

## PHYSICAL ACTIVITY AND BODY COMPOSITION OF PRESCHOOL CHILDREN

Andrea PALANSKÁ, Ján JUNGER, Pavel ČECH

Faculty of Physical Education, University of Rzeszow, Poland

### Keywords:

- obesity,
- physical intensity,
- NASPE,
- ISCED 0,
- Polar Team 2,
- In Body 230.

### Abstract:

Current standard for daily preschooler's physical activity has been recommended to perform at least 60 minutes of moderate to vigorous structured physical activity and at least 60 minutes of unstructured physical activity every day. The purpose of this study was to extend knowledge about the volume of physical activity in preschool children in relation to their body composition. The sample consisted of 131 pre-school age children (5 - 6 years) attending selected kindergartens located in the area of Presov and Kosice self-governing region. Of 131 children, 67 were girls and 64 were boys. The volume and intensity of physical activity performed by children during their stay in kindergartens was measured using heart rate monitoring system POLAR Team<sup>2</sup> Pro. Body composition was assessed using direct segmental multi-frequency bioelectric impedance analysis (DSM-BIA) device InBody 230. However, the physical activity levels of children are decreasing. The volume of physical activity does not meet the minimum standard recommended by NASPE and average intensity of physical activity expressed by heart rate does not reach the medium intensity zone.

### INTRODUCTION

Knowledge about lives of our predecessors has confirmed that physical activity has been dominant in promoting health of people throughout entire phylogeny (Frömel, Novosad and Svozil, 1999; Junger, 2010). Performing regular physical activity (PA) in childhood increases levels of future physical activity in adulthood (Kraut et al., 2003; Malina, Bouchard and Bar-or, 2004). Positive effect of physical activity on health is generally known and has been supported by scientific evidence (Junger, 2000). Moreover, regular physical activity increases physical fitness, improves body weight and promotes overall health depending on the optimal physical activity level (Lamonte and Blair, 2009). *According to physical activity guidelines for children preschoolers should accumulate at least 60 minutes daily of structured physical activity and should engage in at least 60 minutes of unstructured physical activity* (NASPE; Sigmund and Sigmundová, 2011). *Children should perform moderate to vigor intensity physical activity, which corresponds to 130 bpm, or more than 3 METs.* Corbin, Pangrazi and Pangrazi, Corbin & Welk have reported that children should perform at least 30 to 60 minutes of moderate to vigorous physical activity during their school time and leisure time. It should be noted that almost 30 years ago, to stimulate the natural development of their organisms children were supposed to engage in physical activity during 60% of time being awake, which amounts to approximately 6 hours, at least 2.5 to 3 hours of physical activity in the average zone for the stimulation of cardiovascular functions equaling to 150% of resting values (Kučera, 1985 and 1991).

Despite decrease in the recommended physical activity levels, several studies have reported that preschoolers do not engage in sufficient physical activity. According to Tucker, only 54% of participants throughout the studies analyzed achieved current NASPE recommendations suggesting a minimum of 60 minutes of physical activity per day. The current trend in low physical activity levels is not being eliminated accordingly. Over the past few years, pediatricians have revealed that children suffer with diseases present in adults such as hypertension, cardiovascular and respiratory diseases and diabetes. These diseases share overweight as an identical risk factor. Compared to their age-matched counterparts from the 1960s to 1980s, present children are taller (boys by 1.4 cm and girls by 1.2 cm) and heavier (Bláha et al., 1990; Bláha and Vignerová, 1998; Prokopec et al., 1986). As reported by Canning, Courage, & Frizzell (2004) and WHO (2011) as much as 22 million children under the age of 5 are obese. In Slovakia, 6% of children are overweight and 12% are obese (Béderová, 2003). Chronic and non-infectious diseases including overweight and obesity cause 63% of deaths worldwide, which amounts to 36 million deaths per year. The number of deaths in childhood and at productive age was 9 million (WHO, 2011 a 2015). Therefore, engaging in physical activity as a beneficial factor should be emphasized in terms of obesity prevention (Marinov et al., 2012; Hainer et al., 2004; Jakicic, Otto, Polzien and Davis, 2009).

### **AIM OF PAPER**

The purpose of this study was to extend knowledge about the volume of physical activity of preschool children in relation to their body composition.

### **METHODS**

#### **Participants**

A non-randomized cross-sectional study was used to describe body composition and physical activity of preschool children and to evaluate gender differences. The sample consisted of 131 preschool age children (5 - 6 years) attending selected kindergartens located in the area of Presov and Kosice self-governing region. Of 131 children, 67 were girls and 64 were boys. Mean age, body height and body weight at the time of measurement was  $5.8 \pm 0.5$  years,  $117.2 \pm 6.0$  cm, body weight  $22.1 \pm 4.0$  kg. At the time of testing, children did not suffer with any metabolic or motor disorders that could have effect on test results.

#### **Measures and Procedures**

The volume and intensity of physical activity performed by children during their stay in kindergartens was measured using heart rate monitoring system POLAR Team<sup>2</sup> Pro (Polar Electro; Kempele, Finland). This system allows for direct and real-time heart rate monitoring of several individuals at the same time. Data are transmitted wirelessly to a receiver which is connected with a standard laptop with relevant software. During the entire time spent in kindergartens, children wore heart rate monitors to determine their average heart rate. Also, we determined the average heart rate during physical activity performed in the kindergarten. The intensity of physical activity was set at 135 bpm (3 METs), which corresponds with at least medium intensity exercise monitored according to NASPE. In total, we monitored 40 days during autumn under standard weather conditions typical for this season of year. Average daily temperatures ranged from 16 to 25°C. Children had a chest strap attached to their chests and wore it for approximately 8 hours per day. The volume of their physical activity during their leisure time was determined according to time records filled in by their parents during the weeks children were monitored.

Before analysis of body composition, the participants took part in the basic measurement of anthropometric parameters. Body height was measured using a portable stadiometer (SECA 217, Hamburg, Germany) to the nearest 0.1 cm. Body weight was

measured to the nearest 0.1 kg. Body composition was assessed using direct segmental multi-frequency bioelectric impedance analysis (DSM-BIA) device InBody 230 (Biospace Co., Ltd.; Seoul, Korea). Measurement history was retrieved using database management software Lookin'Body version 3.0 (Kyle et al., 2004). To compute indirectly measurable parameters we used prediction equations available for particular age categories. The room temperature was kept between 20 and 24°C to prevent undesirable changes in body water composition. Among parameters measured were skeletal muscle mass (SMM), absolute value of fat free mass (FFM), percentage of body fat mass (PBF), waist to hip ratio (WHR), estimated value of basal metabolic rate (BMR) and parameters of nutrition in the protein mass (PM) and mineral mass (MM).

### Statistical Analysis

Collected data were processed statistically and effect size analysis was conducted. Descriptive statistical characteristics of data were arithmetic mean as measure of central tendency and standard deviation as a measure of variability. The statistical significance of gender differences in parameters of the participants' body composition and physical activity parameters was determined using t-test for independent samples. To reject the null hypothesis and to accept alternative hypothesis, level of significance was set at  $p < .05$ .

Practical significance by gender was assessed using coefficient "Eta square" ( $\eta^2$ ), which determines the contribution of the contribution of an effect. The association between selected measures of body composition and physical activity levels irrespective of gender of preschool children was determined using Pearson's correlation coefficient. Statistical analysis was carried out using program STASTICA 12 (Cohen, 1998).

Parents of participants received a verbal description of the study procedures before testing and completed a written informed consent that was approved by the ethical committee of Presov University in Presov. Measurements were performed according to the ethical standards of the Helsinki Declaration.

Paper is a part of research task within the frame of VEGA 1/0237/13 „*Physical, motor and functional development of preschool children in the reflection of The National Educational Programme ISCED 0*“.

### RESULTS AND DISCUSSION

One of the purposes of the study was to assess body composition of preschool children. There were no statistically or practically significant differences between genders for age, body height, body weight and BMI. The greatest differences, although insignificant, were found for body height and body weight. Boys were taller by 2.4 cm and heavier by 1.0 kg than girls. There were minimal differences with regard to differences between children relative to age and BMI. Similarly, no statistically significant ( $p > .05$ ) or practically significant ( $\eta^2 < 0.06$ ) differences were found for body composition parameters. The difference between genders for percentage body fat (PBF) was 2.3%. Significant differences between boys and girls was found for skeletal muscle mass (SMM), fat-free mass (FFM) and basal metabolic rate (BMR). Higher values in body composition parameters were found for boys. Significant gender differences were found for parameters indicating nutritional status of children, i.e. protein mass ( $t = 2.653$ ,  $p = 0.013$ ,  $\eta^2 = 0.91$ ) and mineral mass ( $t = 2.479$ ,  $p = 0.016$ ,  $\eta^2 = 0.86$ ). Values for these body composition parameters were higher for boys than girls.

We focused on some body composition characteristic, in which we found out notably facts. Mean skeletal mass (SMM) was 8.2 kg (SD = 1.5 kg) and mean fat-free mass was 17.3 kg (SD = 2.4 kg). Despite this, mean percentage body fat (PBF) was 18.2% (SD = 6.3%). Alarming with respect to WHO standards is the fact that percentage muscle mass was lower than reference WHO value in 42 children. Contrary to this, 38 children were found to have

percentage body fat higher than reference norms. Regarding nutritional status of children, mean protein mass (PM) was 3.3 kg (SD = 0.6 kg) and mean mineral mass (MM) was 1.23 kg (SD = 0.2 kg). In total, 24 children had deficient volume of protein mass, which may be attributed to lower degree of muscularity. Mean waist-to-hip ratio (WHR) indicative of abdominal obesity was 0.77 (SD = 0.04).

In addition to body composition assessment, we analyzed physical activity levels in both the kindergarten setting and the home setting. With respect to parameters used to assess physical activity levels, significant differences between boys and girls were found for average heart rate during physical activity ( $t = 2.469$ ,  $p = 0.018$ ,  $\eta^2 = 0.147$ ) and the volume of physical activity performed in the kindergarten ( $t = 2.552$ ,  $p = 0.016$ ,  $\eta^2 = 0.135$ ). Boys compared to girls had higher average heart rate and physical activity level. There were no statistically significant ( $p > .05$ ) and practically significant gender differences ( $\eta^2 < 0.06$ ) for  $HR_A$ ,  $PA_H$  and  $PA_{Sum}$ .

Monitoring lifestyle of children showed that average volume of daily physical activity (PA) performed in the kindergarten was 33 minutes (SD = 18.1 min). Mean volume of physical activity performed out of kindergartens during weekdays was approximately 73 minutes per day (SD = 27.06 min). Total volume of daily physical activity was 106 minutes (SD = 3.5 min). This shows that children engaged in 14 minutes less physical activity according to minimum daily physical activity level recommended by NASPE.

The response of child organism to physical activities was monitored by heart rate recorded during children's stay in kindergartens. The average heart rate of children was 121 bpm (SD = 6 bpm). We decided to monitor especially heart rate of children during structured physical activities, which showed that average heart rate was 131 bpm (SD = 10 bpm). Compared to findings reported by Kučera (1985) who monitored heart rate of preschool children using telemetry, average heart rate of children in our study is lower by 40 bpm. According to NASPE guidelines accepted in both Czech Republic and Slovak Republic, a child should engage in at least 120 minutes of moderate to vigorous physical activity. The zone of medium intensity physical activity equivalent to 3-6 METs ranges from 135 bpm to 191 bpm. With respect to the heart rate range mentioned above, children in our study rarely performed physical activity at a required level of medium intensity.

**Table 1.** Analysis of a relationship between physical activity and body composition indicators

Variables	$HR_A$ (bpm)	$HR_{PA}$ (bpm)	$PA_S$ (min)	$PA_H$ (min)	$PA_{Sum}$ (min)
BH (cm)	-0.046	-0.211	0.213	0.115	-0.122
BW (kg)	-0.076	-0.036	0.068	0.057	-0.123
BMI (kg.m <sup>-2</sup> )	0.081	0.101	0.001	0.013	0.012
SMM (kg)	-0.214	-0.122	0.231	0.123	-0.253
FFM (kg)	-0.218	-0.122	0.135	0.236	-0.143
PBF (%)	0.294	0.063	-0.275	-0.301	-0.114
WHR	-0.274	-0.243	0.140	0.317	-0.192
BMR (kcal)	-0.214	-0.126	0.134	0.145	-0.143
PM (kg)	-0.319	-0.134	0.177	0.173	-0.156
MM (kg)	-0.073	0.011	0.334	0.146	-0.089

**Note.** BH - body height; BW - body weight; BMI - body mass index; SMM - skeletal muscle mass; FFM - fat free mass; PBF - percentage of fat mass; WHR - waist to hip ratio; BMR basal metabolic rate, PM - protein mass; MM - mineral mass;  $HR_A$  - heart rate average;  $HR_{PA}$  - heart rate during physical activity;  $PA_S$  - school physical activity;  $PA_H$  - home physical activity;  $PA_{Sum}$  - sum of physical activity; \*  $p < 0.05$

The assessment of the relationship between physical activity levels and body composition of children showed only weak or very weak power of relation in most parameters

(see Table 1). We consider these results as alarming, because the effect of inadequate physical activity is not visible in this period of life. The responsible institution, formal and informal factors which have serious influence on PA of preschoolers will start to carry out late. Physical activity will become an implement for removing the negative effects, not the prevention.

## CONCLUSIONS

1. The results imply that the children have lower skeleton and protein mass than reference WHO value.
2. Measures of somatic development are disproportionate to physical activity levels of children, which is regarded as an irreplaceable factor underlying their healthy development. However, physical activity level of children is gradually decreasing.
3. The volume of daily physical activity does not meet the minimum standard recommended by NASPE and average intensity of physical activity expressed by heart rate does not reach the medium intensity zone.
4. The analysis of body composition data has confirmed our personal experience in that somatic development of preschool children is still determined predominantly by endogenous factors and not by difference in their lifestyles.
5. Relation between body composition and physical activity has not confirmed in expected parameters. The effect of inadequate physical activity is not visible in this period of life but may have serious health consequence in adulthood.

## REFERENCES

1. BÉDEROVÁ, A. 2003. Príloha o racionálnej výžive v škole a rodine. *Prevenčia a učiteľia*. In: *Rodina a škola*. č. 1, s. 29.
2. BLÁHA, P. et al., 1990. *Antropometrie českých předškolních dětí ve věku od 3 do 7 let: výskumná správa*. Praha: Ústav sportovní medicíny.
3. BLÁHA, P. a J. VIGNEROVÁ, 1998. *Vývoj tělesných paramtrů českých dětí a mládeže se zaměřením na rozměry hlavy*. Praha: Univerzita Karlova. ISBN 80-7071-122-1.
4. CANNING, P. M., M. L. COURAGE a L. M. FRIZZELL, 2004. Prevalence of overweight and obesity in a provincial population of Canadian preschool children. In: *Canadian Medical Association Journal*. Roč. 171, s. 240–242. ISSN 1488-2329.
5. COHEN, J., 1998. *Statistical power analysis for the behavioral sciences*. 2nd ed. Hillsdale: NJ Lawrence Erlbaum Associates.
6. CORBIN, C. B. a R. P. PANGRAZI, 1996. How much physical activity is enough? In: *The Journal of Physical Education, Recreation & Dance*. Roč. 4, s. 33 – 37. ISSN 0730-3084.
7. FRÖMEL, K., J. NOVOSAD a Z. SVOZIL, 1999. *Pohybová aktivita a sportovní záujmy mládeže*. Olomouc: Univerzita Palackého. ISBN 80-7067-945-X.
8. HAINER, V. et al., 2004. *Základy klinické obezitologie*. 1. vyd. Praha: Grada Publishing. ISBN 80-247-0233-9.
9. JAKICIC, J. M, A. D. OTTO, K. POLZIEN a K. DAVIS, 2009. *Physical activity and weight control*. Oxford University Press: NY.
10. JUNGER, J., 2010. Štátny vzdelávací program pre predprimárne vzdelávanie ISCED 0 v reflexii motorického rozvoja dieťaťa. In: *Perceptuálno-motorické učenie sa v predprimárnej edukácii v kontexte súčasnej kurikulárnej reformy*. Roč. 1, č. 1, s. 391. ISBN 978-80-555-0208-3.
11. JUNGER, J., 2000. *Telesný a pohybový rozvoj detí predškolského veku*. Prešov: Grafotlač. ISBN 80-8068-003-5.



12. KRAUT, A. et al., 2003. Effect of school age sports on leisure time physical activity in adults: The CORDIS study. In: *Medicine and Science in Sports and Exercise*. Roč. 35, s. 2038–2042. ISSN 0195-913.
13. KUČERA, M., 1985. *Kvalitativní a kvantitativní změny bipedální lokomoce v průběhu vývoje*. Praha: UK. ISBN 60-017-84.
14. KUČERA, M., 1991. Tělesná zátěž při školním vyučování. In: *Tělesná výchova a sport mládeže*. Roč. 57, č. 7-8, s. 198. ISSN 1210 – 7689.
15. KYLE U. G., et al., 2004. Bioelectrical impedance analysis principles and methods. In: *Clinical Nutrition*. Roč. 23, č. 5, s. 1226-1243.
16. LAMONTE, M. and S. N. BLAIR, 2009. *Physical activity, fitness, and delayed mortality*. Oxford University Press: NY.
17. MALINA, R. M., C. BOUCHARD a O. BAR-OR, 2004. Growth, maturation, and physical activity. Champaign IL: Human Kinetics. ISBN 9780880118828.
18. MARINOV, Z. et al., 2012. *Praktická dětská obezitologie*. 1 vyd. Praha: Grada Publishing. ISBN 978-80-247-4210-6.
19. NATIONAL ASSOCIATION FOR SPORT AND PHYSICAL EDUCATION (NASPE). Active Start: A Statement of Physical Activity Guidelines for Children Birth to Five Years. Available at: <http://journal.naeyc.org/btj/200605/NASPEGuidelinesBTJ.pdf> (access:21.5.2015).
20. PANGRAZI, R. P., C. B. CORBIN a G. J. WELK, 1996. Physical activity for children and youth. In: *The Journal of Physical Education, Recreation & Dance*. Roč. 4, s. 38 – 43. ISSN 0730-3084.
21. PROKOPEC, M. et al., 1986. Výška a hmotnost českých dětí v roce 1981 podle výsledků celostátního antropologického výskumu. In: *Čs. Pediater*. Roč. 41, č. 1, s. 20-26. ISSN 0069-2328.
22. SIGMUND, E. a D. SIGMUNDOVÁ, 2011. *Pohybová aktivita pro podporu zdraví dětí a mládeže*. Univerzita Palackého v Olomouci: Olomouc. ISBN 978-80-244-2811-6.
23. TUCKER, P., 2008. The physical activity levels of preschool-aged children: A systematic review. In: *Early Childhood Research Quarterly*. Roč. 23, s. 547–558. ISSN 0885-2006.
24. WORLD HEALTH ORGANIZATION. Childhood overweight and Obesity. Available at: <http://www.who.int/dietphysicalactivity/childhood/en/> (access: 21.5.2015).
25. WORLD HEALTH ORGANIZATION. Noncommunicable diseases country profiles 2011. Geneva World Health Organization, 2011.