THE COMPARISON OF PHYSICAL DEVELOPMENT IN ADOLESCENTS FROM THE PRESOV REGION AFTER A 20 YEAR INTERVAL

Bibiana **VADAŠOVÁ**, Pavol **ČECH**, Andrea **PALANSKÁ**

Faculty of Sports, University of Presov, Presov, Slovak Republic

Keywords:

- body height,
- body weight,
- body mass index,
- sum of skin folds,
- boys.

Abstract:

The paper presents partial results of the research task supported by the Slovak Research and Development Agency based on agreement No. APVV-0768-11 titled 'Physical, functional and motoric development of high-school youth in relation to their physical activity'. The research problem is focused on the examination of the current somatic profile and assessment of the trend of physical development in adolescents from selected high schools in the Presov region. The research group included 433 boys aged between 15 – 18 years. The monitored anthropometric parameters were as follows: body height, body weight, body mass index (BMI), thickness of 5 skin folds and the sum of skin folds. Data of physical development were evaluated according to national growth charts from 2011 and compared with data obtained in measurements of the same age Slovak school population taken in 1993-1994 using Eurofit test battery. Analysis of results indicates that the monitored group with its average values of body height, body weight and BMI took place at the level of 50^{th} – 75^{th} percentile according to national growth charts. Based on analysis of BMI values, we identified 6.9 % of boys in the zone of overweight and 8.5 % in the zone of obesity; however, higher sums of skin folds were found in fewer boys, namely in 6.2 % in the zone of overweight and only in 3.9 % of boys in the zone of obesity. After a 20-year interval we can state that, along with stagnating body height, we found an increase of average values of body weight accompanied with an increase of the sum of skin folds in all age categories; however, a significant difference ($p < 0.05$) was only found in body height in 15-years-old boys, body weight in 17- and 18-years old boys and in thickness of the triceps skin fold in 18-years-old-boys.

INTRODUCTION

The global emergence and increase in adolescents obesity represents a serious public health problem that contributes to a higher prevalence of obesity-related chronic diseases in adult populations [8,7,6]. Economic growth, rapid industrialization and market globalization have resulted in dramatic shifts in diet composition and lifestyle trends in many nations. Greater availability of food products, higher standard of living, better consumer services and lack of physical activity represent some of the trends that influence children's lives in many developed, transitional, as well as developing countries [13]. It results in unfavourable changes in body composition and physical fitness of children and youth. Additionally, the need to constantly monitor physical development of children, youth and adults is determined by data on poorer health of population as well as considerable prevalence of overweight and obesity already in young age categories. Physical development of children and youth,

especially body height and weight, represent sensitive indicators of health and nutritional state influenced by a number of factors, namely genetic, nutritional and environmental factors on the back-ground of social-economic and psycho-social conditions in which children are growing [10]. In the Slovak Republic, national surveys on physical development of children and youth have been carried out for several decades. Data from national growth charts are intended not only to set standards for individual assessment of physical development of children and youth but also to define growth differences in relation to various living conditions [10].

The aim of the study is to assess the current somatic profile based on comparison with anthropometric data obtained in the last, 7th national survey on physical development of children and youth in the Slovak republic taken in 2011 and to evaluate the trend of physical development of adolescents using the comparison with data obtained in measurement of the same age Slovak school population using Eurofit test battery in 1993 – 1994 [5].

METHODS

A non-randomized cross-sectional study in high school students from the Presov region was used. The analysed group consisted of 433 boys aged between 15 to 18 years from 13 randomly selected high schools of different professional orientation in the Presov region. Subjects were divided into four categories according to age: 15-years-old group consisted of 103 boys with average decimal age of 15.6 ± 0.3 years, 16-years-old group consisted of 105 boys with average decimal age of 16.5 ± 0.3 years, 17-years-old group consisted of 126 boys with average decimal age of 17.5 ± 0.3 years and, finally, 18-years-old group consisted of 99 boys with average decimal age of 18.5 ± 0.3 years. Testing took place in gyms of the selected schools in September and October of the academic year 2014/2015 in the morning. Anthropometric measurements of students wearing underwear were taken after being duly informed about the progress of the measurement. The following basic anthropometric parameters were observed – body height, body weight, body mass index (BMI) and thickness of five skin folds. Body height was measured using Seca stadiometer with an accuracy of 0.1 cm and body weight using InBody 230 device (Biospace Co., Ltd.; Seoul, Korea) with an accuracy of 0.1 kg. Body mass index BMI was calculated using the following formula: TH (kg) : TV^2 (m). Thickness of five skin folds (s.f. over triceps, s.f. over biceps, s.f. subscapularis, s.f. supraspinalis and s.f. calf medialis) were measured using a Best calliper with an accuracy of 0.5 mm. The observed parameters of physical development were assessed according to national growth charts from the 7^{th} national anthropometric survey carried out in 2011 with respect to particular age categories; moreover, they also were compared with results of physical development of Slovak school population obtained using Eurofit test battery in 1993 – 1994. This allowed us to assess the trend in physical development of adolescent population over the last two decades.

Participant's legal representative (in the case when a subject was younger than 18 years) or participants (in the case when a subject was older than 18 years) received a verbal description of the study procedures before testing and completed a written informed consent that was approved by the ethical committee of the University of Presov. Measurements were taken according to the ethical standards of the Declaration of Helsinki [3].

For descriptive analysis of research data, the following statistical characteristics were used: mean, standard deviation, minimal and maximal value. To assess significance of differences in male adolescents after the 20 year interval, t-test for independent data samples was used, calculation of which was carried out using the known values of mean and standard deviation [5] according to guidelines by [4].Consistency of variances was assessed using F-test. Rejecting the null hypothesis was carried out with a 5 % probability of error ($\alpha = 0.05$).

RESULTS AND DISCUSSION

Anthropometric parameters are suggested as sensitive indicators of physical development and health status of children and youth. The purpose of regular monitoring of their growth is to record developmental trends in children and youth population. Body height represents a parameter that characterizes individual's physical development as well as health and associated social-economic state of population. Decreasing positive secular trend in body height noticeable over the last decades can mean that genetic material has already been exhausted in this notion or that negative changes caused by the external environment occur, or, eventually, that these both components operate simultaneously [1]. In contrast, increasing tendency can be observed in body weight, which, with stagnating values of body height, causes an increase of average values of BMI in all age categories of boys and girls [12]. Table 1 represents descriptive characteristics of basic anthropometric indicators of boys in various age categories. The comparison with results of the 7th national anthropometric survey from 2011 indicates that average values of body height, body weight and BMI of the currently tested boys of different age are slightly lower than reference values of the Slovak population and according to national growth charts they are placed between the 50th – 75th percentile, i.e. in the zone of medium body height and normal body weight. Average values of the monitored parameters increased along with increasing age. The most noticeable increase was found in body weight between 15 and 16 year, namely by 4.1 kg. The group of 18-years-old students achieved body height of 178.7 cm, body weight of 71.8 kg and BMI of 22.5 kg.m^{-2}, while in comparison to 15-years-olds, the average value of body height increased by 3.5 cm, body weight by 7.3 kg and average BMI value by 1.5 kg.m^{-2}.

Table 1. Descriptive characteristics of anthropometric parameters in the group of boys

Age	Parameter	Mean	Standard deviation	Minimal value	Maximal value	NAS 2011	
						Mean	Standard deviation
15 years (n = 103)	**BH (cm)**	175.2	6.1	161.2	190.6	175.8	7.6
	BW (kg)	64.5	11.1	41.7	96.5	66.0	12.9
	BMI (kg.m^{-2})	21.0	3.3	15.3	30.6	21.3	3.5
16 years (n = 105)	**BH (cm)**	176.9	6.2	164.5	193.2	177.6	7.1
	BW (kg)	68.6	12.8	47.8	108.7	69.2	12.6
	BMI (kg.m^{-2})	21.9	4.1	15.6	32.4	21.9	3.6
17 years (n = 126)	**BH (cm)**	177.2	6.5	156.1	190.0	178.4	7.1
	BW (kg)	69.4	11.8	41.5	110.7	72.1	13.0
	BMI (kg.m^{-2})	22.1	3.3	16.1	32.0	22.6	3.6
18 years (n = 99)	**BH (cm)**	178.7	6.3	166.4	191.7	179.3	6.7
	BW (kg)	71.8	11.7	52.5	100.7	74.1	12.2
	BMI (kg.m^{-2})	22.5	3.2	16.7	30.8	23.1	3.6

Note. n = number of participants; BH – body height; BW – body weight; BMI – body mass index; NAS 2011 – national anthropometric survey 2011

Assessment of overweight and obesity in childhood and adolescence has its specific conditions in relation to growth and development of the body and requires simple non-invasive screening methods. Body mass index as a measure of proportionality and obesity was accepted by WHO as a criterion for assessing overweight and obesity also in children; however, in contrast to adult population, standards for children and adolescent population have to be developed for all age categories and both sexes [11]. Concerning the Slovak children and adolescent population, reference values of BMI regarding age and sex were processed from the last, 7th national anthropometric survey taken in 2011, while BMI limits

for overweight and obesity have been set at the level of 97th, i.e. 90th percentile, taking into account age and sex [9].

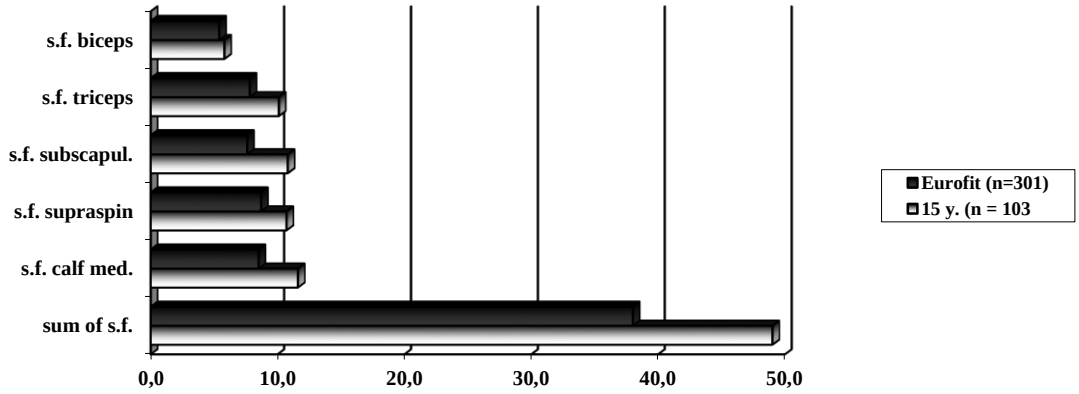
Intra-individual analysis of BMI values according to national growth charts from 2011 revealed that 30 boys (6.9 %) took place in the zone of overweight (90th – 97th percentile) and 37 boys (8.5 %) in the zone of obesity (> 97th percentile); however, in 3 boys (10.0 %) from the zone of overweight and even in 20 boys (54.1 %) from the zone of obesity we did not measure higher sums of skin folds. Thus, increased BMI values of these boys could have been caused by robust skeleton or higher proportion of muscle tissue [2]. Higher sums of skin folds were detected in 27 boys (90.0 %) in the zone of overweight and in 17 boys (45.9 %) in the zone of obesity, which indicates a higher proportion of body fat in their body composition. Representation of obese boys was equally distributed among all age categories; on the other hand, most overweight boys with higher sums of skin folds were found in 15-years-old group and in 18-years-old group. Between 1993 and 1994, Slovak national testing of physical development and physical fitness of 7 – 19-years old population was carried out. Within physical development, body height, body weight, thickness of five skin folds and the sum of skin folds were observed. Table 2 and Figures 1 – 4 illustrate the comparison of average values of the monitored anthropometric parameters of the currently tested groups of boys and groups tested using Eurofit in 1993 and 1994 of different age categories. The comparison after 20 years points out only minimal differences in average values of body height in 16 – 18-years-old boys; on the contrary, in 15-years-old boys we detected a significantly higher average value of body height ($p < 0.05$). Increased average values of body weight and the sum of skin folds were recorded in all age categories but the statistically significant difference ($p < 0.05$) was only found in body weight of 17 and 18-years-old boys. The greatest differences in body weight were found in 15 and 16-years-old boys (3.2 and 3.0 kg) and the lowest in 18-years-old boys (0.3 kg). The greatest differences in the sum of skin folds were detected in 15-years-olds (11.0 mm) and in 18-years-olds (10.3 mm). On the contrary, the slightest differences were revealed in the category of 16-years-old boys, namely 7.2 mm and in 17-years-old boys, namely 7.3 mm. Analysis of skin fold thickness indicates that, apart from biceps skin fold in 16 and 17-years-old boys, higher average values in thickness of the rest of skin folds were found. A significant difference ($p < 0.05$) was only found in triceps skin fold in 18-years-old boys.

Table 2. Reference values of basic somatometric characteristics Eurofit (1993 – 1994) and results of statistical analysis of anthropometric characteristics of the screened sample

	15 years			16 years			17 years			18 years		
	BH	***BW***	**∑ 5 skin folds**	***BH***	***BW***	**∑ 5 skin folds**	***BH***	***BW***	**∑ 5 skin folds**	***BH***	***BW***	**∑ 5 skin folds**
	(cm)	(kg)	(mm)	(cm)	(kg)	(mm)	(cm)	(kg)	(mm)	(cm)	(kg)	(mm)
Mean	174.0	61.3	38.0	176.9	65.6	40.7	177.7	67.5	40.1	179.4	71.5	40.0
St. dev.	7.3	9.3	13.2	6.5	9.4	17.6	5.9	7.6	13.2	6.6	9.0	12.9
t-test	*							*			*	

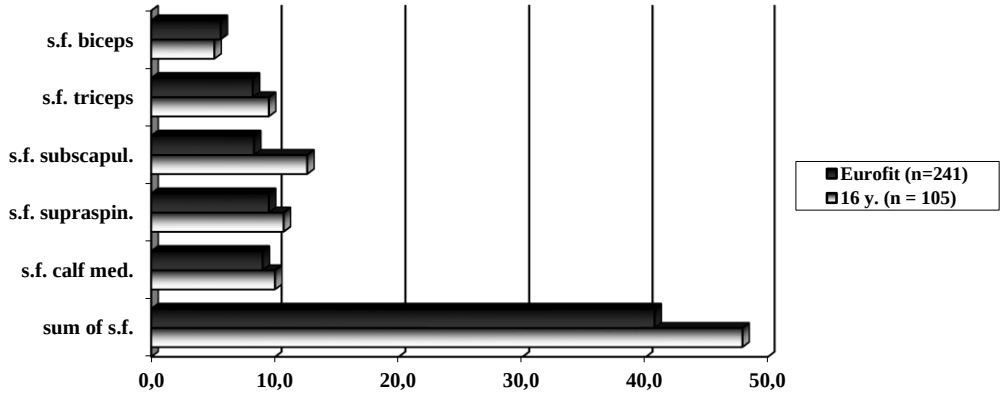
In 15-years-old category we found out that boys (n = 103) are higher by 1.2 cm and heavier by 3.2 kg than their peers 20 years ago (n = 301). As shown in Figure 1, they also achieved higher average values of skin fold thickness, while the greatest difference was found in subscapularis skin fold (3.2 mm) and calf medialis skin fold (3.1 mm); on the contrary, the

slightest difference was measured in biceps skinfold, namely 0.4 mm. In this age category, we also detected the greatest difference in the sum of skin folds from all monitored age categories, which amounted to 11.0 mm. When comparing the groups, a significant difference ($p<0.05$) was only found in body height. Concerning the 16-years-old category, the currently tested boys (n = 105) achieved body weight higher by 3.0 kg and sum of skin folds higher by 7.2 mm along with the identical average body height in comparison to boys tested 20 years ago (n = 241). From Figure 2 it is evident that, apart from biceps skin fold, they achieved greater thickness of skin folds, while the greatest difference was found in subscapularis skin fold (4.3 mm); differences in thickness of other skin folds were only minimal, in the range of 1.0 to 1.3 mm. In this age category, we did not record any statistically significant difference in the monitored anthropometric indicators between the compared groups.



	sum of s.f.	s.f. calf med.	s.f. supraspin.	s.f. subscapul.	s.f. triceps	s.f. biceps
Eurofit (n = 301)	38.0	8.5	8.7	7.6	7.8	5.4
15 y. (n = 103)	49.0	11.6	10.7	10.8	10.1	5.8

Figure 1. Comparison of average values of skin folds thickness (mm) in 15-years-old boys (n = 103, age x = 15.8) and the group tested using Eurofit in 1993 – 1994 (n = 301, age x = 15.5)



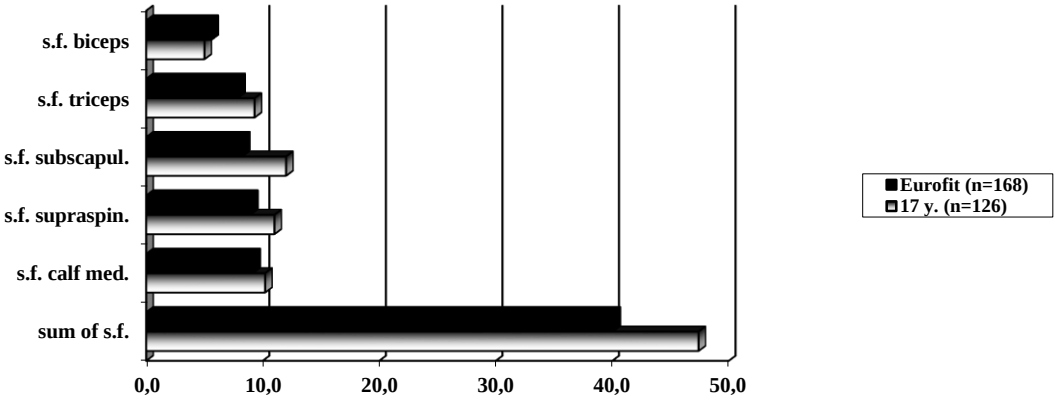
	sum of s.f.	s.f. calf med.	s.f. supraspin.	s.f. subscapul.	s.f. triceps	s.f. biceps
Eurofit (n = 241)	47.9	10.0	10.7	12.6	9.5	5.1
16 y. (n = 105)	40.7	9.0	9.5	8.3	8.2	5.6

Figure 2. Comparison of average values of skin folds thickness (mm) in 16-years-old boys (n = 105, age x = 16.7) and the group tested using Eurofit in 1993 – 1994 (n = 241, age x = 16.5)

In the group of 17-years-old boys (n = 126), we recorded average body height lower only by 0.5 cm and body weight higher by 1.9 kg in comparison to boys of the same age tested 20 years ago (n = 168). Similarly as in 16-years-old boys, we detected lower average thickness of biceps skin fold, namely by 0.6 mm, the sum of skin folds higher by 7.3 mm and

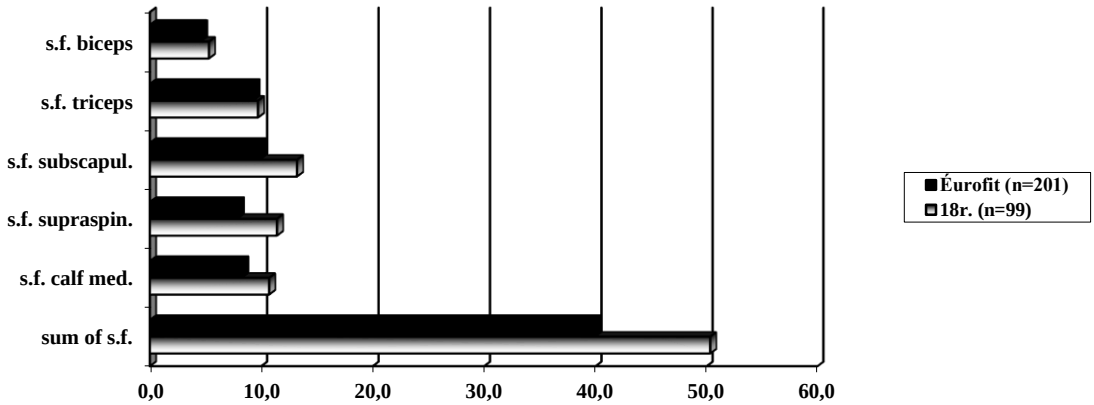
also the greatest difference was found in subscapularis skinfold (3.7 mm). Differences in thickness of other skin folds ranged between 1.0 and 2.0 mm. A significant difference ($p<0.05$) between the compared groups was only found in body weight.

Finally, in the group of 18-years-old boys (n = 99), we measured body height lower by 0.7 cm, body weight higher only by 0.3 kg and the sum of skin folds higher by 10.3 mm. Analysis of skin fold thickness (Figure 4) showed that our boys achieved greater thickness of skin folds, while the greatest difference was found in subscapularis skin fold (3.3 mm) and supraspinalis skin fold (3.5 mm) and, on the contrary, the slightest difference in triceps skin fold (0.4 mm). When comparing the groups, we found only significant differences ($p<0.05$) in body weight and thickness of triceps skin fold.



	sum of s.f.	s.f. calf med.	s.f. supraspin.	s.f. subscapul.	s.f. triceps	s.f. biceps
Eurofit (n = 168)	47.4	10.2	11.0	12.0	9.3	5.0
17 y. (n = 126)	40.1	9.2	9.0	8.3	7.9	5.6

Figure 3. Comparison of average values of skin folds thickness (mm) in 17-years-old boys (n = 126, age x = 17.5) and the group tested using Eurofit in 1993 – 1994 (n = 168, age x = 17.4)



	sum of s.f.	s.f. calf med.	s.f. supraspin.	s.f. subscapul.	s.f. triceps	s.f. biceps
Eurofit (n = 201)	50.3	10.7	11.4	13.2	9.7	5.3
18 y. (n = 99)	40.0	8.3	7.9	9.9	9.3	4.6

Figure 4. Comparison of average values of skin folds thickness (mm) in 18-years-old boys (n = 99, age x = 18.5) and the group tested using Eurofit in 1993 – 1994 (n = 201, age x = 19.5)

CONCLUSIONS

The assessment of physical development of adolescents after the 20 year interval shows stagnation in body height accompanied by increase in average values of body weight and sum of skin folds in all age categories; however, a statistically significant differences at the level

of 5 % were only found in body weight of 17 and 18-years-old boys, in body height of 15-years-old boys and in thickness of triceps skin fold in 18-years-old boys. The described trend of increasing body weight and slowing growth of adolescents is an unfavourable indicator observed over recent decades not only in Slovakia but also in other countries. Optimal physical development cannot be ensured in case of insufficient physical stimulation during ontogeny. Therefore, education about healthy active life style is essential, as well as taking adequate measures focused especially on increasing motivation for physical activity in children. In this context, an important role of family must be recognised because this unfavourable situation, not only in physical development but also in physical fitness, cannot be reversed only by compulsory school physical education; especially due to time devoted, it is not able to compensate a lack of physical activity of children and youth. It is parents who shall lead their children towards various physical activities so that they gradually become a natural part of their life style.

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