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Original Article

Dependencies of coordination abilities and body composition of children at younger school age

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Abstract:
In this contribution we present the results of selected paremeters of coordination abilities and body composition of children in younger-school age. The aim of the contribution is to determine the dependence of parameters of coordination abilities and body composition paremeters of 6-7 years old children. The sample consisted of 60 probands (40 boys and 20 girls) with the average age 6.73 ±0.3 decimal years. We used the precision standing long jump, precision knee throw over a head, run to target, rhythmic jumps, static balance on a dynamometric plate, reaction speed of lower extremities to diagnose coordination abilities. We used the direct analysis of segmental multi-frequency bioelectrical impendance to find out body composition parameters. All obtained results were compared to each other and evaluated using statistical methods. In monitored sample, we recorded significant dependencies in coordination abilities and in selected parameters of body composition. We recorded intersexual statistically significant differences ($p < 0.05$) in parameters of nutritional status (minerals, proteins). We found out little differences in the level of coordination abilities between boys and girls at the age of 6-7 years. We confirmed the dependence ($p < 0.05$) in parameters of body composition and coordination abilities which require a higher level of running abilities.
Key words: coordination, bioelectrical impedance, 6 -7 years old children, correlation analysis.

Introduction

Physical activity should be an integral part of everyone´s life so as to promote healthy physical and mental development and also to prevent the occurrence of a variety of diseases. Children have a natural and spontaneous need of any physical activity at early age.

At early stage of younger-school age children have necessary assumptions for mastering combined physical activities, nevertheless, boys dominate in acquiring these skills (Wiart, & Darrah, 2001). The age of 6 - 7 years is defined by Batchel (2003) as the stage of maturation within the basic phase of motor development of an individual. Gallahue and Donelly (2007), Laczo et al. (2014) state minimal differences between girls and boys which are possible to monitore already at the age of 3 – 8 years in terms of body weight and body height. In this research, Čillík et al. (2014) stated in indicators of physical development a statistically significant difference in body height and body weight in favor of boys.

Halmová (2005) states that increasing the level of coordination abilities in children is possible by changing the starting or final position, by changing exercises or by performing activities in difficult conditions.

Generally, it is known that the development of coordination abilities belongs among the basic tasks in younger-school training and it is crucial for mastering the techniques of individual athletic disciplines (Nosek, 2009).

Seliger, Vinařský, and Trefný (1980), Laczo et al. (2014) state that between the age of 6 and 8 the amount of body fat decreases. Gradually, after the 8th year of life begins to show the difference in the amount of fat between the sexes, while the girls have a higher proportion of fat compared to the boys.

Junger, Palanská, and Čech (2014) in this research did not note statistically significant changes in parameters of body composition in preschool and younger-school aged children, except for parameters indicating nutritional status (amount of minerals and proteins). Bioelectrical impedance (BIA) is a relatively simple, fast and non-invasive method for evaluating the body composition, mainly it is reliable and widely used. This method detects parameters of body composition by means of a small alternating current (Kim et al. 2004).

Material & methods

Participants

Younger school-age children participated in this research. Monitored sample consisted of 60 probands (40 boys and 20 girls) at the age of 6.73 ±0.3 years. In somatic parameters, we recorded body height 124.56 cm, body weight 24.81 kg and BMI 15.88 $kg.m^{-1}$ in boys. We recorded body height 122.08 cm, body weight 23.09

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kg and BMI 15.92 kg.m^{-1} in girls. Based on the results of physical development, we state that boys are about 0.13 years older, 2.48cm higher and 1.72 kg heavier in comparison to girls.

Procedure

We found out basic somatic indicators: body height, body weight, BMI. We have followed the methodology for given age category when diagnosing coordination abilities. We found out kinesthetic differentiation ability of lower extremities using the precision standing long jump according to Šimonek (2015). Tested person has a precisely marked location where to make a jump (75 % of maximum performance). The average distance of all three attempts from the marked location was the evaluation criterion. The kinesthetic differentiation ability of upper extremities was determined by modified test the precision knee throw over a head. Tested person has a precisely marked location where to performed a throw (50 % of maximum performance). The average distance of all three attempts from the marked location was the evaluation criterion. We used the test lateral rhythmic jumps with the use of metronome to diagnose a rhythmic ability, according to (Raczek, Mynarski, & Ljach, 2002), which was modified to lateral jumps over the line. The metronome was set to one-second intervals and a proband performed 20 lateral jumps over the line. The evaluation criterion is the time difference of 20 lateral rhythmic jumps with and without the use of metronome sound signals. The spatial orientation was determined using the test run to targets (Halmová, 2005). We used simple pictures instead of numbers due to the proband age, so children could easily distinguish them. Reaction speed of lower limbs was assessed by a diagnostic device FITRO agility check (FiTRONiC, Bratislava, the Slovak Republic). The device consists of four contact switches that measure the reaction speed for each side. The proband stands between four squares of 35cm. The individual plates are 0.4 meters apart. The task of a tested person is to touch one of the plates as quickly as possible, according to the location of the impression on the monitor. In our case, we used the 2 best reaction times in each direction with a correlation coefficient r = 0.742 (Zemková, 2008; Zemková, & Hamar, 2015). The static balance was found out using the dynamometer plate of the device FiTRO sway check (FiTRONiC, Bratislava, Slovak Republic).

This system monitors the movement of the center of gravity in the horizontal plane based on a vertical force distribution analysis registered using a dynamometer plate with three strain gauge of power with frequency 100 Hz. Tested person stands on a dynamometric plate barefoot, free hands running beside the body. The look is directed to the fixed point placed before the tested person. Every test consisted of 2 repetitions after 30seconds and we used the better of 2 attempts for evaluation (Štefániková, & Zemková, 2008). Zemková and Hamar (2002) recommend as the most reliable parameter of balance abilities the average velocity of movement of the center of gravity that we evaluated in our contribution.

We used a device InBody 120 (Biospace Co., Ltd.; Seoul, Korea) to diagnose parameters of body composition. Using a direct analysis of segment multi-frequency bioelectrical impendance (BIA), we used the results of body composition paramenters. The device InBody is mainly used for its ability to analyze a wide range of human body composition values, but also because of its clinical reliability. By using the 8 point touch electrode method, the device diagnoses the body by segments using the most accurate technology DSM-BIA. We recorded the history of measuring using the database software Lookin'Body120 version 1.2.2.7 from company Biospace. From the measured impedance values and other corrections, according to Kyle et al. (2004) we analyzed the percentage of body fat (PBF), skeletal muscle mass (SMM), visceral fat level (VFL), waist to hip ratio (WHR), total body water (TBW), protein mass (PM), mineral mass (MM) and basal metabolic rate (BMR).

Statistical analysis

We calculated the arithmetic mean, the standard deviation, the maximum and the minimum using the basic mathematical-statistical indicators.

The statistical significance of differences between genders in the parameters of physical abilities was determined using a T-test for independent samples. The data were processed using correlation analysis to determine relationships between individual parameters. Statistical significance was evaluated at the level of significance $p < 0.05$ and $p < 0.01$.

Results

When comparing the parameters of coordination abilities in intersexual comparison, we conclude that boys achieved better average results in these tests: precision knee throw over a head, run to target, reaction speed of lower extremities (table 1). Girls achieved better results in precision standing long jumps, rhythmical jumps and static balance. It confirms generally better level of girls' rhythmic abilities and better stability of body position. In intersexual comparison, however, we did not record statistically significant differences in any test, so we can state homogeneity in performance.

In the indicators of body composition (table 2), we recorded 2.51 % more body fat in girls. Skeletal muscle mass (SMM) was higher by 0.77 kg in boys. Visceral fat level (VFL) was higher in girls by 0.17. We recorded 0.72 waist-to-hip ratio (WHR), the same in boys and girls.

In boys, we recorded more body water (TBW) by 1.15 l, more proteins (PM) by 0.29 kg, more minerals (MM) by 0.09 kg. These parameters showing nutritional status were also statistically confirmed ($p < 0.05$). We

also recorded a statistically significant difference ($p < 0.05$) in the level of basal metabolic rate in favor of boys.

Table 1 Characteristic of indicators of coordination abilities in intersexual monitoring

		Mean	SD	t-test
PSLJ[cm]	B	10.55	8.10	0.076
	G	6.87	4.49	
PKTOH [cm]	B	29.39	17.2	0.164
	G	36.46	18.99	
RJ [s]	B	3.65	3.03	0.441
	G	3.02	2.46	
RTT [s]	B	11.96	1.7	0.566
	G	12.23	1.46	
RSLE [ms]	B	1064.01	115.02	0.389
	G	1091.82	109.38	
SB [$mm.s^{-1}$]	B	31.91	11.52	0.644
	G	30.47	9.43	

Note: SD – standard deviation; B – boys; G – girls; PSLJ – precision standing long jump; PKTOH – precision knee throw over a head; RJ – rhythmic jumps; RTT – run to target; RSLE – reaction speed of lower extremities; SB – static balance

Table 2 Characteristic of indicators of body composition in intersexual monitoring

		Mean	SD	t-test
PBF [%]	Ch	16.82	5.68	0.128
	D	19.33	5.88	
SMM [kg]	Ch	10.1	1.59	0.078
	D	9.33	1.36	
VFL [i]	Ch	1.39	0.74	0.519
	D	1.56	1.2	
WHR [i]	Ch	0.72	0.03	0.915
	D	0.72	0.03	
TBW [L]	Ch	15.02	1.95	0.032*
	D	13.87	1.55	
PM [kg]	Ch	4.01	0.52	0.039*
	D	3.72	0.42	
MM [kg]	Ch	1.47	0.16	0.04*
	D	1.38	0.12	
BMR [kcal]	Ch	812.22	56.55	0.041*
	D	780.72	44.85	

Note: SD – standard deviation; B – boys; G – girls; PBF – percentage of body fat mass; SMM – Skeletal muscle mass; VFL – visceral fat level; WHR – waist to hip ratio, TBW – total body water; PM – protein mass; MM – mineral mass; BMR – basal metabolic rate; * - statistic significance $p < 0.05$

We recorded 16 statistically significant correlates between coordination abilities and parameters of body composition (table 3).

Table 3 Correlation matrix of significant correlates between the variables in the group of 6 and 7 year-old boys and girls.

	PSLJ	*PKTOH*	*RJ*	*RTT*	*RSLE*	*SB*
PBF	-0.031	0.086	0.082	0.091	-0.109	-0.011
SMM	-0.016	-0.096	0.278	-0.254	-0.335	-0.158
TBW	0.005	-0.072	0.273	-0.261	-0.313	-0.140
PM	0.011	-0.072	0.275	-0.256	-0.312	-0.152
MM	0.073	0.008	0.105	-0.259	-0.274	-0.077
VFL	0.079	-0.053	0.148	0.040	-0.024	-0.121
WHR	-0.027	0.049	0.221	-0.032	-0.264	-0.259
BMR	0.001	-0.074	0.263	-0.259	-0.319	-0.145

Note: PSLJ – precision standing long jump; PKTOH – precision knee throw over a head; RJ – rhythmic jumps; RTT – beh k métam; RSLE – reaction speed of lower extremities; SB – static balance PBF – percentage of body fat; SMM – skeletal muscle mass; TBW – total body water; PM – protein mass; MM – mineral mass; VFL – visceral fat level; WHR – waist to hip ratio; BMR – basal metabolic rate; ▒ – $p < 0.05$; ■ – $p < 0.01$

In monitored group we recorded significant dependencies in coordination abilities and selected parameters of body composition. Dependencies in the parameters of obesity analysis and parameters of active body mass were confirmed as statistically significant. We confirmed dependence in the parameters of body composition with selected co-ordination abilities that require a higher level of running abilities. We observed dependencies with multiple parameters of body composition ($p < 0.05$) in the tests of rhythmic jumps, run to target and reaction speed of lower extremities. There were found significant correlations ($r = 0.335$, $p < 0.05$) (Fig. 1) between the reaction speed of lower extremities and skeletal muscle mass.

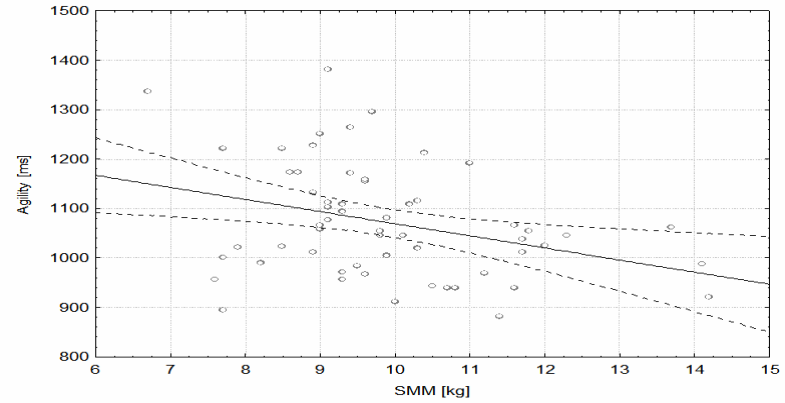

Fig. 1 Analysis of dependencies between skeletal muscle mass (SMM) and reaction speed of lower extremities

Dicussion

Mayooran, Attygalla, and Subasinghe (2014) state that body composition is one of the basic components of physical fitness. Appropriate body composition parameters can definitely contribute to achieving optimal levels of physical activity. There are numerous studies that show that it is important to detect body composition in terms of children's health and performance (Cristi-Montero et al., 2014; Mayooran, Attygalla, & Subasinghe 2014). In addition, some studies confirm that there is a correlation between motor coordination and body mass index (Birch et al., 2014, D'Hondt et al., 2014, Ferguson et al., 2014). Junger, Palanská, and Čech (2014) state that in the pre-school age between boys and girls there are no statistically significant differences in body composition parameters, except parameters indicating the nutritional status (amount of minerals and proteins), but there was a statistically significant difference in basal metabolic rate in intersexual comparison. Our findings, in children at the age of 6-7, are strongly correlated with their findings.

Vasiljević et al. (2015) state alarming data showing the older the infant population is, the more often they meet with a question of overweight, especially among boys. In boys at the age of 6-7 years, the average body height was 122.54 cm, body weight was 26.32 kg and BMI was 17.6 $kg.m^{-1}$. In girls at the age of 6-7, the average body height was 123.98 cm, body weight was 25.64 kg and BMI was 16.55 $kg.m^{-1}$. In the research of Čillík et al. (2014) we also found a higher level of BMI in boys than in girls.

Milanesse et al. (2010) state that in boys at the age of 6-7 they reported correlation dependencies between BMI and the waist circumference. They did not record any correlation dependencies between BMI and waist and hip ratio. Between the level of speed abilities and the value of skin algae, they state marginal statistical dependencies ($r = 0.368$) in boys at the age of 6-7.

Lopes et al. (2011) state a significant correlation ($r = 0.17$; $p < 0.01$) between BMI and motor coordination in children at the age of 6-7 . They also mention a statistically significant difference ($p < 0.05$) in favor of boys in motor coordination in intersexual comparison.

Conclusions

When comparing the parameters of coordination abilities, we found out small differences in the level of coordination skills between boys and girls at the age of 6-7. The boys achieved better average results in three tests as well as the girls. We recorded better results in boys in the tests focused on orientation, reaction and kinesthetic-differentiation ability of the upper extremities. Girls achieved better results in kinesthetic-differentiation ability of the lower extremities, rhythmic ability and static balance.

Dependencies on the parameters of obesity and active body mass were statistically significantly confirmed. In the group, we found out dependence in the parameters of body composition with selected coordination abilities that require a higher level of running ability. There were significant correlations ($r = 0.335$, $p < 0.05$) between reaction speed of lower extremities and skeletal muscle mass.

We even statistically confirmed intersexual differences in favour of boys in the parameters showing nutritional status (MM and PM) and in the level of basal metabolic rate (BMR)

Determining children´s peformance parameters is one of the important elements of talent selection. The diagnosis of body composition parameters is equally important in terms of interdependence as it can later identify and minimize civilization diseases. Somatic parameters and parameters referring to children´s performance should be monitored in detail during the development of children.

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