p<0.20		

Legend: TA- *Mult. R-multiple correlation; St. Err.- standard error of estimation; F-significance; p-significance level of multiple correlation coefficient; β- standardize partial regression coefficient, SEβ – standard error of standard regression coefficient; significant level of regression coefficients, *statistical significance (*p<0.01, **p<0.05); BMI_M- boys body mass index; BMI_F- girls body mass index*

As well in the research conducted by Babin, Bavčević and Moretti (2006) on first-grade girls, the negative impact of an increased amount of subcutaneous fat on the results in strength tests was proven. Furthermore, Awad and Aneis (2022) have confirmed in their research that children who were normal weight or underweight had higher motor skills than those who were overweight or obese.

CONCLUSON

Considering the results of the conducted research, it is necessary to implement interventions in the direction of raising the level of physical activity of overweight and obese students. Furthermore, since research has confirmed the lower level of motor skills of girls compared to boys, it is necessary to work on the motivation of schoolgirls so that they are more involved in the implementation of various forms of physical activities, either in the school environment or outside of it.

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