PECULIARITIES OF PHYSICAL FITNESS AND BODY COMPOSITION OF 5—7 YEAR-OLD CHILDREN OF SEVERAL KAUNAS PRESCHOOLS AND INTERACTION BETWEEN THOSE INDEXES

Sandrija Čapkauskienė, Kristina Visagurskienė, Rima Bakienė, Irena Vitkienė, Daiva Vizbaraitė
Lithuanian Academy of Physical Education, Kaunas, Lithuania

Sandrija Čapkauskienė. PhD in Biomedical Sciences, lecturer at the Department of Applied Physiology and Physical Therapy, Lithuanian Academy of Physical Education. Research interests — the influence of physical activity on functional and morfological health indexes.

ABSTRACT

Childhood obesity is a key public health issue around the globe in developed and developing countries (Dugan, 2008). The recent worldwide increase in the prevalence of childhood obesity may be due in part to a decrease in children's physical activity levels (Ball et al., 2001). It is necessary to develop early interventions to improve physical fitness in children and to prevent the increase of childhood obesity (Brunet et al., 2006). So, the aim of this study was to evaluate the body composition and physical fitness of children aged 5—7 years and to estimate the interaction between body composition components and physical fitness tests.

Participants: 216 children participated in this study: 104 girls, mean age 5.90 ± 0.63 years and 112 boys — mean age 5.98 ± 0.50 years from Kaunas city (Lithuania) preschools. Methods: all the subjects have been measured for their height, body mass, waist circumference (WC) and skinfolds at 2 different places — triceps and subscapular. Body mass index (BMI) and percentage body fat mass (BFM) were evaluated. All the participants did four physical fitness tests including speed shuttle run, 20 meters distance run, standing long jump and throwing 1 kg ball. General physical fitness level was evaluated based on B. Sekita (1988) methods.

Results. Results showed that BMI did not significantly differ between boys and girls, and was evaluated as "optimal" for both groups. BFM was significantly higher in girls (p < 0.001), and WC did not differ between genders. But WC had a tendency to increase with age in both boys and girls. Strong relationship was observed between BMI and BFM (r = 0.660, r = 0.660 respectively; p < 0.01), and between BMI and WC (r = 0.703, r = 0.826 respectively; p < 0.01) for both boys and girls. The results of physical tests showed that boys did all the tests better than girls (p < 0.01). When we evaluated the general physical fitness of each child, the results indicated that their physical fitness was low, evaluated as "good enough" for most boys and girls. General physical fitness of children negatively but slightly correlated with BFM (r = –0.201; p < 0.001), it indicated that higher BFM determined lower evaluation of general physical fitness.

Conclusions. Optimal body weight, according to body mass index, percentage body fat mass and waist circumference, was established for the bigger part of children, aged 5—7 years old. This study shows that physical fitness of children was low — evaluated as "good enough" and negatively correlated with body fat mass, showing that high body fat mass negatively impacted physical fitness.

Key words: *body mass index, percentage body fat mass, waist circumference, physical fitness.*

INTRODUCTION

Overweight in children and adolescents represents an uncontrolled, worldwide epidemic (Flodmark et al., 2004). Even in developing countries, the rates of overweight and obesity are increasing rapidly (Guillaume et al., 2002). The recent worldwide increase in the prevalence of childhood obesity may be due in part to a decrease in children's physical activity levels (Ball et al., 2001).

The first paper on body mass index, overweight and obesity from this survey was published in 2004 by I. Lissau et al. (2004). This scientist collected information of height and weight data from 15 countries, including Lithuania, and on their basis a reference standard of overweight and obesity was calculated as the 85th and 95th centiles. The results showed that among the Nordic and Baltic countries, Lithuania and Denmark have the lowest

rates on overweight and obesity. (Lissau et al., 2004). Lithuanian professor J. Tutkuviene (2005) collected, analyzed and published the data of 2000—2004 years research period, which showed that BMI of Lithuanian children had even decreased in the period of 10—15 years. She noticed, that when children and juvenile's height acceleration became lower, the overweight continued to rise (Tutkuviene, 2006). So, it is necessary to develop early interventions to improve physical fitness in children and to prevent the increase of childhood obesity (Brunet et al., 2006).

Thus, the aim of this study was to evaluate the physical fitness of children aged 5—7 years and to estimate the interaction between body composition components and physical fitness tests. We wanted to know if there was a tendency in preschool children's overweight. If it is so, how it interacted with preschool children's anthropometric data and physical fitness.

METHODS

Subjects. 216 children: 104 girls (mean age 5.90 ± 0.63 years) and 112 boys (mean age 5.98 ± 0.50 years) from Kaunas city (Lithuania) preschools participated in this study to assess the peculiarities of their physical fitness. The research was done in eleven preschools in Kaunas city by two researchers. The children were selected for the experiment depending on their age (from 5 to 6 years old) and the agreement of their parents (only those children participated in the research, whose parents' agreements had been received). The experiment was performed in spring and in early autumn of 2007.

Anthropometric measurements. Anthropometric measurements were made before the physical tests. All the subjects were measured: 1. for their **height** (cm) — standing children were measured undressed and unshod to with the stadiometer, keeping the shoulders in a relaxed position and the arms hanging free. 2. **Body mass** (kg) — standing weight was measured undressed and unshod in the minimum clothing possible. Body mass of all the participants was measured by the same electronic scale. 3. **Body mass index** (BMI) (kg / m^2) was calculated by dividing weight (kg) by height squared (m^2). Children were categorized into non-overweight, overweight and obese categories according to the World Health Organization (2006) gender and age-specific cut-off points. 4. **Waist circumference** (WC) — directly with a tape-measure at a level midway between the lower rib margin and iliac crest with the tape all around the body in horizontal position. Children were measured undressed and unshod. WC was evaluated based on McCarthy et al. (2001) method.

5. **Percentage body fat mass** (BFM) was evaluated by measuring skinfold at 2 different places for children using a formula from the internet site http://www.health-calc.com/body-composition/skinfold-children, which was deviced according to M. H. Slaughter et al. (1988), K. R. Boye et al. (2002) and N. Wedderkopp et al. (2004). Measurements of two skinfolds — triceps and subscapular — were made on the right hand side of the body using a Harpenden caliper — in millimeters and using the average of the 3 readings. BFM (Lohman, 1987) was used to classify levels of body fatness for children.

All the anthropometrical measurements were made two times, and the average of the results were chosen.

Physical tests. Physical fitness of children was assessed using: 1. Sleight test (s) — speed
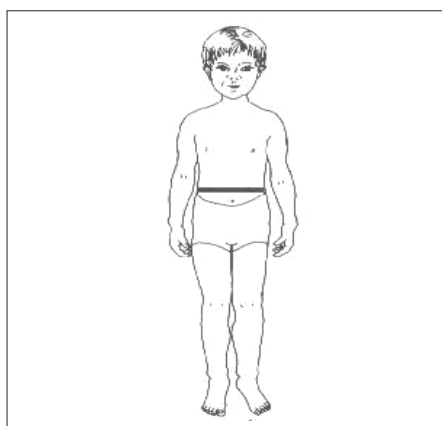

Figure 1. **Tape position for measuring waist circumference (Moreno et al., 1999; McCarthy et al., 2001; Freedman et al., 2004)**
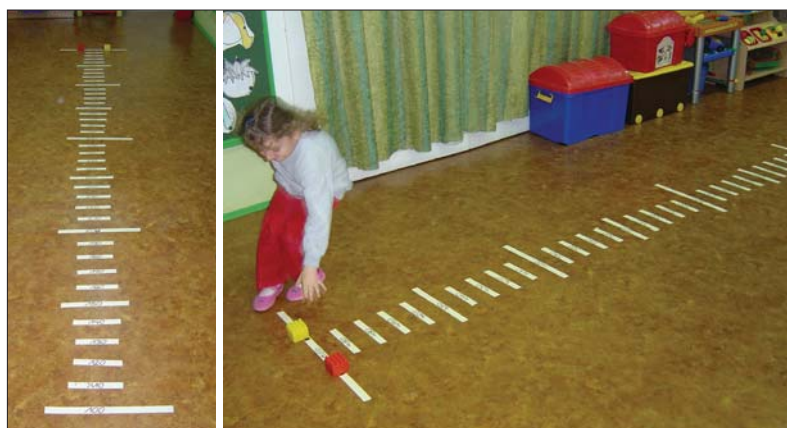
Figure 2. **Sleight test (s) — 5 meters × 4 shuttle-running**

Figure 3. **Force test (cm) — standing long jumping**

Figure 4. **Power test (cm) — throwing 1 kg ball**

5 meters × 4 shuttle running (Figure 2); 2. Quickness test (s) — 20 meters running. 3. Force test (cm) — standing long jump (Figure 3); 4. Power test (cm) — throwing 1 kg ball into the distance from behind the head (Figure 4). Children did the all physical tests indoors, except for 20 meters running, which was done outdoors, in the morning, before 12 p.m., Physical tests were done two (20 meters running and shuttle running) — three times, and the best result was chosen. Every test gave certain points, and after all 4 tests, every child had some points. Using the whole sum of points and according to the physical fitness evaluation charts, deviced by a Polish scientist B. Sekita (1988) we estimated the physical fitness of children.

Statistics. Descriptive data are presented as mean ± SD. To check the hypothesis of the quantitative variables Student's t-test was used. The groups (boys and girls) were compared by a one-way analysis of variances (ANOVA). Pearson's correlation coefficient was used for the quantitative values. Statistical significance was set at $p < 0.05$.

RESULTS

Body composition. The physical characteristics of the total group and of boys and girls separately are shown in Table 1. Boys were not significantly different from girls with respect to weight, height, BMI. However, as expected, BFM was significantly higher in girls ($p < 0.05$).

BMI, BFM and WC percentage characteristics of the total group and of boys and girls separately according to the children's body composition are shown in Table 2.

Summarizing the evolution of BMI during the period of age of 5, 6 and 7 years in both gender groups, definition of BMI above 85 percentile for both genders showed risk of obesity (overweight), BMI values above 95 percentile showed too big weight (obesity) (Cole, 2000; Kuczmarski, Flegal, 2000; Reilly, 2006).

The prevalence of being overweight and obese in the group of boys aged 5—7 years was 15.2 and 12.5%, in the group of girls of the same age it was 9.6 and 10.6%.

BFM was calculated by means of subscapular and triceps skinfolds measurement values. BFM data showed that this index for girls was significantly higher than for boys ($p < 0.001$). According to the percentage body fat chart by T. G. Lohman (1987), BFM was evaluated as an optimal range for 66.3% of girls and for 67.9% of boys. BFM was defined as high for 14.4% of girls and for 17.8% of boys.

WC between genders did not differ, but it had a tendency to increase with age in both girls and boys. WC at 90 percentile for both genders showed overweight (McCarthy et al., 2001). 4.8% of girls and 8.0% boys had WC values higher than 90th percentile. WC at 95 percentile for both genders showed obesity (McCarthy et al., 2001). So, our obtained results showed obesity for 9.6% of girls and 8.9% boys, because they had WC values higher than 95th percentile (Table 2).

Strong relationship was observed between BMI and BFM ($r = 0.661$; $p < 0.01$), and between BMI and WC ($r = 0.781$; $p < 0.01$), as well as between BMI and BFM ($r = 0.660$; $r = 0.660$ respectively; $p < 0.01$), and between BMI and WC ($r = 0.703$, $r = 0.826$ respectively; $p < 0.01$) for both boys and girls.

BMI also highly correlated with weight ($r = 0.854$; $p < 0.01$), but it was slightly related to height ($r = 0.232$; $p < 0.01$). High correlation was also found between BMI and subscapular and triceps skinfolds ($r = 0.702$, $r = 0.574$; $p < 0.01$).

PFM strongly correlated with weight ($r = 0.595$; $p < 0.01$), with WC ($r = 0.631$; $p < 0.01$), and

Table 1. **Characteristics of subject**

Indexes	Girls	Boys	Significance
n	104	112	
Age, y	5.90 ± 0.63	5.98 ± 0.50	—
Height, cm	118.0 ± 5.16	119.30 ± 5.33	—
Weight, kg	22.07 ± 4.01	22.57 ± 3.52	—
BMI, kg / m^2	15.76 ± 2.03	15.79 ± 1.73	—
Subscapular skinfold, mm	7.81 ± 3.83	6.44 ± 2.49	p < 0.05
Triceps skinfold, mm	12.87 ± 4.06	10.69 ± 3.03	p < 0.01
BFM, %	18.73 ± 4.71	16.53 ± 4.39	p < 0.001
WC, cm	52.63 ± 4.48	53.13 ± 4.13	—

Note. All values are x ± SD; S — sex.

Table 2. **BMI, BFM and WC percentage (%) characteristics**

Baseline	Low weight		Optimal weight		Overweight		Obese	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
BMI, kg / m^2	20.2	16.1	59.6	56.2	9.6	15.2	10.6	12.5
WC, cm	12.6	13.5	73	69.6	4.8	8.0	9.6	8.9
BFM, %	19.2	14.3	66.3	67.9	—	—	14.4	17.8

Note. BMI was evaluated according to Cole (2000); Kuczmarski and Flegal (2000); Reilly (2006). BFM was evaluated according to Lohman (1987). WC was evaluated according to McCarthy et al. (2001).

with subscapular and triceps skinfolds (r = 0.841, r = 0.937; p < 0.01).

WC had high correlation with weight and height (r = 0.831, r = 0.479; p < 0.01), and with subscapular and triceps skinfolds (r = 0.683, r = 0.541; p < 0.01).

Physical fitness. The results showed that the boys did all the tests — 20 meters running, shuttle running, jumping and throwing the ball — better than the girls (p < 0.01), but when we evaluated the general physical fitness (Sekita, 1988) of each child, the results indicated that physical fitness was evaluated as "good enough" for both genders — 54.5% for boys and 48.1% for girls (p > 0.05). Only 5.4% of boys and 3.8% of girls have a "high" level evaluation of physical fitness (p > 0.05). There was no significant difference in the physical fitness level (between the points received) between the boys (179.32 ± 35.25 points) and the girls (187.86 ± 33.91 points). General physical fitness based on the points received was evaluated as "good enough" for the boys and for the girls.

We found some significant interaction between body composition components and physical fitness tests. 20 meters running and shuttle running tests negatively and slightly correlated with height (r = –0.211 and r = –0.253; p < 0.001), showing that as body height increased, run performance times were slower. Correlation between 20 meters running and shuttle running tests and BFM was positive but also slight (r = 0.225; p < 0.001 and r = 0.154; p < 0.05).

Force test slightly correlated with height (r = 0.200; p < 0.001), and negative correlation was found with BFM (r = –0.232; p < 0.001).

Power test slightly correlated with weight and height (r = 0.353 and r = 0.434; p < 0.001). Slight interaction was found between power test and BMI (r = 0.177; p < 0.001), and with WC (r = 0.283; p < 0.001), too.

General physical fitness of children negatively but slightly correlated with BFM (r = –0.201; p < 0.001), and it indicated that higher BFM determined lower evaluation of general physical fitness.
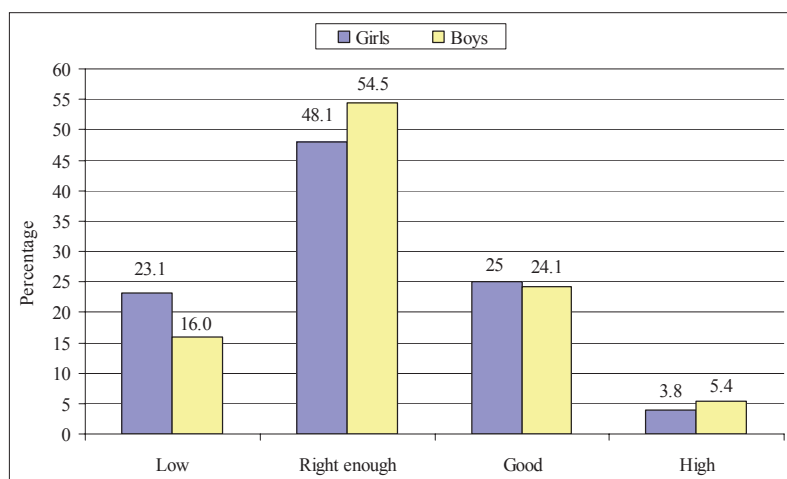

Figure 5. **Percentage distribution of physical fitness level among the girls and the boys**

Note. Physical fitness level was evaluated according B. Sekita (1988).

We also examined interaction between physical fitness and body composition components separately for boys and for girls: Among the girls — 20 meter running test results slightly correlated with BMI (r = 0.259; p < 0.001) and BFM (r = 0.262; p < 0.001). Shuttle running negatively correlated with height (r = −0.248; p < 0.001). Force test negatively correlated with BMI (r = −0.326; p < 0.001), BFM (r = −0.359; p < 0.001) and WC (r = −0.297; p < 0.001). Power test significantly correlated only with height (r = 0.397; p < 0.001) and weight (r = 0.226; p < 0.05). The general fitness level of girls negatively correlated with body composition components as BMI (r = −0.203; p < 0.001), PFM (r = −0.322; p < 0.001) and WC (r = −0.237; p < 0.001). It showed that when the BMI, BFM and WC values increased, the general fitness level of a child became worse. Also, the general fitness level of girls showed negative correlation with running test results (r = −0.693 and r = −0.594; p < 0.001), positive and strong correlation with force (r = 0.691; p < 0.001) and with power tests (r = 0.464; p < 0.001).

Among the boys — 20 meters running test slightly and negatively correlated with height (r = −0.275; p < 0.001) and positively with BFM (r = 0.204; p < 0.05). Shuttle running test also negatively correlated with height (r = −0.216; p < 0.001) as among the girls, too. Force test positively correlated with height (r = 0.252; p < 0.001), weight (r = 0.235; p < 0.05) and WC (r = 0.202; p < 0.05). Power test positively correlated with height (r = 0.441; p < 0.001), weight (r = 0.460; p < 0.001), BMI (r = 0.288; p < 0.001) and WC (r = 0.373; p < 0.001). The general fitness level of boys slightly correlated with such body composition components as height (r = 0.257; p < 0.001) and weight (r = 0.253; p < 0.001). Also, the general fitness level of boys showed negative correlation with running tests (r = −0.536 and r = −0.519; p < 0.001), positive and strong correlation with force (r = 0.663; p < 0.001) and with power tests (r = 0.604; p < 0.001).

DISCUSSION

Results obtained from our study showed that:
1. Body composition indexes were optimal for a bigger part of children aged 5—7 years.
2. We found an interaction between the indexes of physical fitness and body composition.

We examined several important indexes of body composition — body mass index, percentage body fat mass and waist circumference in children aged 5—7 years. We found that children aged 5—7 years were not overweight because many participants had an optimal body mass index — 60.6% of girls and 56.3% of boys, normal percentage body fat mass — 66.3% girls and for 67.9% boys, and an optimal value of waist circumference — 73% of girls and 69.6% of boys. The highest prevalence of optimal body composition, and the lowest prevalence of overweight and obesity among the children was assessed by waist circumference values. We set a great store on all the indexes. Foreign scientists also discussed about the priority of these basic body composition markers. We accepted the opinion of some foreign scientists that BMI is widely used as a measure of adiposity (Freedman et al., 2004; Flodmark et al., 2005). They also suggested that according to the facts that BMI is a practical indirect measure of adiposity (Ponce-Rivera, Fuentes-Lugo, 2008; McCarthy et al., 2003) and children's BMI is a better predictor of lean mass than fat mass (Cole et al., 2007), waist circumference is a sensitive marker for abdominal obesity in the pediatric age group (Schwandt et al., 2008) and until recently, it has not been regarded as an important measure of adiposity in children (Brambilla et al., 1994). Foreign scientists also notify that information on waist circumference in children could be as useful as BMI as a means of identifying the overweight and obese in childhood population studies (Zannolli, Morgese, 1996; Moreno et al., 1999).

It should be noted that waist circumference could be adopted as an alternative or additional measurement to BMI in children (McCarthy et al., 2001).

The years just before puberty (6—9 years) are an important time to target the management and prevention of obesity in children. This period is recognized as a critical period for the development of obesity, with early adiposity rebound appearing to predict the development of later obesity (Whittaker et al., 1997; Dietz, 1997). The ages of 6—9 years are also of interest because this is the time when activity and eating patterns may be changing as children become established in school and other routines of middle childhood. For these reasons, it was of particular interest to examine the relation between physical activity and body fatness in children of this age group (Deurenberg, 1999). So we also evaluated physical fitness of children, aged 5—7 years and its interaction with their body composition. This study shows that physical fitness of children negatively correlated with BFM, showing that overweight or obesity negatively

interacted with physical fitness. Comparing the results of physical fitness in each gender, the results obtained showed a negative correlation of physical fitness and BMI, BFM and WC for girls, and a slight correlation of physical fitness with height and weight for boys. The registered data are similar to those observed by the foreign scientists too — according to which low levels of physical activity in preschool children are associated with raised levels of body fat (Davies et al., 1995). Our results showed the girls' physical fitness level correlated with BMI, BFM and WC, and not the boys, as E. O. Ball (Ball et al., 2001) suggested that percentage of body fat is inversely associated with physical activity level in boys but not girls. Physical activity is one factor contributing to body fatness in boys, but additional factors may influence the size of the fat stores in girls (Ball et al., 2001). Our data contradict to these findings. We could explain this as the girls', who participated in our study, body fat mass was significantly higher than that of the boys, and the bigger fat mass determined their physical fitness level.

CONCLUSIONS

Optimal body weight, according to body mass index, percentage body fat mass and waist circumference was established for a bigger part of children, aged 5—7 years. This study shows that physical fitness of children was low — evaluated as "good enough" and it negatively correlated with body fat mass, showing that high body fat mass negatively impacted physical fitness.

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KAUNO MIESTO DARŽELIUS LANKANČIŲ 5—7 METŲ AMŽIAUS VAIKŲ FIZINIO PAJĖGUMO IR KŪNO KOMPOZICIJOS YPATUMAI BEI ŠIŲ RODIKLIŲ RYŠYS

**Sandrija Čapkauskienė, Kristina Visagurskienė, Rima Bakienė,
Irena Vitkienė, Daiva Vizbaraitė**
Lietuvos kūno kultūros akademija, Kaunas, Lietuva

SANTRAUKA

Vaikų antsvoris — tai visuomeninė problema tiek išsivysčiusiose, tiek besivystančiose šalyse (Dugan, 2008). Pastaruoju metu padidėjusio vaikų antsvorio paplitimo visame pasaulyje priežastimi iš dalies gali būti vaikų fizinio aktyvumo sumažėjimas (Ball et al., 2001). Tad svarbu iš anksto numatyti priemones, gerinančias vaiko fizinį pajėgumą ir apsaugančias nuo antsvorio didėjimo vaikystėje (Brunet et al., 2006).

Tyrimo tikslas — nustatyti 5—7 metų amžiaus vaikų kūno kompoziciją ir fizinį pajėgumą, įvertinti sąsają tarp kūno kompozicijos komponentų ir fizinio pajėgumo testų rodiklių. Buvo tiriami 216 Kauno miesto ikimokyklinio amžiaus vaikų — 104 mergaitės (amžiaus vidurkis — 5,90 ± 0,63 m.) ir 112 berniukų (amžiaus vidurkis — 5,98 ± 0,50 m.). Išmatuotas visų tiriamųjų ūgis, svoris, liemens apimtis (LA), trigalvio žasto raumens ir pomentinės odos raukšlės. Apskaičiuotas kūno masės indeksas (KMI) ir procentinė kūno riebalų masė (KRM). Fiziniam pajėgumui (FP) įvertinti atlikti keturi testai — bėgimas šaudykle, 20 metrų nuotolio bėgimas, šuoliukas iš vietos stovint ir 1 kg kamuolio metimas. Vaikų FP įvertintas remiantis B. Sekita (1988).

Berniukų ir mergaičių KMI rodikliai reikšmingai nesiskyrė ir atitiko normos ribas, tuo tarpu mergaičių KRM buvo didesnė (p < 0,01), LA koncentracija patikimai nesiskyrė tarp abiejų lyčių tiriamųjų. Visgi berniukų ir mergaičių LA koncentracija su amžiumi turi tendenciją didėti. Ryšys tarp KMI ir KRM (r = 0.661; p < 0.01) bei KMI ir LA (r = 781; p < 0,01) rodiklių buvo stipriai reikšmingas analizuojant bendrą vaikų skaičių, taip pat berniukų (r = 0,660, r = 0,703; p < 0,01) ir mergaičių (r = 0,660, r = 0,826; p < 0,01) pogrupiuose. Berniukų FP testo rezultatai geresni nei mergaičių (p < 0,01). Tiek berniukų, tiek mergaičių bendrasis FP patenkinamas. Bendrasis FP neigiamai koreliavo su KRM (r = −0,201; p < 0,001). Tai rodo, kad didesnė riebalų masė lemia mažesnį fizinį pajėgumą.

Įvertinus KMI, KRM ir LA koncentracijos rodiklius galima teigti, kad dauguma 5—7 metų amžiaus vaikų turi optimalią kūno masę. Vaikų FP yra mažas ir įvertintas patenkinamai. Be to, jis neigiamai koreliavo su KRM rodikliais. Vadinasi, didesnė riebalų masė lemia mažesnį fizinį pajėgumą.

Raktažodžiai: kūno masės indeksas, kūno riebalų masė, liemens apimtis, fizinis pajėgumas.

Sandrija Čapkauskienė
Lithuanian Academy of Physical Education
(Lietuvos kūno kultūros akademija)
Sporto str. 6, LT-44221 Kaunas
Lithuania (Lietuva)
Tel +370 37 302671
E-mail sideraviciute@lkka.lt