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The role of muscle and fat mass in the expression of explosive power in preschool children

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Abstract

Introduction: Motor development, motor abilities, and physical fitness level in children are potent biomarkers of health from an early age. In order to assess motor abilities and physical fitness in young children practical and easy-to-perform tests are necessary. Explosive power is defined as the ability to perform the maximum effort in a minimum amount of time. Body composition has a significant impact on motor skills and consequently on motor development and health status. With this research we want to find out what the role is a muscle and fat mass in the expression of explosive power in preschool children according to their body weight status. *Methods:* A causal non-experimental method was used to obtain the data. The sample consists of 5-6-year-old children of both genders (N=75), divided into three groups based on body mass index (WHO BMI for age 5-19 years) – Normalweight (N=54), Overweight (N=5) and Obesity (N=16). The explosive power of the legs was measured with the motor test long jump from the site and the motor test counter movement jump tests on the ARS balance plate. Muscle and fat mass were measured with a Tanita DC 430-MA body composition analyzer. ANOVA (Eta squared / Effect Size) was used to compare results between groups and Pearson correlation for differences between groups. *Results:* Children in the Normalweight group achieved the best results on explosive power tests, and children in the Obesity group achieved the worst results. However, the differences between the groups are not statistically significant ($p > 0.05$). *Discussion and conclusions:* Reducing the proportion of fat mass in the body and increasing the proportion of muscle mass in the preschool period is important for well-developed explosive power. Children need to be offered enough exercise and sports activities, including jumping and running.

Keywords: muscle mass, fat mass, explosive power, preschool children

Introduction

Physical fitness is an indicator of health in youth and is related to later body composition in preschool age (Henriksson et al., 2019). The obesity epidemic, at one time confined to adults, has now penetrated the pediatric age range and shows every sign of a rapid escalation (McCarthy et al., 2006). Studies examining the association of health-related physical fitness and total and central body fat in a population of preschool children as young as 3 to 5 years old are scarce and mainly measured by one fitness test. Research data Martinez-Tellez et al. (2016) shows that excess body fat in preschool children results in poorer performance on all tests that require bodyweight movement. Explosive power is the ability to activate the maximum number of movement units in the shortest possible time, it appears as the maximum initial acceleration when moving the body in space (Pistotnik, 2011). It is characterized by the rapid production of a large amount of muscle power in a very short time. It manifests itself mainly in acyclic movement types of jumping, throws and kicks, and in short sprints (Pistotnik et al., 2002). Direct online control of movement is not possible without fast, explosive and instantaneous movements. This is done on the basis of sensory information at different levels: spinal cord, brain stem, subcortical centers and sensory-motor centers in the cerebral cortex. For preschool children engaged in an additional form of organized physical activity, the influence of morphological characteristics on the expression of strength is less obvious compared to children who do not have organized additional physical activity, primarily due to the reduction of subcutaneous fat and body mass as disruptive factors (Sadri et al., 2014). Appropriately designed and controlled strength training is safe for children, contributes to increasing muscle strength, better performance of other sports movements and reduces susceptibility to injuries. Such a method also improves the general health status of the child and has a positive effect on the psychosocial component of the child (Škof, 2016).

Methods

A causal non-experimental method was used to obtain the data. The sample consisted of 5-6-year-old children of both genders (N=75), divided into three groups based on body mass index (WHO BMI for age 5-19 years) – Normalweight (N=54), Overweight (N=5) and Obese (N=16). The number of children in each BMI group was not balanced. The explosive power of the legs was measured with two motor tests – a long jump from the site and counter movement jump tests on the ARS force plate. Muscle and fat mass were measured with a Tanita DC 430-MA body composition analyzer. 1-way analysis of variance (ANOVA) with eta squared values for effect size, was used to compare the results between groups and Pearson correlation was used for assessing relationship between outcome variables.

The values of fat and muscle mass represent the independent variables. Explosive power, expressed as the average Z-value of the two motor tests, represents the dependent variable.

Results

The results of the research show descriptive data of variables, differences between BMI groups and the correlation of Explosive Power with fat and muscle mass.

Table 1: Descriptive statistic and ANOVA (according to the BMI rang) of motor tests results and body composites data

	BMI rang				
	Normalweight N=54	*Overweight N=5*	*Obesity N=16*	*p*	*η^2*
CMJ/Hft [m]	0,110	0,068	0,100	0,331	0,030
LJS [m]	1,073	1,120	1,062	0,847	0,005
FATp [%]	16,87	20,26	27,66	0,000	0,590
FATm [kg]	3,59	4,66	8,22	0,000	0,590
MUSCp [%]	77,81	63,10	68,36	0,000	0,249
MUSCm [kg]	16,39	17,42	19,69	0,000	0,266
ExPower [Z-Value]	0,038	-0,181	-0,073	0,787	0,007

CMJ/Hft - counter movement jump/jump height; LJS - long jump from the site; FATp - Fat percent; FATm - Fat mass; MUSCp – Muscle percent; MUSCm - Muscle mass; ExPower – average Z-Value of CMJ and LJS test results; p - Sig.; η2 - Eta-squared (ANOVA Effect Size)

The best results on the CMJ height test and in overall explosive power scores were achieved by children in the Normalweight group, and the best result on the long jump test was achieved by children of the Overweight group. Children in the Obesity group achieved the worst result on the long jump test and in overall explosive power (Table 1). Differences between BMI groups are not statistically significant ($p > 0.05$). Eta Squared indicates a medium effect for the CMJ height ($\eta^2 < 0.01$) and small effect for long jump test and overall explosive power ($\eta^2 < 0.01$).

Table 2: Correlation of Explosive Power with fat and muscle mass

		FATm	*FATp*	*MUSCm*	*MUSCp*
Normal weight (N=54)	r	0,030	-0,032	0,065	-0,091
	p	0,832	0,819	0,640	0,515
Overweight (N=5)	r	0,609	-0,102	0,794	0,185
	p	0,275	0,870	0,109	0,766
Obesity (N=16)	r	-0,133	-0,093	-0,052	0,079
	p	0,624	0,731	0,849	0,770

r – Pearson correlation coefficient; p - Sig. (2-tailed)

In the Normal_weight group (Table 2) was detected a low degree of correlation between explosive power and muscle and fat mass (r <0.29). In the Overweight group was detected a high degree of correlation between explosive strength and muscle and fat mass (r > 0.50), except for fat mass percentage, there is a low negative correlation (r = -0.102). In the Obesity group was detected a low degree of correlation between explosive power and muscle and fat mass (r <0.29). In all BMI groups, the correlation of explosive strength with muscle and fat mass is not statistically significant (p >0.05).

Discussion

The findings of our research are consistent with the findings of the research conducted by Matarma et al. (2018). Healthy-weight children had higher scores in strength and agility compared to overweight or obese children. Moreover, in a study by Reeves et al. (1999) higher body fat as measured by skinfolds in preschool children was associated with worse half-mile running time. Also, Henriksson et al. (2016) in their research found that in four-year-old children, body fat percentage was associated with a worse performance in the 20 m shuttle run, standing long jump and 4 x 10 m shuttle run tests.

Carnevale Pellino et al. (2020) investigated the difference between the sexes and reported that boys did not significantly increase their performance while growing up, while girls did improve their performance. Sadri et al. (2014) also found the same. In our study, possibly due to the small sample size, we did not detect gender differences.

Conclusions

Reducing the proportion of fat mass in the body and increasing the proportion of muscle mass in the preschool period is important for well-developed explosive power. Improvements in lower body muscle strength over the 12-month follow-up period are associated with decreases in body fat mass index and body fat percentage (Henriksson et al., 2019).

For the development of explosive power and consequently for good physical health it is necessary to offer children enough physical and sports activities, which include jumping and running, already in the pre-school period.

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