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PHYSICAL FITNESS IN PRESCHOOLERS ACCORDING TO BODY COMPOSITION

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ABSTRACT

The objective of this study was to investigate physical fitness of preschool-aged children just before entering school according to their body mass index, and to examine possible associations of body mass index, fat mass and fat-free mass with physical fitness in preschool-aged children. Two hundred and fifty-six preschoolers aged 6 to 7 years participated in the study. Physical fitness was assessed using PREFIT test battery and body composition was estimated using four skinfold thickness parameters. Overweight children had lower cardiorespiratory fitness and lower results in all weight-bearing fitness tests, and better handgrip strength test result in comparison with normal-weight children. Significant associations were found between body composition indices and the results of physical fitness tests. Higher BMI associated negatively with weight-bearing physical fitness tests. The results of the research indicate that weight-status and body composition have significant effect on physical fitness in 6–7 years old preschoolers.

***Keywords**: preschoolers, physical fitness, body composition, body mass*

INTRODUCTION

Over the past two decades, the global prevalence of overweight and obesity in preschool children has risen sharply [7]. Maintaining a healthy weight in childhood is particularly important given that childhood overweight and obesity can be detrimental towards physical, psychological, and social development [7]. Childhood obesity is a serious public health problem globally [22], and is accompanied with high body fatness, which may have a negative impact on physical fitness [21].

Physical fitness has been considered a powerful marker of health in children and adolescents [12, 16]. Sufficient fitness level in childhood is needed to carry forward favourable behavioural and biological effects into later life [12]. However, the reported level of physical activity (PA) and physical fitness of children has decreased during the last decades [5]. In addition, physical fitness, adiposity and the distribution of body fat during childhood have shown a high correlation with cardiovascular health in adulthood [8].

In preschool children, the level of physical activity is associated to improvements in heart abilities and aerobic capacity, consequently being a determinant of cardiovascular risk. Likewise, high levels of aerobic performance and motor coordination are strong predictors of physical activity during childhood [2, 9].

Subjects with high physical fitness during adolescence may have lower levels of body fatness as adults. In contrast, low levels of physical fitness in children are associated with a number of risk factors such as hypertension, hyperlipidaemia, and obesity [19].

The aim of this study was to determine the physical fitness in preschool children aged 6–7 years, discriminating performance by BMI.

METHODS

Participants

The study sample consisted of 13 randomly chosen kindergartens from Tartu, Estonia. All parents of the children from the last preschool year groups of selected kindergartens received written information about the study, whereas 284 children with parents agreed to participate. Anthropometrical measurements and physical fitness indicators were obtained from 256 children (132 boys and 124 girls). Written informed consents were obtained from the parents of all participants. The study was approved by approval 254/T-16, Medical Ethics Committee of the University of Tartu, Tartu, Estonia.

Procedures

Anthropometric measurements were carried out in the kindergarten settings. Assessment of body size and composition were performed as described elsewhere [15]. Body height, weight and fatness indices were examined. Age-adjusted body mass index (BMI) cut-off points were used to define over-

weight and obese subjects [4]. Fat mass (FM) and fat free mass (FFM) were calculated [15].

Physical fitness was tested using five tests within the PREFIT fitness test battery: 20-m shuttle run test for cardiorespiratory fitness, handgrip strength test for upper body muscular strength, standing long jump test for lower body muscular strength, 4×10-m shuttle run test for motor fitness, modified Flamingo test was used to assess balance [13]. All tests were applied twice and the best values of two attempts were used in the analyses, except the 20-m shuttle run test that was only conducted once [3]. The details of the procedures for the physical fitness tests have been described previously [3].

Statistical analysis

Data analysis was made using the SPSS version 20.0 for Windows (SPSS, Inc., Chicago, IL, USA). Descriptive statistics are presented as mean and standard deviations. All variables were checked for normality before the analysis. Group differences between means were analysed with independent t-test. Effect size (ES) was calculated and considered to be small if ES > 0.2, moderate if ES > 0.5 or large if ES > 0.8 [18]. Multiple linear regression models were used to examine the independent associations of body composition (BMI, FM, FFM) values with physical fitness indices (20 m shuttle run, 4x10 m shuttle run, standing long jump, handgrip strength, balance test). Two regression models were used: unadjusted model (Model 1) and model adjusted for age and gender of the child (Model 2). Significance was set at $p<0.05$.

RESULTS

Descriptive data of participants are demonstrated in Table 1. Normal weight and overweight children differed according all measured parameters ($p<0.05$) except the age (Table 1). From all participated children, 16% were classified as overweight, among these 17% of boys and 15% of girls. The magnitude of differences was higher in body composition parameters as compared with physical fitness indices (Table 1).

Table 1. Descriptive data of study participants.

	Normal-weight (n=215)	Overweight (n=41)	Whole sample (n=256)	Effect size
Age (yrs)	6.6±0.5	6.6 ±0.5	6.63 ±0.5	
Height (m)	1.24±0.05	1.29±0.04*	1.25± 0.05	1.1
Weight (kg)	23.9±3	31.9±3.4*	25.2± 4.2	2.5
BMI (kg/m^2)	15.4±1.0	19.3±1.5*	16.0±1.8	3
Fat percent	19.7±3.5	26.6±4.8*	20.8±4.5	1.6
Fat mass (kg)	4.7±1.1	8.6±2.7*	5.4±2.0	1.9
FFM (kg)	19.2±2.4	23.3±2.1*	19.9±2.8	1.7
20m shuttle run (laps)	19.5±10	14.7±6*	18.9±9.7	0.6
4x10m shuttle run (s)	15.19±1.5	16.04±4.2*	15.32±2.16	0.3
Standing long jump (cm)	123.5±16.7	113±18.1*	122.0±17.3	0.6
Handgrip strength (kg)	10.5±2.1	12.2±2.1*	10.9±2.1	0.8
Balance test (s)	22.5±11.3	18.1±8.4 *	22.0±11.2	0.44

$p<0.05$ as compared with normal-weight children
BMI – body mass index; FFM – fat free mass

Associations between body composition values and physical fitness are shown in Table 2. Both in adjusted and unadjusted models, each unit (kg/m^2) increase in BMI was associated with a 0.34 kg increase in handgrip strength and decrease in the result of 20 m shuttle run by 0.2 laps. Negative association was also found between BMI and standing long jump in unadjusted model and after adjustment with age and gender (Table 2). Increase in BMI by one unit was associated with the lower result in standing long jump by 0.18 cm. FM was negatively associated with the 20 m shuttle run and standing long jump results in unadjusted model and after adjustment with age and gender (Table 2). Similarly, to BMI, each unit of FM weakened the result of 20 m shuttle run by 0.2 laps. Negative association was found between balance test result and BMI, FFM and FM values in both models analysed (Table 2).

Table 2. Associations of physical fitness and physical activity with body composition values.

	BMI			FFM			FM		
	r^2	β	p	r^2	β	p	r^2	β	p
20 m shuttle run									
Model 1	0.042	–0.204	0.003	0.006	–0.077	0.274	0.048	–0.220	0.001
Model 2	0.048	–0.219	0.015	0.092	–0.119	<0.001	0.049	–0.216	0.017
4x10 m shuttle run									
Model 1	0.013	0.115	0.087	0.001	–0.033	0.630	0.017	0.132	0.055
Model 2	0.016	0.124	0.324	0.070	0.017	0.002	0.020	0.124	0.246
Standing long jump									
Model 1	0.013	–0.176	0.009	0.017	0.129	0.062	0.044	–0.210	0.002
Model 2	0.034	–0.189	0.055	0.071	0.081	0.002	0.045	–0.203	0.023
Hand grip strength									
Model 1	0.117	0.342	<0.001	0.380	0.616	<0.001	0.091	0.302	<0.001
Model2	0.119	0.349	<0.001	0.398	0.589	<0.001	0.111	0.332	<0.001
Balance test									
Model 1	0.035	–0.187	0.05	0.013	–0.114	0.098	0.067	–0.258	<0.001
Model 2	0.037	–0.193	0.042	0.086	–0.131	<0.001	0.074	–0.256	0.001

Model 1– unadjusted; Model 2 – adjusted with age and gender
FM – fat mass; FFM – fat free mass; BMI – body mass index; FFM – fat free mass

DISCUSSION

The aim of present study was to investigate physical fitness of preschoolers according to their weight status and to examine possible associations of BMI, FM and FFM with physical fitness. In childhood and adolescence, fitness testing is feasible, reliable and related to later health [3]. To our knowledge, similar studies performed with 6–7-year-old preschool-aged children just before entering school are scarce. Recent studies have been carried out with younger [5] or elder [19] children. The results of the study confirm that differences occurred between normal-weight and over-weight children in all physical fitness tests performed. Moreover, the other authors [9] indicated also that BMI-group-related differences in physical fitness can already

be present in preschool-age children. Accordingly, Vameghi et al. [20] suggested that both overweight and obese children have lower performance in fitness tests than normal-weight children [20] Otherwise, in the study with Spain pre-schoolers, BMI did not correlate with physical fitness [8].

It has been consistently reported that a low level of cardiorespiratory fitness and muscular strength in children are associated with low bone mass, metabolic risk factors, cardiovascular diseases and premature mortality later in life [17]. Accordingly, the assessment of physical fitness in children is relevant from a public health point of view. Existent evidence refers primarily adolescents with few information about fitness and health in 6–7-years old preschoolers [6]. There is no reason to believe that fitness is less important in preschoolers than in older children [3]. The PREFIT battery is feasible and reliable to assess physical fitness in preschoolers [3].

The negative impact of obesity on physical fitness has been documented in youth. Previous studies show that there are inverse relationships between physical fitness and overweight [14]. Thus, the participants of our study were divided as normal-weight and over-weight to find out the possible associations between body composition and physical fitness. Seventeen percents of our preschoolers were overweight or obese. In a recent survey with European children nearly 27% of 6–6.9-years old preschoolers were overweight or obese [1]. Almost third (30%) of Estonian 7–8-years old children were classified to be overweight in a recent study [15]. Thereafter the prevalence of obesity in present study is lower than that detected in Europe in preschool children [1] and in Estonian primary school children [15]. It is not surprising that overweight children had significantly higher BMI values in our study. However, it is important to emphasize that BMI reflects both the FM and the FFM in the body, which may have different associations with physical fitness [6]. This opinion could explain the negative association between FFM and results of 20m shuttle run and 4x10m shuttle run in present study. Higher value of FFM was associated with better performance in standing long jump and handgrip strength, which are the indices of lower and upper body muscular strength, but not with 20 m shuttle run and 4×10 m shuttle run, which reflect cardiorespiratory and motor fitness. The weaker results of over-weight children in weight bearing physical fitness tests have also been suggested in several other recent studies [3,10]. A higher BMI and FM have also consistently been associated with a lower cardiorespiratory fitness in children [11,21]. It could be assumed that overweight children avoid strenuous weight-bearing physical activities like running and prefer light physical activities. Overweight children had expectedly better results in handgrip strength, which is also reported in previous studies in preschoolers

[6, 15]. In the present study both higher BMI and FM weakened the results of weight-bearing physical fitness tests.

A limitation of the present study is its cross-sectional design, so caution must be applied when interpreting the observed associations. However, the strengths of our study include a relatively homogenous sample of children analysed at the last kindergarten year and the use of reliable physical fitness tests in preschool children.

In conclusion, associations between physical fitness, body weight status and body composition exist already in 6–7-years old children. Normal-weight children exceed their over-weight peers in weight-bearing fitness tests. Attention should be paid to physical fitness of preschool age to ensure the healthy lifestyle habits. The improvements in physical fitness performance through the promotion of physical activity could be beneficial for the health of preschool children, particularly in obesity prevention. Increasing the amount of time devoted to physical education can improve the physical fitness and health of preschool children.

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