

ORIGINAL SCIENTIFIC PAPER

Relationship between Fine Motor Skills and BMI of Preschool Children

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Abstract

The study aimed to determine the relationship between fine motor skills and BMI categories of preschool children 5-6 (6.14 ± 0.43) years of age (body height 118.86 ± 5.96 cm, body mass 22.88 ± 4.68 kg). 129 subjects, preschool children (59 boys and 70 girls) participated in this transversal study. Body mass index (BMI) was calculated based on measures of body height and body mass, and WHO cutoff points were used to create BMI categories while fine motor skills were determined using two Bruininks-Oseretsky (BOT-2) subtests for children's motor efficiency. Pearson's correlation coefficient was used to determine the relationship between the variables. The results showed a significant negative correlation between BMI and fine motor integration ($r = -.235$, $p < .001$), manual dexterity ($r = -.290$, $p < .001$), and the overall result of fine motor skills ($r = -.342$, $p < .001$). These results indicate that in addition to the significant connection between gross motor skills and basic motor skills, proven by numerous previous studies, higher BMI also has a negative effect on the fine motor skills of children, even in preschool age. Overweight children have lower scores on fine motor skills tests compared to normal weight children, which can have consequences for motor development in later life.

Keywords: BOT-2, manual dexterity, fine motor integration, motor development, nutritional status

Introduction

Fine motor skills represent the ability to use the smallest body muscles to perform precise movements. These skills are closely related to the eye-hand coordination, and they refer to hand dexterity skills, which include reaching, grabbing, manipulating objects, and using different tools. Fine motor integration and manual dexterity which together indicate the fine motor skills of children are most frequently investigated (Aleksić Veljković, Katanić & Mašanović, 2021). The fine motor skills of children are also associated with coordination skills. The coordination here, where the main parameters are the eye and the hand, refers to the ability of the fingers and the hand to properly perform the task ordered and controlled by the eye (Brown, 2012). Abilities and skills are dramatically developed at the preschool age, which is defined as the age of 3 to 6 in children (Cople & Bredekamp, 2009). During the preschool age, children develop many basic skills and functions (Zwicker & Harris, 2009). More and more researches in the last few years indicates that preschool children spend a lot of

time playing and exploring their environment.

In addition to the development of motor skills, special attention should be paid to the development of the fine motor skills in children, because they are crucial for proper growth and development, as well as for the motor progress of children that comes later, and especially for participation in different activities during school, but also for normal functioning and performance of daily activities (Min, Jung, Jung, & Kang, 2008). The authors of many researches deal with the question of why the correct acquisition of basic motor skills is of crucial importance for the children's development. According to Whitall (2003), careful studying of the motor skills of children gives a clearer picture of perceptive, cognitive, and affective processes. From today's point of view, there is a large number of children who master motor skills slowly and with much effort, so it is important to know which level of ability is expected at a given age and how to make an individual program for students who have problems with mastering certain skills.

Fine motor skills are one of the basic functions of the body,

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and their center is located in the cerebral cortex. It is a center for movement coordination which occupies a significant part of the cerebral cortex (Schmid, Miodrag, & DiFrancesco, 2008). If a child does not develop fine motor skills, synapses will not be formed between these centers, and various cognitive disorders can occur, such as dyslexia, dysgraphia, various learning disorders, etc, which can cause many problems later in life. These centers are connected by direct connections between the nerves, nervous system, and all the muscles of the body (Min et al., 2008). By developing fine motor skills, children develop skills of coordination which they need for all life activities (Schmid et al., 2008). The children who do not develop this ability from the earliest age are less active, slower thinkers, and react badly to numerous life situations.

Recently, many studies have focused on the analyses of the BMI status of children to determine the differences between normal weight and overweight children. Thus, World Health Organization (WHO) indicates that even 340 million children and adolescents aged 5-19 are overweight or obese. The prevalence of overweight and obesity among children and adolescents aged 5-19 has increased dramatically from just 4% in 1975, to over 18% in 2016. (World Health Organization, 2021). It is well known that obesity in children is connected with many health issues such as diabetes mellitus type 2, asthma, hypertension, psychosocial problems, early arteriosclerosis, etc. (Dikanović & Vignjević, 2009). Also, obesity negatively affects the motor efficiency of children (Han, Fu, Cobley, & Sanders, 2018) and their participation in physical activities in general (Lopes et al., 2012; Gentier et al., 2013; Spessato, Gabbard, Robinson, & Valentini, 2013).

That is why more and more papers deal with the correlation between BMI and motor skills in children (Graf et al., 2004; D'Hondt, Deforche, De Bourdeaudhuij, & Lenoir, 2009; Lubans, Morgan, Cliff, Barnett, & Okeli, 2010; Lopes et al., 2012). The studies confirmed that motor efficiency is connected with the BMI status, i.e. that excessively nourished children have a lower level of motor skills (Graf et al., 2004; Lubans et al., 2010; Cliff et al., 2012), although this still applies to gross motor skills. A small number of papers dealt with the connection between BMI and fine motor skills in the population of children, with some authors indicating that the BMI category does not affect the level of the fine motor skills (D'Hondt, Deforche, De Bourdeaudhuij, & Lenoir, 2008). However, research on fine motor skills in the obese children population is limited. Due to all the above, this research aims to determine the connection between fine motor skills and BMI of preschool children, as well as to determine the differences in the fine motor skills between the groups of normal weight and overweight children.

Methods

129 respondents, children aged five to six are participating

in this transversal research. The children attend preschool "Ljubica Vrebalov" in Pozarevac. The respondents are compared according to their sex and BMI categories according to WHO criteria. The criteria for inclusion and selection of the respondents were as follow: healthy children of both sexes, aged five to six, not included into any type of organized physical exercise. The research was conducted in accordance with the Declaration of Helsinki, which was approved by the Ethics Committee of the Faculty of Sports and Physical Education in Nis (number: 04-1186/2).

For measuring anthropometric characteristics standardized anthropometric instruments were used (GPM, Switzerland). Measurements were performed according to the established international procedures. Body mass index was calculated based on the standard formula: $BMI = TM(kg)/TV(m)^2$ (World Health Organization, 1995). Body mass index has a high correlation with the quantity of body fat and for that reason is used as an indicator of the children's obesity status (Jensen, Camargo, & Bergamaschi 2016). WHO cut-off points were used to assess (non)obesity status (World Health Organization, 2022).

Two subtests from the BOT-2 tests battery were used to assess fine motor skills (Bruininks-Oseretsky Test of Motor Proficiency). BOT-2 is used as a standardized measure of the level of physical abilities of children and adolescents from 4 to 21 years of age and the previous research in this area has shown that the BOT-2 test was quite valid (Abbas, Jaya Shanker, & Krishnan, 2011). For the purposes of this research, the subtests for fine motor integration (FMI) and manual dexterity (MD) were used, which together indicate the level of fine motor skills (FMS).

SPSS 19.0 software was used for statistical data processing and descriptive statistics results (mean and standard deviation) were presented for all data, while Pearson's correlation coefficient was used to determine the relationship between the variables, and a t-test for small independent samples was used to determine differences between groups, while the significance of interference was determined at the level of $p < .05$.

Results

Table 1 shows the results of descriptive statistics for the examined variables. Based on the results of girls and boys, it was determined that they can make up one group of respondents because there was no significant difference in the achieved results. The average values on the tests were standardized before data processing, and thus it was determined that they are within the normal range for the given age. When the subjects were divided into two groups, according to the BMI category (normal weight and overweight) it was found that there was a significant difference in manual dexterity (.046, $p < .05$) and the overall result of fine motor skills (.023, $p < .05$), while there is no

Table 1. Descriptive statistics and t-test for tested variables

Variables	Boys		Girls		Total		Normal (n=97)		Obese (n=32)		t-test
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p
FMI	13.47	3.58	12.91	4.57	13.17	4.14	13.44	4.21	12.34	3.84	.194
MD	12.05	3.71	11.17	4.78	11.57	4.33	12.02	4.25	10.21	4.33	.046*
FMS	25.52	5.71	23.97	7.37	24.68	6.68	25.48	6.44	22.25	6.89	.023*
BMI	15.89	1.98	16.30	2.61	16.11	2.35	15.08	1.25	19.25	2.09	.000**

Legend: FMI-fine motor integration, MD-manual dexterity, FMS-total fine motor skills, BMI-body mass index

significant difference in the results of fine motor integration.

Table 2 shows the result of the Pearson correlation coefficient. The results showed a significant negative correlation between

BMI and fine motor integration ($r = -.235$, $p < .001$), manual dexterity ($r = -.290$, $p < .001$), and the overall result of fine motor skills ($r = -.342$, $p < .001$).

Table 2. Correlation between variables

Variables		FMI	MSS	FMS
MD	r	.222*		
	p	.011		
FMS	r	.771**	.778**	
	p	.000	.000	
BMI	r	-.235**	-.290**	-.342**
	p	.007	.001	.000

Legend: FMI-fine motor integration, MD-manual dexterity, FMS-total fine motor skills, BMI-body mass index, *-The correlation is significant at the 0.05 level, **-The correlation is significant at the 0.01 level.

Discussion

This study aimed to determine the relationship between fine motor skills and BMI categories of preschool children, and also to establish differences in fine motor skills between the groups of normal weight and overweight preschool children. The results showed that in addition to the significant association between fine motor skills and BMI, Higher BMI negatively affects the fine motor skills of children, even in preschool age.

The results of this study are consistent with previous studies (Graf et al., 2004; D'Hondt et al., 2009) which showed that normal weight children had better results in motor efficiency tests than obese children. In the study of Marmeleira (Marmeleira, Veiga, Cansado, & Raimundo, 2017), in which children were divided into several groups according to their (non)obesity status, it was found that overweight and obese children have the worst motor performance. The reason for these results is the assumption that the excess weight prevents obese children from performing optimal movements because it is necessary to carry their weight and most of the excess weight must be moved against gravity during the tasks performed (Graf et al., 2004; D'Hondt et al., 2009; Castetbon & Andreyeva, 2012). Castetbon & Andreyeva (2012) point out that the relationship between motor skills and obesity varies depending on the type of motor skills. That is, motor skills are negatively associated with obesity only in those movements in which the excess weight of children directly complicates the performance of the task (Castetbon & Andreyeva 2012; Quka, Selenica, Quka, & Shore, 2019). Accordingly, Marmeleira et al. (2017) point out that the negative impact of being overweight is greater for gross motor skills, while they believe that fine motor skills are relatively independent of the limitations imposed by being overweight, which is not the case in our study.

When it comes to fine motor skills, the authors D'Hondt et al. (2009) found that obese children had poorer results in manual dexterity, which corresponds to our results. However, in our study, in addition to manual dexterity, obese children achieved significantly lower results in overall fine motor skills. In the study of D'Hondt et al. (2009) was found a significant negative correlation between BMI and visual-motor integration, and the analysis of differences showed that girls with low BMI values were significantly more advanced in fine motor performance, which is also in line with the results of our study in which negative correlation was accomplished between BMI and all parameters of fine motor skills of preschool children. Marmeleira et al. (2017) also established a negative relationship, but only between certain subtests results of motor skills (visual-motor integration) and BMI of preschoolers. In contrast, Castetbon & Andreyeva (2012) found that there was no significant association between obesity and fine motor skills in the population of children aged four to six, although this association was nevertheless confirmed at a later age. These insufficient and contradictory data point to the need for more complete research in this area. It should be noted that fine motor skills are not directly affected by the amount of excess weight involved in the

movement, so it is not enough to explain the differences between BMI groups. Therefore, some authors suggest that there may be a deficit in the integration and processing of sensory information in obese children (Marmeleira et al., 2017). However, this relationship between perceptual-motor functioning and obesity in children needs to be further investigated. Prevention of fine motor skills violation in early childhood is important so that all children have the same chance of successful development (Castetbon & Andreyeva, 2012). Some authors emphasize that in addition to gross motor skills, children must also develop fine motor skills because integral motor development is necessary for the later development of more complex and specialized movements so that children can competently participate in various physical activities and sports (Quka, Selenica, Quka, & Shore, 2019). It should be added that fine motor skills have a positive effect on the sensorimotor development of the nervous system (Ivković i sar., 2004), so special attention should be paid to its development during the entire period of childhood.

The limitations of our study are reflected in the small sample of respondents, as well as the fact that due to the small sample size, they could not be divided into several categories in relation to BMI, but only into two groups: normal weight and overweight children. In relation to the mentioned limitations, the proposal for further research would be to conduct a study on a larger sample of respondents, as well as to divide the sample according to the (non)obesity status into underweight, normal weight, overweight and obese children. Also, the fine motor skills of children should be examined with the help of several parameters. Such research could give a detailed insight into the level of fine motor skills in relation to different BMI categories of preschool children.

Conclusion

Overweight children have lower scores on fine motor skills tests than normal weight children, which can have consequences on motor development in later life, so it is recommended to implement various activities and programs for their development at an early age, for prevention.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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