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Original Articles

Somatotype Characteristics of Bulgarian Children from the Region of the Eastern Rhodope Mountains

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Abstract

The purpose of the present study is to investigate the age and sex-related changes that occur in the somatic typological characteristics in children and adolescents from the Eastern Rhodope Mountains /Bulgaria/. Anthropometrically measured 1481 clinically healthy children and adolescents aged 7 to 17 years. The contingent is divided into 11 (for each year) age groups.

The result analysis show that there are age and sex-related changes in both the mean values of the three somatotype components and in the mean somatotype. In both sexes, changes in the average somatotype occurred mainly during prepuberty and puberty ages. The distribution according to somatotype categories showed that mesomorphic types predominate in both sexes, followed by mixed and ectomorphic ones.

Key words: Heath-Carter somatotype, children, somatotype components, somatotype categories

Introduction

The somatotype is an integral characteristic of the morphological status of an individual. It gives a complex assessment of body shape and structure. During the growth period, there are changes in physique and many specialists believe that there is a pronounced dependence between the characteristics, which determine the somatotype, the sex, the age of an individual, and the specific climate-geographical and socio-economic factors [1, 3, 6, 9, 10, 11, 12, 14, 19, 20, 21, 22, 23, 24]. The results of such research are of great practical importance in a number of directions, especially in medicine, as they are related to the prevention of a number of diseases.

The purpose of the present study is to investigate the age and sex-related changes that occur in the somatotype characteristics of children and adolescents from the Eastern Rhodope Mountains, and to contribute to the formation of the overall morphological picture of the adolescent generation in Bulgaria.

Material and Methods

The study involved 1481 /782 girls and 699 boys/ clinically healthy children and adolescents, aged 7-17, from the region of the Eastern Rhodope, Bulgaria. They were divided into 11 age groups, for each year of age. The study was conducted in the period 2007-2008 according to the classical methodology of Martin-Saller [7], after prior parents' information and their signed consent, in accordance with the „International Helsinki Federation for Human Rights" 1976, re-signed as „International Partnership for Human Rights" 2013. The somatotype of each child was determined according to the methodology of Heath & Carter [3, 4], which gives reliable data on the manifestation of the three components – endomorphic, mesomorphic, and ectomorphic. The values of the three components represent the somatotype in numerical form using somatotype units /SU/.

Directly measured were the main anthropological parameters for determining the somatotype: height, weight; biepicondylar diameters of humerus and femur; the circumferences of the arm and forearm, and the skin folds of the triceps, calf, subscapular and suprailiac skin folds. Toteva and Nacheva's graphic model was applied to represent the somatotype characteristics [24].

The data were analyzed using the statistical package "Statistica 6.0", and the reliability of gender and age differences were verified by the ANOVA test ($p \leq 0.05$).

Results

The results of the variational analysis (X, SD) of somatotype components in each age period, in both sexes, are presented in **Tables 1-2.** Gender and age differences in the mean values are also given.

In boys, the endomorphic component varies between 3.05 SU at 7 years of age and 1.97 at 17, with the highest values reported at 8 years of age – 3.53 SU. During the growth period studied, the endomorphism changed by 1.08 SU. The second component, mesomorphic, had values ranging from 4.90 SU at the age of 7 to 4.24 SU at the age

of 17, or it decreased by 0.66 SU on average. The lowest mean values were reported for 16-year-old boys – 4.00 SU, while the highest – in 12-year-olds – 4.91 SU. The ectomorphic component at 7 years of age was 1.98 SU, and at 17 years – 3.08 SU, an increase of 1.10 SU was observed.

The endomorphic component in girls at the age of 7 is 3.25 SU, and after 11 up to 17 years of age a permanent decrease to 2.41 SU are observed. The highest values were reported for 8-year-old girls – 3.99 SU. In the growth period researched, there was a reduction in endomorphism by 0.84 SU. The mesomorphic component also showed a decrease after the age of 11. It ranges from 4.33 SU at the age of 7 to 3.17 SU at the age

Table 1. Descriptive statistics of somatotype components in boys

Age	N	Boys					
		Endomorphism		**Mesomorphism**		**Ectomorphism**	
		mean	SD	mean	SD	mean	SD
7	52	3.05	1.00	4.90	1.10	1.98	1.27
8	59	3.53	1.48	4.70	1.15	2.20	1.24
9	93	3.28	1.60	4.73	1.21	2.53	1.86
10	60	3.17	1.70	4.75	1.48	2.40	1.58
11	68	2.93*	1.30	4.79	1.47	2.43	1.52
12	58	3.08	1.25	✓ 4.91	1.33	2.30	1.49
13	63	2.69	1.27	✓4.69	1.73	2.72	1.59
14	81	2.37	1.34	4.37	1.54	✓ 3.22*	1.56
15	61	2.13	1.08	✓4.24	1.58	✓3.38	1.70
16	52	2.25	0.69	✓4.00	1.17	✓ 3.15	1.30
17	52	1.97*	0.46	✓ 4.24	1.37	✓ 3.08	1.43

Table 2. Descriptive statistics of somatotype components in girls

Age	N	Girls					
		Endomorphism		**Mesomorphism**		**Ectomorphism**	
		mean	SD	mean	SD	mean	SD
7	52	3.25	1.02	4.33	1.17	2.19	1.10
8	57	3.99	1.60	4.66	1.41	2.10	1.29
9	76	3.25	1.19	4.23	2.10	2.80	1.44
10	84	3.49	1.23	4.39	1.60	2.41	1.55
11	74	3.17	1.22	4.14	1.41	2.63	1.66
12	60	✓2.87*	0.95	3.76*	1.46	2.96	1.57
13	57	✓2.97	0.74	3.78	1.33	2.71	1.36
14	84	✓2.76	0.81	✓3.50	1.42	2.98	1.52
15	82	✓2.87	0.79	3.75	1.50	2.72	1.34
16	88	✓2.99	0.87	3.14*	1.92	2.16	1.29
17	68	✓2.41	0.66	3.17*	1.37	2.16	1.36

✓– inter-sex differences /p≤ 0.05/

*– inter-age differences /p≤ 0.05/

of 17. The reduction in mesomorphism averaged 1.16 SU. For the eleven-year period, the mean values of the ectomorphic component showed relative stability – from 2.19 SU at 7 to 2.16 SU at 17. The highest values of this component were reported for the 12th and 14th years, respectively 2.96 and 2.98 SU.

In both sexes, the mean values of the endomorphic component decreased after the age of 11, and the gender differences were statistically significant /p≤ 0.05/. Throughout the growth period, the mesomorphic component had higher values in boys, with significant differences observed after the age of 12. The differences in the ectomorphic component between the sexes, up to 13, were insignificant, and after this age, boys were significantly more ectomorphic than girls.

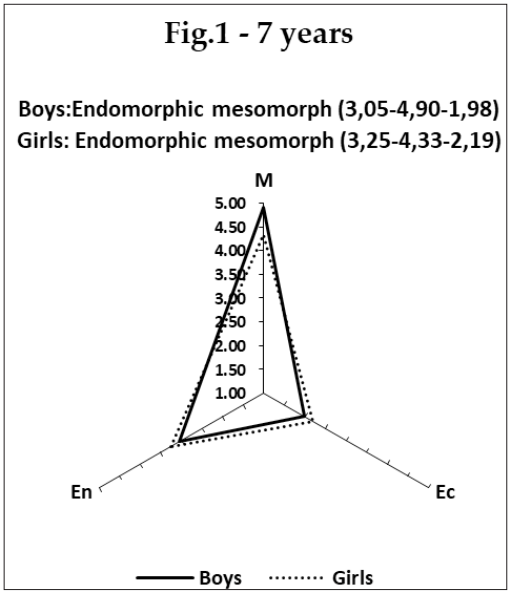
Table 3 shows that in boys up to 11 years of age, the mean somatotype was an endomorphic mesomorph. During this period, mesomorphism is predominant and endomorphism is the second component, which indicates a predominance of body weight. At the age of 11 and 13, the mean somatotype is a balanced mesomorph, characterized by a predominance of the mesomorphic component, and the other two do not differ by more than 0.5 SU. At all the other ages, the mean somatotype in boys is an ectomorphic mesomorph, representing good muscle-skeletal development.

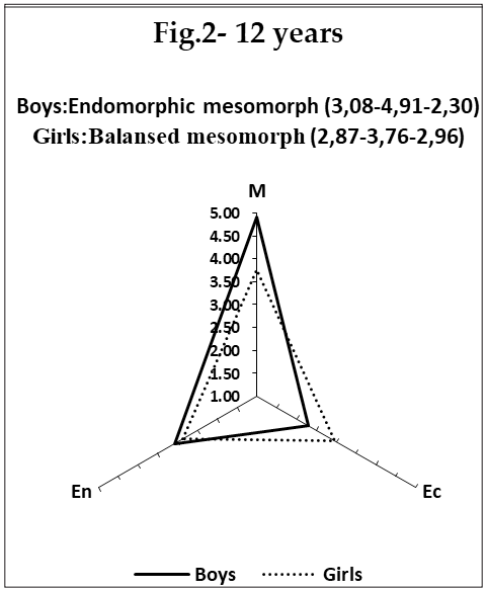
Table. 3 Average somatotype in boys and girls by age

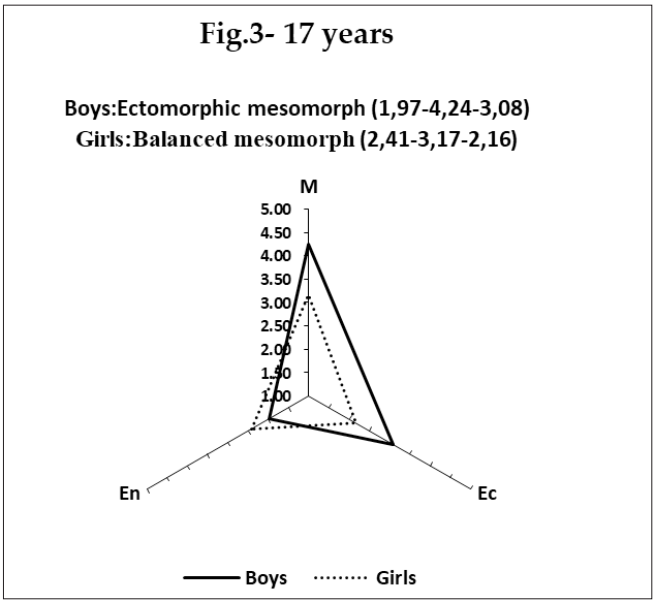
Somatotype	Boys			Age	Girls			Somatotype
	En	Me	Ec		En	Me	Ec	
Endomorphic mesomorph	3,05	4,90	1,98	7	3,25	4,33	2,19	Endomorphic mesomorph
Endomorphic mesomorph	3,53	4,70	2,20	8	3,99	4,66	2,10	Endomorphic mesomorph
Endomorphic mesomorph	3,28	4,73	2,53	9	3,25	4,23	2,80	Endomorphic mesomorph
Endomorphic mesomorph	3,17	4,75	2,40	10	3,49	4,39	2,41	Endomorphic mesomorph
Balanced mesomorph	2,93	4,79	2,43	11	3,17	4,14	2,63	Endomorphic mesomorph
Endomorphic mesomorph	3,08	4,91	2,30	12	2,87	3,76	2,96	Balanced mesomorph
Balanced mesomorph	2,69	4,69	2,72	13	2,97	3,78	2,71	Balanced mesomorph
Ectomorphic mesomorph	2,37	4,37	3,22	14	2,76	3,50	2,98	Balanced mesomorph
Ectomorphic mesomorph	2,13	4,24	3,28	15	2,87	3,75	2,72	Balanced mesomorph
Ectomorphic mesomorph	2,25	4,00	3,15	16	2,99	3,14	2,16	Mesomorph-endomorph
Ectomorphic mesomorph	1,97	4,24	3,08	17	2,41	3,17	2,16	Balanced mesomorph

In girls up to 12 years of age, the average somatotype is an endomorphic mesomorph. From the age of 12 to 16, the average somatotype is a balanced mesomorph, at the age of 16 it is an mesomorph-endomorph, and at the age of 17, it is a balanced mesomorph again. The illustration in the age changes of the average somatotype at 7, 12 and 17 years old are presented in **Figs. 1 – 3.**

Graphic somatotype models illustrating age changes







The percentage distribution of the 13 somatotype categories was brought together by us into four major groups: **Endomorphic type** – endomorphy is dominant and mesomorphic and ectomorphic components are more than one-half somatotype unit lower (meso-endomorphic and ecto-endomorphic types). **Mesomorphic type** – dominant is mesomorphy and endomorphic and ectomorphic components are more than one-half somatotype unit lower (endo-mesomorphic and ecto-mesomorphic types). **Ectomorphic type** – ectomorphy is dominant and endomorphic and mesomorphic components are more than one-half somatotype unit lower (endo-ectomorphic and meso-ectomorphic types). The remaining 7 body types (including the **central** type) are united in the group **other category** in which there are equal shares of two or three somatotype components.

The data are presented in **Table 3** and **Figures 4** and **5.**

As it can be seen in **Fig. 4**, the tendency for the leading role of the mesomorphic body structure in boys stays the same throughout the growth period, as its relative share is highest at 7, 11, and 12 years, on average about 70%. By the age of 13, the share of mixed and central types is relatively high. After the 12th year, there is a clear tendency to increase the frequency of occurrence of ecto- types at the expense of others, and at the end of the growth period, their relative share is almost equal to meso- types. Endomorphism plays an important role in the formation of body structure up to the 12th year, and its relative share is highest in the 8th and 10th years. After the age of 11, there are no boys of endomorphic type.

In girls, the leading role of the mesomorphic component remains again, with its relative share being the highest at the beginning of the growth period, about 60% – **Fig. 5**. With the exception of 11, 12, and 17-year-olds, the share of mixed and central types is relatively high. During puberty, there is a clear tendency to increase the frequency of occurrence of ectomorphic type at the expense of others, with the relative share being highest at 12- and 17-year-olds. In terms of body building, endomorphism is crucial until the age of 11, and after this age, there are no girls of endomorphic type. The highest relative share of endomorphism was recorded in 8-year-old girls.

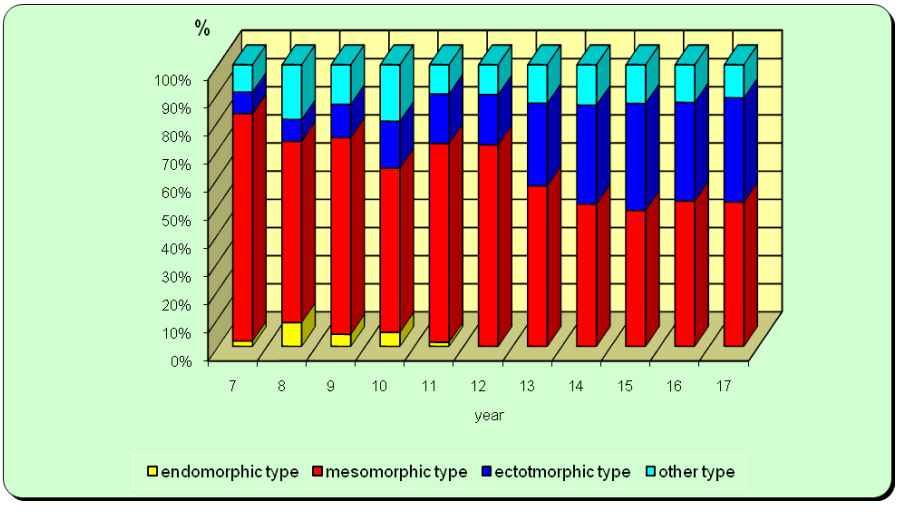


Fig. 4. Percentage distribution of somatotype categories in boys.

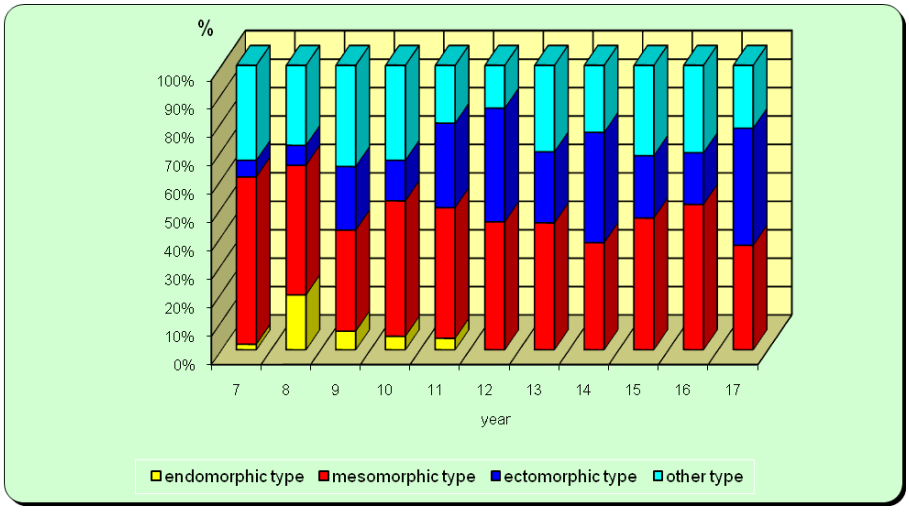


Fig. 5. Percentage distribution of somatotype categories in girls.

Discussion

In the process of growth, gender-specific changes in the individual somatotype components occur. Our results show that in both sexes in the prepubertal and pubertal periods the mean values of endomorphic component decrease, and they are the lowest in 17-year-olds, which is probably due to the pubertal growth spurt in height. At all ages, girls are more endomorphic than boys, except for 12-year-olds, with gender differences statistically significant after the age of 11. This shows a stronger development of subcutaneous adipose tissue and a relatively higher proportion of it in body composition compared to boys, which is particularly pronounced in 8-, 16- and 17-year-olds.

Many other authors report a better development of the endomorphic component in girls than in boys. [1, 6, 9, 10, 11, 14, 21, 24, 26]

In boys, during and after puberty, the amount of subcutaneous adipose tissue in the upper and lower limbs, back, and lower torso decreases, while the increase in height per unit of body mass explains the low values of endomorphism at these ages, especially in 17-year-olds. A similar decrease in the values of the endomorphic component in boys during puberty was found by several authors [8, 12, 13, 15, 16, 18, 25, 27]. For girls, significant age differences are observed between the ages of 11 and 12, and for boys in two age ranges – between 10 and 11 years and between 16 and 17 years.

The mesomorphic component is very well expressed in the boys in the initial age periods – 7-8 years and reaches its peak of development in the 12th year. Then the importance of this component for determining the somatotype decreases until the age of 17. The changes are similar for girls. These results do not differ from the results for children from Plovdiv, Sofia, and Smolyan [8, 14, 15, 18, 24]. It is noteworthy, however, that in the population of Smolyan boys mesomorphism has high values at the end of the growth period. This is probably due to the specific genetic characteristics of the population, modified under the influence of environmental living conditions. In this

regard, a higher hereditary conditionality of mesomorphism in boys has been reported in the literature, followed by ecto- and endomorphism [5], as well as the influences of hereditary factors and the environment on the individual somatotype components and the average somatotype [6, 18, 21, 23].

For boys, the ectomorphic component has the lowest values at the age of 7, and the highest – at 15. The age differences are significant between 13 and 14 years of age, and the gender differences after 13 years of age. Ectomorphism up to 13 years is higher, although insignificant, in girls, i.e., they have more elongated body shapes. After this age, the values of the ectomorphic component are significantly higher in boys, which reflects the process of forming a longer proportionality in them.

A matter of interest is the analysis of changes, with age advancing, in the ratio between the sizes of the three somatotype components. Up to the age of 11, girls somatotype is endomorphic mesomorph, from 12 to 15 years of age the mesomorphic component continues to dominate, the endo- and ecto- components are equally and less expressed, and the type turns into a balanced mesomorph. Girls' somatotype switches to the mixed mesomorphic-endomorphic type not before the age of 16, because of the harmonious development of adipose tissue, bone skeleton, and muscles.

In boys, throughout the growth period, the average somatotypes are of the mesomorphic group. Until the age of 13, the average somatotype is an endomorphic mesomorph, with the exception of the 11th and 13th years, when the average somatotype is a balanced mesomorph. After the age of 14, when the pubertal height acceleration occurs, the somatotype becomes an ectomorphic mesomorph and remains such until the end of the growth period.

Changes in the average somatotype of Bulgarian children during growth have been reported by several authors [8, 10, 12, 18, 21]. Similar changes in the average somatotype during growth have been found in Hungarian children [6]; in Czech children [20]; and in Slovenian children [26].

The percentage distribution and the frequency of occurrence of the different somatotype categories in the different age periods show that in both sexses the relative share of somatotypes with dominant mesomorphism occurs throughout the growth period and during puberty, the percentage of ectomorphic type increases. It is noteworthy that the frequency of somatotypes with a predominant endomorphic component, in both sexes, is low, and after 11 years of age, such body types are not found.

Literature analyses done on the frequency of occurrence of the 13 somatotype categories, according to Heath & Carter, in the various territorial and age groups, showed the highest percentage of mesomorphic types, similarly to our data about Smolyan and Plovdiv boys throughout the growth period. In girls, however, the mesomorphic forms predominate throughout the growth period in Smolyan girls, while, in girls from Plovdiv, they are predominant at the beginning of the period [8, 12]. During and after puberty, in girls from Smolyan, the percentage of endomorphic type increases, while in girls from Plovdiv – the percentage of ectomorphic type. These comparisons confirm the fact that each population has its own unique somatic typological profile, which can be determined by specific genetic and environmental factors.

The results of this study show:

1. Age and sex-related changes occur in both the mean values of the three somatotype components and the average somatotype.

2. The skeletal and muscular systems play the leading role in the formation of the body structure of the children, followed by the linearity and proportionality of the body.

3. In both sexes, changes in the average somatotype are observed mainly in the period of prepuberty and puberty, as well as in the post-pubertal period in girls.

4. The distribution in somatotype categories shows that mesomorphic types predominate in both sexes at different age stages of growth, followed by mixed and ectomorphic body types. Endomorphic forms are the rarest.

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