BODY CONSTITUTION AND BODY COMPOSITION OF HIGH-SCHOOL STUDENTS IN THE PREŠOV REGION

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- body height,
- body weight,
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- somatotype
- components.

Abstract:

The paper presents the partial results of a 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 assessing body composition and constitution and identifying a relationship between somatotype components and body fat in high-school students, applicable to both genders, in the Prešov region. The tested group consisted of 100 girls with decimal age of 17.2 ± 1.2 years and 94 boys with decimal age of 17.0 ± 1.1 years. We measured body height, body weight, BMI, the body fat percentage using an Inbody 230 device and somatotypes using the Heath – Carter method for somatotyping [6]. The analysis indicates that the average values of body height, body weight and BMI of the monitored groups of boys and girls take place at the level of a general Slovak population of the same age. In the girls' group, we identified 48 % of girls with higher values of body fat percentage (over 28.0 %), which was reflected in the greatest share of this group in categories dominated by the endomorphic component. Concerning the boys, we recorded a lower number, only 12.05 % of boys with greater proportion of body fat (over 20.0 %). Most of boys were placed in categories dominated by the ectomorphic component (44.8 %) and in categories dominated by the mesomorphic component (37.2 %). From the perspective of a relation between the body fat percentage and somatotype components, the greatest association in the girls' group was found with the ectomorphic component (r_s=-0.758), followed by the endomorphic component (r_s=0.558) and the mesomorphic component (r_s=0.530). In the group of boys, the results were similar when very strong association was detected between the body fat percentage and the ectomorphic component (r_s=-0.845), followed by the endomorphic component (r_s=0.708) and the mesomorphic component (r_s=0.542).

INTRODUCTION

Somatic growth and development as a basic indicator of health is a process determined mainly by genetic, nutritional and environmental factors, especially social-economic and psychosocial environment. A decline in habitual physical activity, preferring passive leisure activities and improper nutrition of young people entail unfavourable changes in body composition and body shape. These are associated with prevalence of overweight and obesity already in this age category and mean a higher risk of chronical diseases in adulthood [15]. Epidemiological studies point to the importance of identifying risk individuals already in adolescence, as well as to the fact that physical activity becomes a risk factor of a number of

diseases [10]. Monitoring basic physical characteristics of children and youths is an important tool for assessing their current health and nutritional state. Body composition may be remarkably influenced by life-style, as fat mass is its most variable component [9]. On the other hand, a somatotype reflecting the individual's current morphological status does not significantly change over ontogenesis as 70 % of it is determined by genetics [11]. 60 – 80 % of mesomorphic and ectomorphic components are genetically determined while the endomorphic component is less affected by genetics [2]. Carter, Heath suggest that genetics significantly influences an individual's phenotype but life-style, including nutrition, physical activity and health state, play a more important role [3]. Body composition is always determined by age, gender, somatotype, genetic factors, physical activity performed and individual variability [8]. Body composition is directly proportional to physical load and individual's genetic predispositions [7]. Regular physical activity contributes to elimination of increased body weight, BMI values as well as the proportion of fat mass [1].

The aim of the study is, in the context of prevailing negative trends in life-style of a young population, to assess body composition and body shape of students of the selected high-schools in the Prešov region.

METHODS

Research sample

The research sample consisted of 194 students of different high-schools in the Prešov region; 100 of them were girls with average decimal age of 17.2 ± 1.2 years and 94 boys with average decimal age of 17.0 ± 1.1 years. The screened sample was, due to the need for randomisation, selected from values measured in 1014 subjects. Raw data were randomised using a method of random sampling by means of the table of random numbers.

Methods and measurements

Before analysis of body composition and skinfolds, the participants took part in basic measurement of anthropometric parameters. Body height was measured using a portable stadiometer (SECA 217, Hamburg, Germany) with an accuracy of 0.1 cm. Body weight measured with an accuracy of 0.1 kg together with body fat percentage parameter was tested using direct segmental multi-frequency bioelectric impedance analysis (DSM-BIA), specifically, using In Body 230 device (Biospace Co., Ltd.; Seoul, Korea). In Body 230 device uses 8-point electrodes and works on the basis of ten repetitions of impedance measurement using two current's frequencies, namely 20 kHz and 100 kHz, in each of five body segments. Measurement's record was processed using Lookin'Body 3.0 version (Biospace Co., Ltd.; Seoul, Korea). Body composition was measured using the bioimpedance method under the standard conditions described in the BIA guidelines [7]. In accordance with the manufacturer's guidelines, the participants held out their arms and legs so that they would not come into contact with any other body segments during the procedure.

To define somatotypes, we used the Heath – Carter method[6]. To determine individual somatotype components, we measured, in addition to basic somatology characteristics, skin fold thickness (s.f. over triceps, s.f. subscapularis, s.f. supraspinalis and s.f. calf medialis) using a Best calliper (Trystom, Olomouc, Czech Republic), biepicondylar breadth of humerus and femur using a digital calliper with an accuracy of 0.1 mm and the flexed arm and calf girth in the greatest circumference using a tape measure.

Somatotypes were further assessed and divided according to dominancy of individual components and their mutual ratio into 13 categories according to Carter [in 12] and graphically depicted in somatochart (Figure 1) which serves for simple and fast orientation in the layout of somatotypes. The values of somatotype components were calculated using Somatotyp 1.2.5 software for Windows.

Measurements were taken according to the ethical standards of the Declaration of Helsinki [4]. 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.

Statistical anlysis

To describe the collected data, we used the mean as a measure of central tendency and standard deviation and standard error of mean as a measure of variability. Supplementary data of basic characteristics also include the minimal and maximal values.

The Shapiro-Wilk test was used to test normality of data distribution as a means of selection of statistical tests. With respect to results in the Shapiro-Wilk test, power of association between parameters was analysed using the Spearman's rank order correlation coefficient. Strength of relationship was interpreted in accordance with Evans, when $r_s < 0.19$ represents very weak, $r_s < 0.39$ weak, $r_s < 0.59$ moderate, $r_s < 0.79$ strong and $r_s \geq 0.80$ very strong association [5]. Relationship significance was assessed at the standard level $\alpha = 0.01$.

Statistical analysis was carried out using IBM SPSS Statistics, version 20 (IBM SPSS Inc., Chicago, IL). Graphical analysis of the relationship between fat mass and somatotype components was carried out using Statistica, version 12.0 (StatSoft, Inc.; Tulsa, USA).

RESULTS AND DISCUSSION

Table 1 presents basic statistical characteristics of the tested groups of girls and boys. In comparison to the national growth charts, both groups with their average values of body height and weight are at the level of normal body height and weight. The examined boys are taller by 13.14 cm and heavier by 10.42 than girls of the same age.

Body height and weight are anthropometric indicators which, if considered separately, do not have such information value as the commonly used weight – height ratio, namely BMI index [13]. The average BMI value in the girls' group achieved the level of the 50th percentile and in the boys' group it was at the level of the 60th percentile.

Table 1. Descriptive analysis of anthropometric indicators of the screened sample

		BH (cm)	BW (kg)	BMI (kg.m^{-2})
Girls (N = 100)	Mean	164.09	57.45	21.28
	St.Dev.	5.97	10.83	3.49
	Min	147.40	40.50	16.48
	Max	177.50	100.20	33.96
Boys (N = 94)	Mean	177.23	67.87	21.55
	St.Dev.	6.54	12.23	3.37
	Min	163.50	46.90	16.00
	Max	196.50	108.40	31.10

Note: BH – body height, BW – body weight, BMI – body mass index

Using intra-individual analysis, we identified 5.3 % of boys and 7.0 % of girls at the overweight level (90th – 97th percentile) and 9.6% of boys and 8.0 % of girls at the level of obesity (over the 97th percentile). In the case of boys at the level of overweight, higher BMI values were accompanied by appropriate values of body fat percentage in the range between 15.0 and 15.4 %, while in boys at the level of obesity and girls at both, the level of overweight and obesity, we recorded higher values of body fat percentage.

In contrast to body height, which is mainly genetically determined, body weight and body fat are instable somatic parameters which are more affected by environmental factors and can be influenced especially by physical activity and nutrition.

Table 2 presents results of normality of research data distribution. In the groups of boys and girls, the normal Gaussian curve was disrupted in parameters of body fat percentage and endomorphic component. The other two components retained their normality.

Table 2. Analysis of normality of research data distribution (Shapiro-Wilk test)

	Boys			Girls		
	Statistic	df	Sig.	Statistic	df	Sig.
Body fat percentage	.885	94	.000	.959	100	.003
Endomorphic component	.917	94	.000	.967	100	.012
Mesomorphic component	.985	94	.363	.985	100	.326
Ectomorphic component	.983	94	.248	.976	100	.069

Table 3 presents descriptive analysis of body fat percentage and somatotype components of the examined groups. Based on the comparison of the achieved values of body fat percentage and standard values reported by Lookin'Body 3.0 software we can state that average values of body fat of both groups are in the recommended range for normal body weight. Girls achieved average value of body fat higher by 12.6 % than boys and with 26.93 % of body fat they were placed at the upper limit of the normal body weight range for the female population (18.1 - 28.0 %). In the girls' group, we identified 7.0% of girls with body fat percentage under 18.0 %; a half of them achieved the recommended value within the range between 18.1 and 28.0 % and 43.0 % of girls had body fat percentage values higher than 28.0 %. Concerning the boys, their average body fat percentage amounted to 14.3 %; 22.3 % of boys had body fat percentage under 10.0 %, 63.9 % of boys between 10.1 and 20.0 % and only 13.8 % of boys had body fat percentage over 20.1 % . The most comprehensive indicator of body constitution is individual's somatotype, which reflects the current morphological status. Endomorphy expresses the relative fatness with a tendency of central fat stores and muscles only hardly noticeable. Mesomorphy as an indicator of the relative musculoskeletal development of the body is characterised by robust bones and strong musculature.

Ectomorphy expresses relative linearity and slenderness of the body with a small tendency for body fat stores [14]. Analysis of somatotype components indicates that average somatotype of girls (4.53 - 3.65 - 2.81) was found in the category dominated by the endomorphic component, namely mesomorphic endomorph (category 10). Average somatotype of boys (3.07 - 4.02 - 3.49) took place in the category balanced mesomorph (category 1), i.e. category dominated by the mesomorphic component.

Using intra-individual analysis of girls' somatotypes we found out that the most of girls, a third of them, was placed in the mesomorphic endomorph category (category 10). With respect to number of girls in categories with particular dominant components we can state that almost half of the tested group of girls (48.0 %) was placed in categories with dominant endomorphic component, which corresponds with their position in the zone with higher body fat percentage. 22.0% of girls were placed in categories dominated by the mesomorphic component and 19.0 % of girls in the category dominated by the ectomorphic component. The central type category (category 13) dominated by no evident component included 11.0 % of girls.

Table 3. Descriptive analysis of body fat percentage and somatotype components in girls and boys

		Body fat percentage	Endomorphic component	Mesomorphic component	Ectomorphic component
Girls (N = 100)	Mean	26.93	4.53	3.65	2.81
	St.Dev.	7.14	1.58	1.34	1.44
	St. E. Mean	0.71	0.16	0.13	0.14
	Min	12.9	1.8	0.0	0.1
	Max	48.0	8.7	7.1	5.6
Boys (N = 94)	Mean	14.31	3.07	4.02	3.49
	St.Dev.	6.74	1.71	1.45	1.56
	St. E. Mean	0.70	0.18	0.15	0.16
	Min	3.0	0.6	1.0	0.1
	Max	37.1	7.6	7.4	7.2

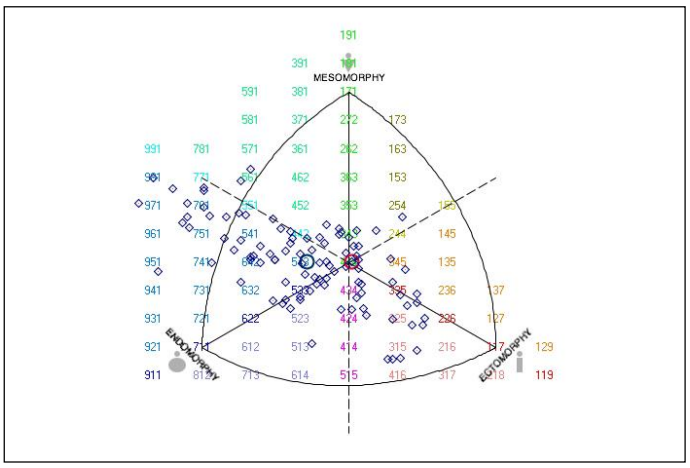

Fig. 1. Somatochart of the girls' group – proportion in individual quadrants

Intra-individual analysis of boys' somatotypes revealed that the most of boys, namely 21.3 %, took place in the mesomorphic ectomorph category (category 4). Concerning the number of boys in categories dominated by the particular component we can state that the most of the examined boys, 44.7 %, were placed in categories dominated by the ectomorphic component. 37.2 % of boys were included in categories dominated by the mesomorphic component and only 12.8 % in categories dominated by the endomorphic component, which corresponds with their placement in the zone with greater proportion of body fat. In the central type category (category 13), 5.3 % of boys were found.

When examining the relation between body fat percentage and somatotype components, we revealed a positive moderate association between body fat percentage and the endomorphic (r_s = 0.558), as well as the mesomorphic component (r_s = 0.530). The correlation coefficient between the body fat percentage and the ectomorphic component was r_s = -0.752, which means negative strong correlation. In all cases, correlation was supported by statistical significance at the level $\alpha = 0.01$ (Figure 3).

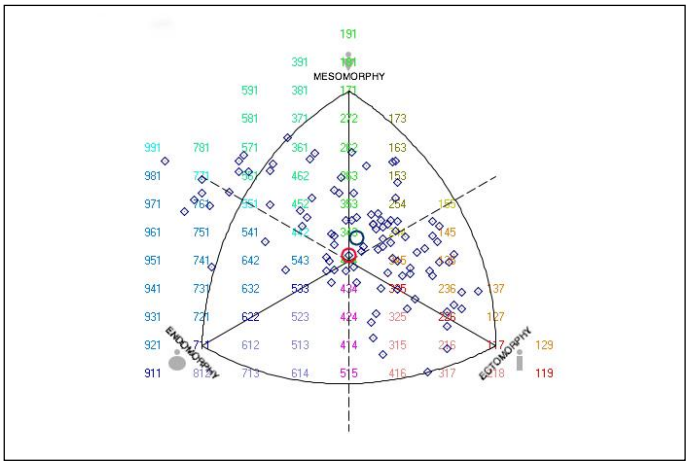

Fig. 2. Somatochart of the group of boys – proportion in individual quadrants

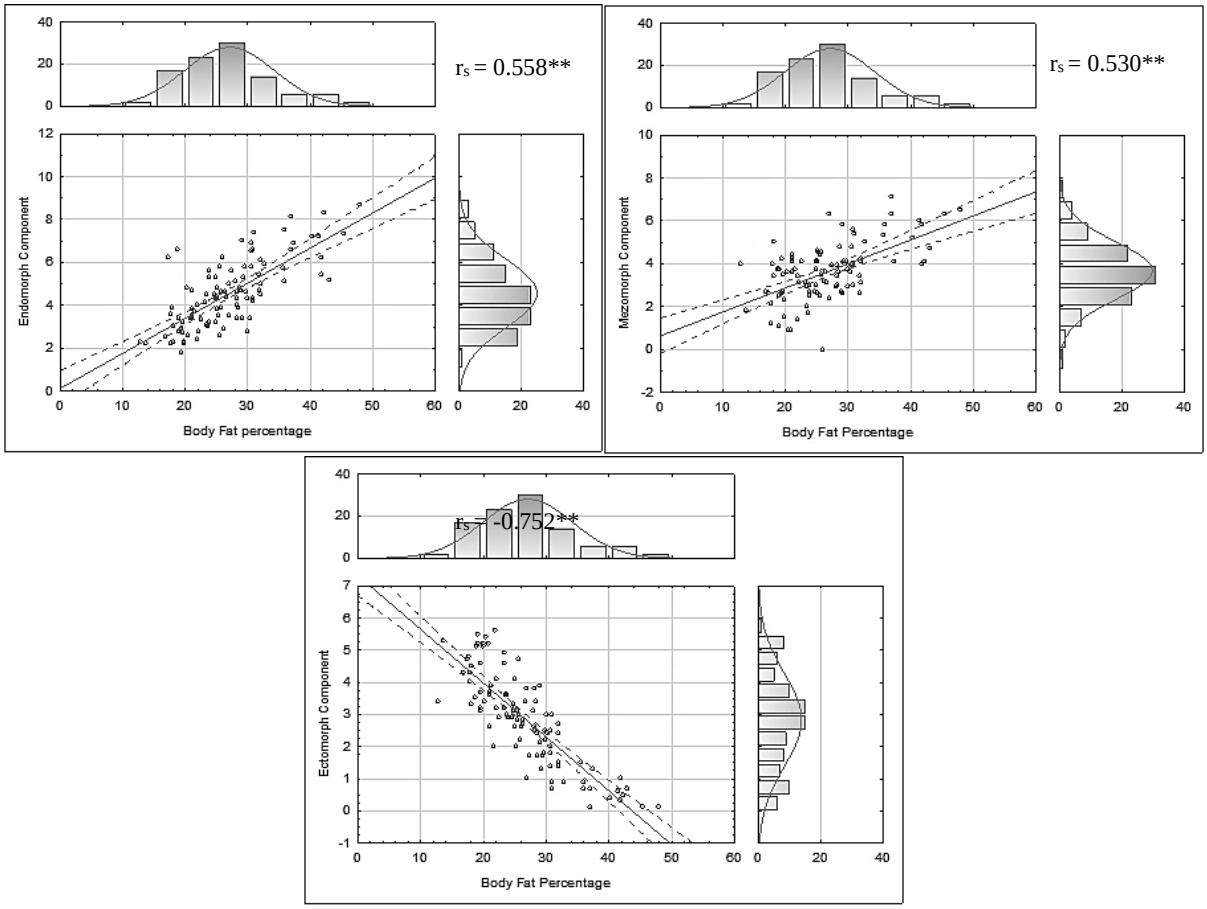

Fig. 3. Graphical depiction of the relation between somatotype components and the body fat percentage in the group of girls (** significance $p < 0.01$)

In the group of boys, Spearman's rank correlation revealed a positive moderate relation between the body fat percentage and mesomorphic component ($r_s = 0.542$). In the case of the endomorphic component, correlation analysis showed the correlation coefficient $r_s = 0.708$, which means strong association. Negative very strong correlation ($r_s = -0.845$) was found in the relation with the ectomorphic component. Also in the group of boys, detected correlations were significant at the level $\alpha = 0.01$ (Figure 4).

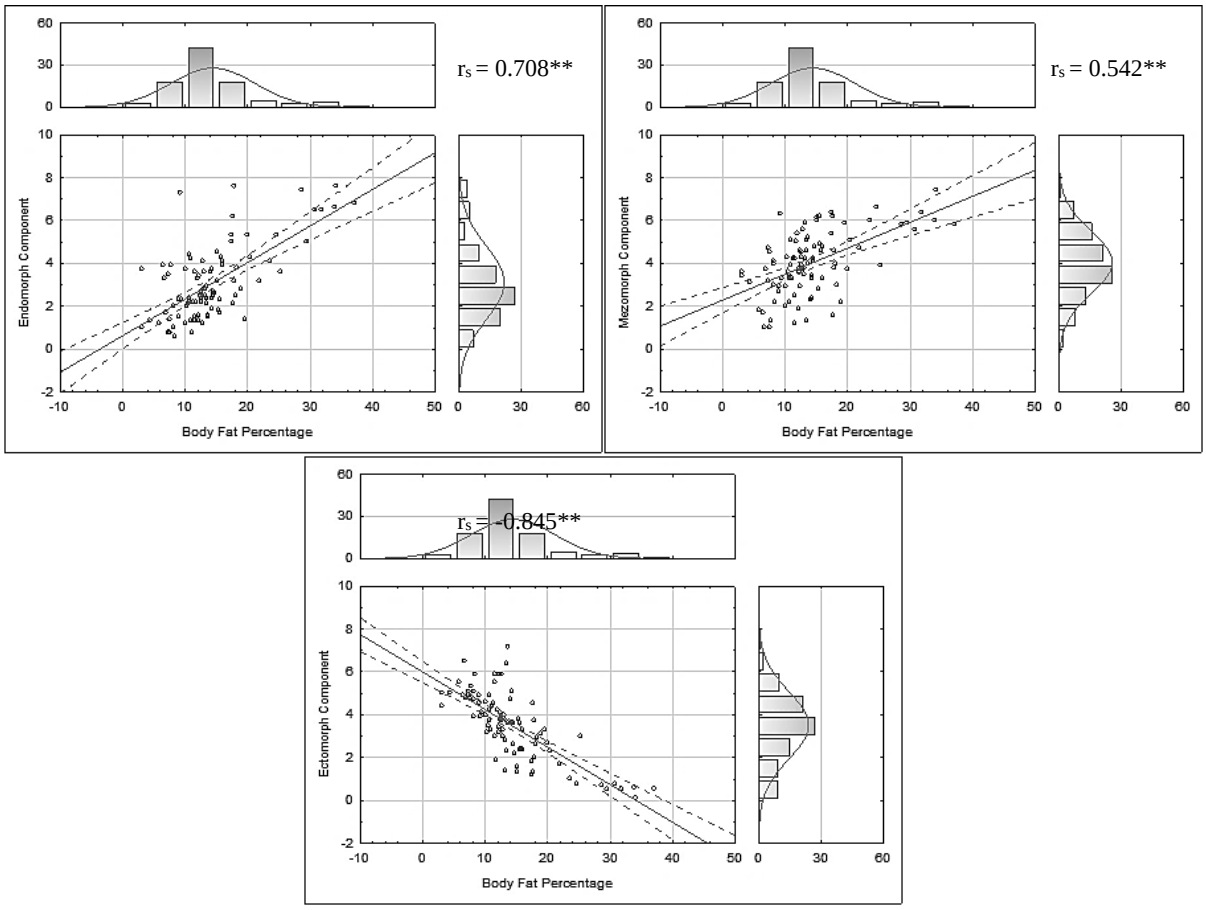

Fig. 4. Graphical depiction of the relation between somatotype components and the body fat percentage in the group of boys (** significance $p < 0.01$)

CONCLUSIONS

The article provides the current somatic profile of students of the selected high-schools in the Prešov region. Based on BMI values, we revealed 7.0 % of girls in the range of overweight and 8.0 % in the range of obesity, which corresponded with high values of body fat percentage in these girls. Almost half of girls were placed in somatotype categories dominated by the endomorphic component, which was in accordance with higher values of body fat percentage. Concerning the boys, 5.3 % of them were in the range of overweight and 9.6 % in the range of obesity; however, only boys in the range of obesity had higher values of body fat percentage.

In contrast to the girls, categories dominated by the endomorphic component included only 12.5 % of boys, which correlated with their values of body fat percentage over 20.0 %. We found significant positive correlation between the body fat percentage and endomorphic as well as mesomorphic component in both tested groups. Parameters of body composition and body shape are important indicators of health and nutritional status of individuals. Monitoring these parameters enables the researchers to identify risk individuals. Hypokinetic way of life of youths has a negative effect on body composition as a result of greater proportion of body fat and it also is associated with increased health risks.

In our screened sample, especially in the group of girls, we recorded unfavourable changes in body composition and body shape. Prevention in this field is very urgent as obesity can be, in most of cases, prevented by proper education, rational nutrition, regular physical activity and overall changes of life-style.

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