THE ASSESSMENT OF SOMATIC PARAMETERS AND PHYSICAL FITNESS LEVELS IN PREPUBERTAL CHILDREN

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Keywords:
- gender differences,
- fitness assessment,
- physical abilities,
- body weight,
- body height.

Abstract:
The purpose of the study was to assess gender differences and associations between physical fitness levels and somatic parameters in prepubertal children. Data were obtained from 101 children (48 girls, 53 boys) aged between 6 and 7 years who attended elementary schools in Presov, Slovakia. To assess physical fitness levels, children performed nine fitness tests of flexibility, strength, speed, endurance, and complex coordination. Children were also measured for body height and body weight. Results showed higher body weight and body height for boys, who also scored better in tests of running speed and agility, lower-body explosive strength, and spatial orientation. Girls performed better in tests of flexibility, complex coordination and aerobic endurance. Correlations between somatic parameters and physical fitness levels were weak. There was a negative correlation between body height and bent arm hang performance for both genders. Correlations between physical fitness parameters were weak to moderate. Correlations between tests of motor coordination were insignificant for boys and significant for girls. Tests of running speed were negatively correlated with lower-body explosive strength, and positively correlated between each other in both genders. There was a positive correlation between tests of motor coordination for both genders. The study was conducted within the project VEGA 1/0997/16 "The structure of talent as a determinant underlying evaluation of sports preconditions".

NTRODUCTION

The term physical fitness refers to the child's ever-increasing ability to function and operate within the environment with regard to the level of physical and motor fitness. Children's physical abilities are influenced by a variety of health- and performance-related factors that in turn influence their movement ability [Fjørtoft 2000]. Physical fitness is used in two close meanings: health-related and skill-related [DHHS 1996]. Health-related components of physical fitness include body composition, cardiovascular fitness, flexibility, muscular endurance, and strength [Ganley et al. 2011]. Agility, balance, coordination, power, reaction time, and speed are components of skill-related fitness [Hian, Mahmud, Choong 2013]. The current emphasis in physical fitness assessment has shifted from skill-related to health-related indicators. Health-related physical fitness has been viewed as a narrower concept focusing on the aspects of fitness that are related to day-to-day functioning and health maintenance [Ujević et al. 2013]. In children, little is known as to how well physical fitness and physical activity track into adolescence and early adulthood [Kemper, Verschuur, Van-Esseen 1990; Malina 1996; Pate et al. 1996]. However, a high degree of tracking would suggest early measurement and intervention as a strategy to assure healthy levels of physical fitness and physical activity in later years and provide evidence that the root determinants of physical fitness occur in childhood [Janz, Dawson, Mahoney 2000]. This health promotion strategy would have long-term implications because the causal relationship among physical fitness, physical activity, and cardiovascular disease outcomes has been established in adults [Blair et al. 1989; Blair et al. 1995]. Extensive research has shown that motor performance of children and youth is significantly determined by the level of somatic development. The effect body weight and body height on physical performance varies for particular fitness tests [Moravec et al. 1990; Turek 1999; Moravec et al. 2002]. Therefore, the assessment of physical fitness and somatic parameters appears to be important for finding associations between somatic parameters and physical fitness levels.

THE MATERIAL AND THE METHODOLOGY

The study was a non-randomized cross-sectional study. Data were obtained from 101 first grade students (48 girls, 53 boys) aged between 6 and 7 years who attended three elementary schools in Presov. Average body height, body weight, and BMI of children were 127.2 cm (*SD* = 5.4), 25.6 kg (*SD* = 4.4), and 15.8 kg.m^{-2} (*SD* = 1.9), respectively. None of children suffered from a musculoskeletal disorder that could influence his or her test scores. Testing took place in the afternoon in the gyms at selected elementary schools. Children were first measured for body height and body weight. Body height was measured using a portable stadiometer (Seca 217, Hamburg, Germany) to the nearest 0.1 cm, and body weight was measured using digital medical scales (Bosogramm 3000, Bosch + Sohn GmbH u. Co. KG, Germany) to the nearest 0.1 kg. After the measurement of somatic parameters students did a 10-minute warm-up led by one of the researchers. After the warm-up children performed the physical fitness tests. The test battery included 50-meter sprint from the standing position (running speed), 4 x 10 m shuttle run (running speed and agility), repeated sequence with a gymnastic stick (complex coordination), bent arm hang (upper-body isometric strength), standing broad jump (lower-body explosive strength), sit-ups (abdominal muscular endurance), stand-and-reach test (flexibility), rolling of three balls (spatial orientation), and 20-meter endurance shuttle run (aerobic endurance). Tests were applied according to the guidelines published by Měkota, Blahuš (1983).

Data distribution was assessed using the Shapiro-Wilcox test (unpublished data). If data were not normally distributed, three-sigma test was used to reduce extreme values, and to attain normal distribution of data. Descriptive statistical characteristics of the data collected were mean and standard deviation. Gender differences were determined using independent samples t-test at 5% probability of error ($\alpha = .05$). Correlations between children's physical fitness test scores and somatic parameters, respectively, were assessed using Pearson's correlation coefficient, with $r < .39$ considered to be weak, $r < .59$ moderate, and $r > .59$ strong correlations, respectively.

The cross-sectional research was approved by the Ethics Committee of the University of Presov in Presov and measurements were taken according to the ethical standards of the Declaration of Helsinki [Harris, Atkinson 2011]. Only participants whose legal representatives completed and signed a written informed consent participated in testing.

RESULTS AND DISCUSSION

Descriptive statistics for particular tests and significant differences between genders are presented in Table 1. Differences between genders in somatic parameters showed lower average body height and body weight for girls compared with boys by 1.1 cm, and 0.8 kg, respectively (see Table 1, F1 and F2). There were no significant differences in body height and body weight between genders.

Table 1. Somatic parameters and physical fitness levels by gender

Factor	*Boys*			*Girls*			*t-test*		
	n	$\bar{x}$	***SD***	***n***	$\bar{x}$	***SD***	***df***	***F***	***t***
F1 (cm)	53	127.7	4.8	48	126.6	6.0	99	1.565	1.061
F2 (kg)	52	26.0	4.4	48	25.2	4.5	98	1.050	0.915
F3 (cm)	52	-0.6	6.5	48	3.0	6.9	98	1.098	-2.707*
F4 (number)	53	19.6	9.1	48	18.6	9.4	99	1.069	0.512
F5 (s)	53	6.5	7.1	46	5.5	4.4	97	2.564	0.772
F6 (s)	53	13.9	1.0	48	14.5	1.0	99	1.002	-2.718*
F7 (s)	53	10.5	0.8	46	10.7	0.6	97	2.072	-1.436
F8 (cm)	53	128.1	14.1	48	118.7	14.8	99	1.095	3.273*
F9 (s)	52	118.5	25.3	48	131.4	32.4	98	1.634	-2.245*
F10 (s)	49	33.1	8.5	43	31.5	7.0	90	1.482	0.995
F11 (m)	45	352.4	146.7	45	361.8	143.6	88	1.045	-0.305

Note. F1 - body height; ***F2*** - body weight; ***F3*** - stand-and-reach test; ***F4*** - sit-ups in 60 seconds; ***F5*** - bent arm hang; ***F6*** - 4 x 10-meter shuttle run; ***F7*** - 50-meter sprint; ***F8*** - standing broad jump, ***F9*** - rolling of three balls; ***F10*** - repeated sequence with a gymnastic stick; ***F11*** - 20-meter endurance shuttle run; ***n*** - sample size; $\bar{x}$ - mean; ***SD*** - standard deviation; ***df*** - degrees of freedom; ***F*** - F-test value (testing criterion); ***t*** - Student's t-value (testing criterion); ***** - level of significance $p < .05$

Similar results were reported by Janz, Dawson, Mahoney (2000), Ružbarská, Turek (2007), and Kopecký (2011) who found that boys were taller and heavier than girls, and that somatic parameters did not change up to 10 years of age, with significantly higher values for body height in girls after 10 years of age.

Average scores in physical fitness tests showed that boys performed significantly better in the 4 x 10 m shuttle run, $t(97) = -2.72$, $p < .05$, standing broad jump, $t(99) = 3.27$, $p < .05$, and rolling of three balls, $t(98) = -2.25$, $p < .05$ There was no significant difference between genders in sit-ups and bent arm hang, with one repetition and one second difference, respectively. However, significant difference between boys and girls was found for stand-and-reach-test, $t(98) = -2.71$, $p < .05$, with girls achieving higher average score than boys by 3.6 cm. Similar findings were reported by Ružbarská, Turek (2007) who found that girls showed higher levels of flexibility than boys. With regard to individual physical fitness parameters, it is important to point out that strength, speed, and endurance differ significantly more than coordination abilities, with boys showing higher level of performance than girls [Ružbarská, Turek 2007]. Research studies revealed that even though boys and girls show comparable rates of physical development, boys achieve better performance in majority of physical fitness tests, which may be attributed to different levels of physical experience influenced by environment and possibilities for practicing physical activities [Piatkowska 2007]. In tests of motor coordination, girls showed a moderately higher level of performance in the gymnastic stick test, with a difference of 1.6 s between group means. As reported by Piatkowska (2007), there is differential tendency of coordination abilities' development between boys and girls. Therefore, it is not possible to clearly identify internal group differences.

Table 2 shows correlations between factors of physical fitness, and factors of physical fitness and somatic parameters, respectively. Bent arm hang performance was negatively correlated with body weight, $r(51) = -.36$, $p < .05$, and with body height, $r(51) = -.33$, $p < .05$, for boys. However, there was no significant correlation between somatic parameters and bent arm hang performance for girls. Bent arm hang test was positively correlated with sit-ups, $r(51) = .53$, $p < .05$, which demonstrates significant effect of abdominal endurance on bent arm hang performance. Similar results were reported by Fjørtoft (2000) who also found only a few significant associations between anthropometric measurements and the test variables, with bent arm hang test negatively associated to weight.

Table 2. Correlations for physical fitness tests and somatic parameters by gender

		F1 (cm)	***F2*** (kg)	***F3*** (cm)	***F4*** (number)	***F5*** (s)	***F6*** (s)	***F7*** (s)	***F8*** (cm)	***F9*** (s)	***F10*** (s)	***F11*** (m)
Boys	***F1*** (cm)	1.00										
	F2 (kg)	.80*	1.00									
	F3 (cm)	-.03	.05	1.00								
	F4 (number)	-.15	-.06	.10	1.00							
	F5 (s)	-.36*	-.33*	.38*	.53*	1.00						
	F6 (s)	-.10	-.10	-.33*	-.15	-.43*	1.00					
	F7 (s)	-.01	-.02	-.22	-.37*	-.47*	.72*	1.00				
	F8 (cm)	-.02	-.04	.25	.23	.51*	-.60*	-.60*	1.00			
	F9 (s)	-.15	-.01	-.05	-.20	-.26	.34*	.26	-.34*	1.00		
	F10 (s)	.13	.26	-.35*	-.22	-.34*	.38*	.28	-.27	.25	1.00	
	F11 (m)	-.23	-.27	.18	.36*	.42*	-.31	-.34*	.17	-.28	-.13	1.00
Girls	***F1*** (cm)	1.00										
	F2 (kg)	.72*	1.00									
	F3 (cm)	-.37*	-.32	1.00								
	F4 (number)	-.04	-.14	.34*	1.00							
	F5 (s)	.01	-.19	-.06	.27	1,00						
	F6 (s)	.10	-.02	-.17	-.23	-.12	1.00					
	F7 (s)	-.31	-.18	-.23	-.43*	-.21	.42*	1.00				
	F8 (cm)	.02	-.09	.27	.12	-.06	-.47*	-.32	1.00			
	F9 (s)	.18	.32	-.18	-.32	-.09	-.17	.00	.23	1.00		
	F10 (s)	.15	.26	-.41*	-.32	-.13	.22	.19	-.18	.36*	1.00	
	F11 (m)	-.20	-.33	.04	.02	.03	.10	-.10	-.09	-.33	.01	1.00

Note. F1 - body height; ***F2*** - body weight; ***F3*** - stand-and-reach test; ***F4*** - sit-ups in 60 seconds; ***F5*** - bent arm hang; ***F6*** - 4 x 10 meter shuttle run; ***F7*** - 50-meter sprint; ***F8*** - standing broad jump, ***F9*** - rolling of three balls; ***F10*** - repeated sequence with a gymnastic stick; ***F11*** - 20-meter endurance shuttle run; ***** - level of significance $p < .05$

The results demonstrate insignificant correlations between somatic parameters and physical fitness scores other than for the bent arm hang. Correlations between physical fitness parameters were weak to moderate. Correlations between tests of motor coordination were insignificant for boys but significant for girls. However, a surprising finding was that tests of running speed were negatively correlated with lower-body explosive strength, $r(51) = -.60$, $p < .05$, and stand-and-reach test was negatively correlated with motor coordination, $r(51) = -.35$, $p < .05$. The strongest positive correlation, $r(51) = .72$, $p < .05$, was found between tests of running speed.

Stand-and-reach performance was negatively correlated with body height, $r(47) = -.37$, $p < .05$, for girls, which shows that girls with lower body height scored better than girls with greater body height. Stand-and-reach was positively correlated with sit-ups, $r(47) = .34$, $p < .05$, and negative correlated with complex coordination, $r(47) = -.41$, $p < .05$. There was a moderately negative correlation between sit-ups and 50-meter sprint, $r(47) = -.43$, $p < .05$.

The strongest positive correlation, *r*(47) = .42, $p < .05$, was found between tests of running speed. A surprising finding was a negative correlation of 4 x 10 m shuttle run with standing broad jump, *r*(47) = -.47, $p < .05$. Compared with boys, girls showed a moderate positive correlation, *r*(47) = .36, $p < .05$, between tests of motor coordination.

Our results correspond with other research studies [Suchomel 2005; Ružbarská, Turek 2007], which, according to correlation analyses in 7-year-old children, showed that physical fitness levels and somatic parameters significantly diffused. Therefore, it is hard to speak about integrity of physical performance.

CONCLUSIONS

The purpose of the study was to assess gender differences and associations between physical fitness levels and somatic parameters in prepubertal children. Differences in body height and body weight between genders were insignificant. Boys scored higher in tests of abdominal muscular endurance (sit-ups), running speed and agility (4 x 10 m shuttle run), running speed (50-meter sprint), lower-body explosive strength (standing broad jump), and spatial orientation (rolling of three balls). Girls performed better in tests of flexibility (stand-and-reach), complex coordination (repeated sequence with a gymnastic stick), and aerobic endurance (20-meter endurance shuttle run). Correlations between somatic parameters and physical fitness levels were weak. There was a negative correlation between body height and bent arm hang performance for both genders. Correlations between physical fitness parameters were weak to moderate. Correlations between tests of motor coordination were insignificant for boys but significant for girls. Tests of running speed were negatively correlated with lower-body explosive strength, and positively correlated between each other in both genders. There was a positive correlation between tests of motor coordination for both genders.

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