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THE RELATIONSHIP BETWEEN BODY COMPOSITION AND BALANCE ABILITIES AT THE AGE OF 4–5 YEARS

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Abstract

This paper presents results of selected body composition parameters of balance abilities in preschool children. The purpose of the research was to examine the relationship of balance abilities and body composition indicators in 4–5 year old children. In total 28 children (18 girls, 10 boys) with a mean decimal age of 4.95 ±0.73 years participated in the research. In order to obtain the body composition parameters, direct segmental multi-frequency bioelectrical impedance analysis (BIA) was used. To obtain balance abilities and to determine vestibular analyser levels, the Biodex Balance System SD (Biodex Medical Systems, Inc.) was employed. All of the obtained measurement results were compared with each other and evaluated using statistical methods. A correlation between body composition parameters and balance abilities was not found, although a statistically significant relationship between the level of balance ability and age was confirmed (r = 0.316, p ≤ 0.1). In the observed group, statistically significant differences between 4- and 5-year-old children were discovered in body composition p < 0.01. There were strong correlations with age and body composition at a significance level p < 0.01. Boys and girls aged between 4–5 years do not differ significantly in body composition characteristics.

Key words: *bioelectrical impedance, body composition, Biodex Balance System, 4–5 year old children*

Introduction

The basic foundation for the implementation of physical activities with preschool children is the knowledge of physiological laws, didactic principles, as well as respect for the individual prerequisites of children. One of the main goals in kindergarten is to develop an interest in movement. Research and practice confirm that physical activity has a prevalent position in one's life, a great importance in the ontogenesis of the child and is encouraging proper motor development [1-3].

The development of children's musculoskeletal system takes place in preschool age, where significant growth in height (up to 5-6 cm per year) and weight gain occur. Particular attention is paid to the proportionality of the figure, which is characterised by a more rapid growth of the limbs [4]. At the age of 6 years, the muscle mass of the child already accounts for 21-22% of the total weight. The increase in body fat is considered a negative phenomenon. Shafizadeh et al. [5] applied an intervention program for overweight/obese boys and discovered that a short-term developmentally appropriate intervention can improve running pattern and achieve a change in body composition. According to Junger, data in 4- and 6-year-old children indicated that there was a deterioration in posture of the neck, abdominal wall, shoulders and shoulder blades.

Trajkovski, Marić and Tomac [6] pointed out the rate of development of anthropological characteristics of preschool children under the influence of the movement program. The research tracings by Donnelly et al. [7] indicate a reduced body mass index after the application of physical activities in primary school children. In a study by Nazario and Vieira [8], children attending only physical education classes exhibited lower performance than children enrolled in sports centers. The results indicated improved performance in movement skills related to the demands of each discipline. The results of research by Tamplain et al. [9] revealed that dynamic postural control improved in children with developmental coordination disorder ($p < 0.05$) after the implementation of the intervention program. Most researchers agree that a specific training program for children improves motor skills. In the research of Marcolin et al [10] no difference in postural control was found in simple tasks between gymnasts and non-gymnastic children. However, specific movement skills suggest improvement in sport-specific tasks. The authors Kochanowicz et al. [11] interpret that gymnastic training has an impact on postural control in children and adults but simple static control tasks do not reflect the abilities of adult gymnasts. Halmová [12] suggests that increasing the level of coordination skills in children can be achieved by changing the starting or ending position, by varying the movement activities, or by performing activities in hindered conditions.

Several studies confirm the statistical significance of the correlation between static balance scores and vestibular analyser levels [13]. Findings in research by Opala-Berdzik, Głowacka and Juras [14] point to relationships between postural stability and discipline-specific training experience as well as anthropometric characteristics. However, cause and effect has not been demonstrated. The conducted researches stated that the development of the child's motor skills is a part of the developmental changes of the organism. With increasing age of children, an inclining trend in body composition as well as in the acquisition of motor skills has been demonstrated [15, 16]. The authors also discuss biological maturity in the acquisition of balance skills in children. The aim of this paper is to investigate the relationship between body composition and balance abilities in preschoolers and how balance abilities are age dependent.

Materials and methods

Participants

The research involved 28 preschool children. The group consisted of 18 girls and 10 boys aged 4.95 ±0.73 years. In somatic parameters of 4-year-old children with a mean decimal age of 4.22 ±0.17 (n=13), we observed a mean body height of 103.62 ±5.15 cm, body weight of 16.73 kg, and BMI of 15.50 kg.m-1. In somatic parameters of 4-year-old children with a mean decimal age of 4.22 ±0.17 (n=13), we observed a mean body height of 103.62 ±5.15 cm, body weight of 19.59 kg, and BMI of 15.03 kg.m-1.

Procedure

Basic somatic indicators were obtained: body height, body weight, BMI. We used the InBody 120 device (Biospace Co., Ltd.; Seoul, Korea) to analyse and evaluate body composition. Using direct segmental multi-frequency bioelectrical impedance analysis (BIA), we obtained the results of body composition parameters. We obtained the measurement records from the database software Lookin'Body120 version 1.2.2.7. Subsequently, we extracted the measured values following Kyle et al. [17], we analyzed body fat percentage (PBF), skeletal muscle mass (SMM), waist-to-hip ratio (WHR), total body water (TBW), protein (PM), minerals (MM), and basal metabolic rate (BMR).

We used the Biodex Balance System SD (Biodex Medical Systems, Inc.) [18] to diagnose balance abilities and thus determine the level of the vestibular analyser. Using this device, practitioners can assess neuromuscular control by quantifying the ability to maintain dynamic bilateral and unilateral postural stability on a static or unstable surface. The test subject stood on the apparatus barefoot, with arms loosely lowered beside the body. The subject's gaze was directed in front of the monitor. The test was conducted 3 times and the evaluation criterion was the average numerical value of the three trials performed. The test subject performed the movement on the balance platform in different directions according to the points shown on the monitor.

Statistical analysis

We employed quantitative methods to detect differences in study sets. Basic mathematical and statistical indicators were used to calculate the arithmetic mean, standard deviation. Correlation analysis was utilised to determine the relationships between the parameters. Statistically significant differences in somatic parameters and performance were assessed by t-test. The measured results were compared at the level of statistical significance $p \leq 0.05$, $p \leq 0.01$. In the processing and evaluation of the measured data, we used the functions of the SPSS exe program.

Results

In (Table 1) Pearson's correlation coefficient between the level of balance abilities (Biodex Balance System) and body composition parameters showed no significant relationship. We proved the dependence between the level of balance abilities (Biodex Balance System) and age ($r = 0.316$, $p \leq 0.1$). Our findings showed that age correlates with body composition parameters and we observed 5 statistically significant correlations $p \leq 0.1$. Statistically significant relationships were confirmed between the amount of active mass and other body composition parameters. Age showed strong correlations for several body composition parameters. In the study set, we observed (Table 2) that total body water (t = -4.947), protein (t = -5.109), minerals (t = -4.947), skeletal muscle mass (t = -5.063), and basal metabolic rate (t = -5.081) among 4- and 5-year-old children demonstrated a statistically significant relationship at the $p < 0.01$ level of significance. There was no significant difference in the following parameters: amount of body fat (t = 0.158; p = 0.876), percentage of body fat (t = 1.587, p = 0.125), and waist-to-hip ratio (t = 0.528, p = 0.604). In these parameters, 4-year-olds (M=0.73; SD=0.02) were not statistically significantly different from 5-year-olds (M=0.72; SD=0.03).

We found no statistically significant differences in body composition between boys and girls (Table 3). Among boys, we observed 0.71 l more body water (TBW), 0.19 kg more protein (PM), 0.06 kg more mineral matter (MM), and 0.6 kg more muscle mass (SMM). On the other hand, in girls, body fat percentage (PBF) was higher by 1.72% and hence body fat mass (BFM) was higher by 0.06 kg. A better level of basal metabolism was found in boys. The waist-to-hip ratio was the same for both sexes with a value of 0.72.

Table 1. Correlation matrix between body composition parameters, Biodex Balance System and age in a group of 4–5 year old children.

	Biodex BS	Age	SMM
TBW	0.046	0.723**	0.999**
PM	0.07	0.737**	0.997**
MM	0.137	0.680**	0.815**
BFM	-0.053	-0.027	0.392*
SMM	0.039	0.731**	-
PBF	-0.028	-0.294	0.071
BMR	0.05	0.732**	0.998**
WHR	-0.097	-0.121	0.365
Age	0.316*	-	0.731**

Note: SD – standard deviation, TBW – total body water, PM – protein matter, MM – mineral matter, BFM – body fat mass SMM – skeletal muscle mass, PBF – body fat percentage, BMR – basal metabolic rate, WHR – waist-to-hip ratio, * – statistical significance $p<0.05$, ** – statistical significance $p \leq 0.01$.

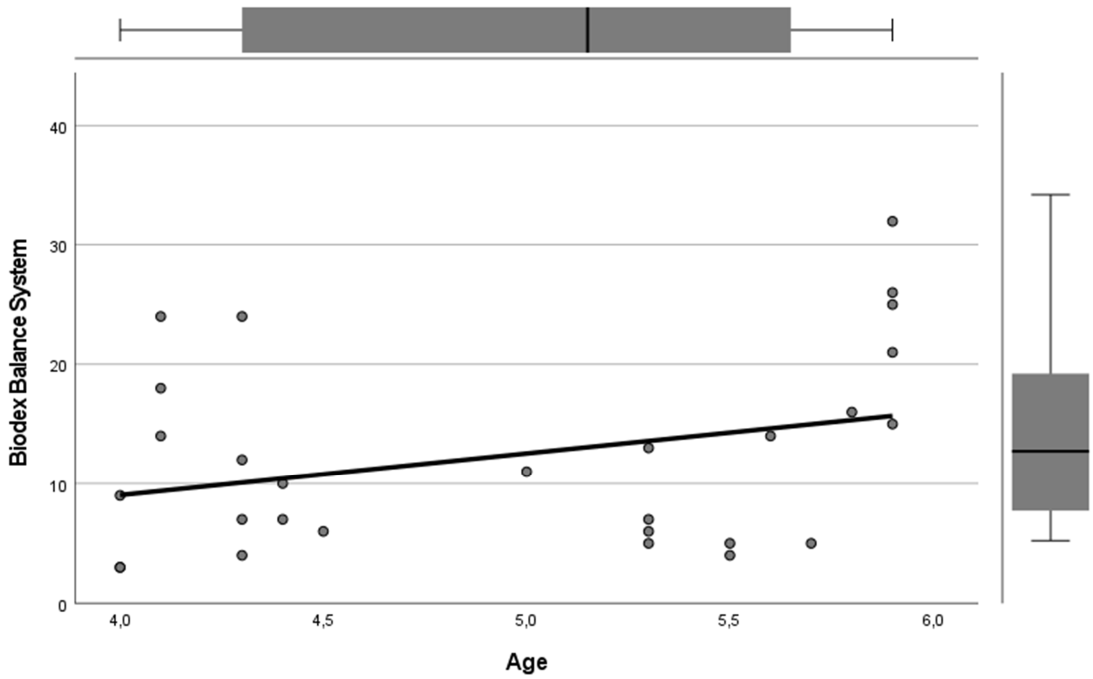

Figure 1. Relationship between level of balance ability (Biodex BS) and age

Table 1. Characteristics of body composition parameters between age groups

	Age	Mean	SD	t-test
TBW [L]	4	9.777	1.1606	-4.947**
	5	11.940	1.1482	
PM [kg]	4	2.585	0.3078	-5.109**
	5	3.187	0.3137	
MM [kg]	4	0.9962	0.1095	-4.497**
	5	1.1887	0.1158	
BFM [kg]	4	3.369	1.362	0.158
	5	3.273	1.785	
SMM [kg]	4	5.831	0.9402	-5.063**
	5	7.613	0.9195	
PBF [%]	4	19.538	5.264	1.587
	5	15.973	6.444	
BMR [kcal]	4	658.15	33.314	-5.081**
	5	721.87	32.898	
WHR [i]	4	0.7254	0.024	0.528
	5	0.7193	0.034	

Note: SD – standard deviation, TBW – total body water, PM – protein matter, MM – mineral matter, BFM – body fat mass, SMM – skeletal muscle mass, PBF – body fat percentage, BMR – basal metabolic rate, WHR – waist-to-hip ratio, ** – statistical significance $p \leq 0.01$.

Figure 2. Characteristics of body composition parameters between sexes

	Sex	Mean	SD	t-test
TBW [L]	Male	11.390	1.7071	1.142
	Female	10.683	1.4905	
PM [kg]	Male	3.030	0.4762	1.127
	Female	2.839	0.4031	
MM [kg]	Male	1.1380	0.16725	1.034
	Female	1.0778	0.1361	
BFM [kg]	Male	3.270	1.7205	-0.118
	Female	3.344	1.5394	
SMM [kg]	Male	7.170	1.3841	1.189
	Female	6.572	1.2136	
PBF [%]	Male	16.520	5.9016	-0.711
	Female	18.244	6.277	
BMR [kcal]	Male	706.00	49.782	1.189
	Female	684.67	43.053	
WHR [i]	Male	0.72	0.02449	-0.277
	Female	0.7233	0.03325	

Note: SD – standard deviation, TBW – total body water, PM – protein matter, MM – mineral matter, BFM – body fat mass, SMM – skeletal muscle mass, PBF – body fat percentage, BMR – basal metabolic rate, WHR – waist-to-hip ratio.

Discussion

Most researchers agree that a specific training program for children improves their motor skills. Opala-Berdzik, Głowacka, and Juras [14] found that longer training experience of modern gymnasts, higher age, body height, body weight, and biological maturity were associated with better anteroposterior postural stability. Greater body weight and BMI percentiles in acrobatic gymnasts were associated with better overall postural stability, regardless of visual conditions. Our findings did not show a correlation between the level of balance abilities and body composition. A significant correlation ($r = 0.17$; $p \leq 0.01$) between BMI and motor coordination in 6- to 7-year-old children was reported by Lopes et al. [19]. However, our results are consistent with claims that most motor abilities develop simultaneously with age. The measured results showed a statistically significant relationship between the level of balance abilities and age ($r = 0.316$, $p \leq 0.1$). Forni et al. [1] confirmed that motor performance is mainly due to the growth of young athletes. Basic motor skills increase with age [16]. The application of the intervention program improved dynamic postural control in children with developmental coordination disorder ($p < 0.05$) [9].

A study by Trajkovski, Marić and Tomac [6] showed that the increase in height and body weight of a child aged 4 to 7 is consistent with the normal growth trend. Čillík and Willwebér [15] came to the conclusion that the measured results on body composition have an increasing trend with advancing age. In our findings, we observed that age correlates with body composition parameters. There was a statistically significant relationship ($p < 0.01$) between 4- and 5-year-old children. Some studies indicated intersex differences between boys and girls [20]. In our research, boys do not differ significantly in body composition from girls aged 4–5 years. Serrano-Gallén et al. [21] suggested that physical activity is associated with better fitness performance in preschool children. Their research pointed out that they did not find significant differences in fitness between overweight, normal weight and underweight children but they did point out a difference in fitness between boys and girls.

Conclusions

Significant physiological, psychological and psychomotor changes occur during child development. In our research, we monitored a period of 4 and 5 years and drew the following conclusions. We demonstrated a correlation between the level of balance ability and age ($r = 0.316$, $p \leq 0.1$). We found that age is strongly correlated with body composition parameters but not with the level of balance abilities. We conclude that age is a significant determinant in the development of motor and locomotor skills.

We compared the body composition scores of 4- and 5-year-old children and found a statistically significant relationship at the significance level ($p < 0.01$) in the study population. Body composition parameters evaluated by t-test resulted followingly: total body water ($t = -4.947$), protein ($t = -5.109$), minerals ($t = -4.947$), skeletal muscle mass ($t = -5.063$) and basal metabolism ($t = -5.081$). There was no statistically significant relationship in the amount of body fat ($t = 0.158$; $p = 0.876$), percent body fat ($t = 1.587$, $p = 0.125$), and waist-to-hip ratio ($t = 0.528$, $p = 0.604$). In our results, boys and girls in the 4–5 years period are not statistically significantly different in body composition.

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