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Body Mass Index (BMI) as an Important Factor in the Manifestation of Motor Abilities of Early Primary School Pupils

Extended summary

Overweight body mass and obesity have been on the increase all over the world in the last couple of decades and have become almost epidemic as a consequence of the modern lifestyle. Obesity can be defined in many ways, and one of them implies the increase of the percentage of body mass and overall body weight over 30% in women and over 25% in men (Ivković-Lazar, 2004). Body mass index is one of the most frequently used indexes for measuring obesity. It is commonly used for adults, while expert opinions vary from oponents to advocates of using this method for measuring obesity of children and adolescents in terms of its reliability (Stupnicki, 2012; Deurenberg et al., 1991).

Child obesity is a global health problem in the modern world. The percentage of obese and overweight children is dramatically on the rise, as the results from 2010 research show: 46% of children in the USA and 38% of children are overweight (Ogden et al., 2006; Wang, & Lobstein, 2006). In the period 1986-2006, the general trend in weight gain was between the ages 6-15 (Péneau et.al., 2008). In Switzerland, 6.5% of children and adolescents in the age group 6-14 were registered as obese (Lasserre, A. M. Et al. 2007), while in Serbia this percentage amounts to 7.3% (Ostojić et al., 2011). There are many negative consequences of obesity in terms of children's and adolescents' health. These consequences are particularly evident regarding the cardio-vascular system, manifesting as the enlargement of the left chamber (Friberg, P. et al., 2004; Mehta et al., 2004; Rabbia et al., 2003), reduction of heart reserve (Drinkard et al.., 2001: Rowland, & Dunbar, 2007), and higher blood pressure (Naylor et al., 2006). Consequently, a reduced functional capacity directly affects motor abilities of children and adolescents.

It is evident from the above stated facts that the impact of obesity is kinanthropologically significant and entails specific consequences. For this reason, the aim of this research is to de-

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termine qualitative differences in motor abilities of the lower primary school children depending on the value of their body mass index.

The sample of respondents consisted of 174 pupils of the 4th grade of primary school and of both sexes, aged 11 ± 0.65 years (BH = 145.7cm ± 6.14, BM = 38.2kg ± 7.17). The entire sample of the subjects was organised by random selection into three groups: undernourished (n = 26), normal weight (n = 113) and overweight (n = 35). Nutrition and classification were measured by the weight ratio measured in kilograms and the square of body height measured in metres (kg / m2), as recommended by the International Obesity Task Force (Henderson, & Sugden, 1992)).

A battery of motor tests applied for the assessment of motor abilities was based on experiences with adult respondents, and modified for the school population (Bala, Stojanović and Stojanović, 2007). This test battery evaluates the efficiency of the mechanism for structuring movement, synergistic and tonus regulation, as well as for regulating the intensity and duration of excitation.

The obtained data were processed by using adequate statistical procedures. At the beginning of data processing, descriptive statistics was used to analyse basic research results. The significance of the differences among the groups of subjects was tested using a univariate variance analysis (ANOVA) for individual variables and multivariate variance analysis (MANOVA) at a global level.

Table 1 shows the basic central and dispersive statistics of motor variables that were applied in this research. The results obtained by multivariate variance analysis (MANOVA) and univariate variance analysis (ANOVA) are presented as well.

Табела 1. Дескриптивни статистици и разлике између група испитаника.

Variables	UNDERWEIGHT (N=26)		NORMAL WEIGHT (N=113)		OVERWEIGHT (N=35)			
	AM	**S**	**AM**	**S**	**AM**	**S**	**f**	**p**
Running 20 м (0,1 с)	54.03	7.14	50.24	7.51	57.17	7.86	7.34	**.00**
Backward polygon(0,1 с)	298.19	44.86	201.29	49.79	401.17	99.89	167.48	**.00**
Hand tapping (freq.)	16.59	2.91	17.01	2.41	16.06	4.32	3.11	.11
Seated wide-leg forward bend (cm)	35.42	7.03	39.30	5.14	33.67	8.24	2.73	**.00**
Standing long jump (цм)	111.18	19.63	112.32	19.81	109.81	21.31	1.79	.14
Bent arm hang (0,1 с)	109.66	99.12	134.33	111.06	61.35	94.11	5.86	**.00**
Sit-ups (freq.)	21.84	8.16	21.62	8.31	15.90	8.79	3.46	**.03**
F=19.98 P=.00								

Legend: AM – arithmetic mean; S – standard deviation; N – number of respondents; f – F-test for univariant analysis of variance; p = level of significance for univariate variance analysis; F – F-test for multivariate variance analysis; P = level of significance for multivariate variance analysis.

Table 1 shows that by applying the multivariate variance analysis (MANOVA) among three groups of subjects that were organised according to their body mass index (BMI), the value of the F test was relatively high by the Wilks Λ criterion (F = 19,98), and the same applies to the level of statistic significance P = ,00. The data clearly indicate that, at a multivariate level, and in the entire system of the analysed motor variables, there is a statistically significant difference in motor variables among the groups organised according to their body mass index. The univariate variance analysis (ANOVA) showed that no statistically significant difference was identified in the variables: Standing Long Jump and Hand Tapping, whereas there was a statistically significant difference among the groups regarding other variables: Running 20m, Backward Polygon, Seated Wide-Leg Forward Bend, Sit-ups, and Bent Arm Hang.

Arithmetic mean, as a measure of central tendency of the results in Table 1, indicates that the subjects in the group *normal weight* scored higher in all motor variables than other two groups. There is a difference in arithmetic means between the groups *underweight* and *overweight* in all motor variables, and in favour of the *undernourished.* It should be noted that, due to inversive metrics, a lower score is actually a better result in the variables backward polygon and running 20m.

Based on the obtained results, we can conclude that there is a statistically significant difference in the applied system of the motor ability variables among the three tested groups. Judging from the values of arithmetic means achieved at the testing of motor abilities, the best results were achieved by the group of children of normal weight. When two other groups are compared, the group of undernourished children achieved better results.

In terms of individual variables: for Backward Polygon, Seated Wide-Leg Forward Bend, Running 20m, and Bent Arm Hang, a statistically significant difference was identified among the three groups (p=,00). Evidently, body mass index is a limiting factor in achieving qualitatively higher values of motor abilities: whole-body coordination, speed of movement, flexibility, and static strength of arms. Increased body weight, registered in the overweight group of children, has a negative effect on the whole-body coordination, which is in correlation with other similar studies (Lopes, Stodden, Bianchi, Maia, & Rodrigues, 2012). This claim is substantiated by the fact that body volume increases proportionally to the increased BMI, which is certainly a distracting factor in achieving coordination as motor ability. As far as flexibility is concerned, it is in negative correlation with increased BMI values and the established differences in this motor ability are logical (Deforche, Lefevre, De Bourdeaudhuij, Hills, Duquet, & Bouckaert, 2003; Graf, et al., 2005). Given that the increased body weight entails a greater circumference of some parts of body (circumference of waist, chest, and limbs), which in turn limits movement, the obtained results are not surprising. In terms of BMI, significant differences among the groups were identified relative to speed. Increased body weight implies generating a greater force for movement in space, which directly impacts the speed of movement. These data match the results of other research (Fogelholm, Stigman, Huisman, & Metsämuuronen, 2008). In the variable Sit-Ups, a statistically significant difference was also identified, but at a slightly lower level of significance (p=.03). Since body volume increases with the increase of BMI, which is a distracting factor for movement, the scores obtained at the Sit-Ups test are also expected. Forward Bend was certainly limited by the mass around waist and belly. As for the variables Hand Tapping (p=,11) and Standing Long Jump (p=,14), no significant difference was observed in the three groups. This outcome was also expected, given that the excessive body weight affected the explosive strength of the lower extremities.

Our general conclusion is that the body mass index (BMI) is a significant factor in developing motor abilities of the early primary school pupils. In addition, one should also consider take into consideration the indirect effect of the BMI on the quality of physical education classes, because the pupils with the lower BMI values achieve qualitatively higher values at motor ability tests. These values are a prerequisite for a purposeful physical education class.

Keywords: Body mass index (BMI), motor abilities, level of nutrition, early primary school pupils.

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