

Characteristic of the absolute and relative growth of the limbs and their segments in children and adolescents from the Eastern Rhodope region

Sl. Tineshev

*Faculti of Biology, Paisii Hilendarski Universiti of Plovdiv
Departement of Human Anatomy and Physiology, 24 Tzar Assen, 4000 Plovdiv
E-mail: slavi02@uni-plovdiv.bg*

The study is based on anthropometrical measuring of limbs and their segments in children and adolescents at the age of 7-17. Age changes in limb proportions and their changeability have been studied.

Throughout the growth period, lower limb proportions in boys are bigger than those in girls. The relative lower limb length in both sexes is the biggest at the age of 14.

The growth of upper limb segments goes in almost the same way in children of both sexes. In the beginning of the age period in both boys and girls, lower limbs and their segments are characterized with a more intensive growth compared to upper limbs, as this characteristic in boys continues to the end of the explored time period, but in girls – up to 15 years.

Limbs and their segments practically reach their definitive values at the age of 15-16 in girls, and in boys they keep growing after this age, though less intensively.

Key words: upper limb, lower limb, body proportions.

Introduction

Exploration of age changeability of a human organism is one of the most important branches of physical anthropology and human biology. For determining a human body type and assessing its total morphological development, the skeleton-metrical condition of limbs is considered as a basic anthropometrical feature, and it is very important itself for body assessment. This makes generations of anthropologists be interested and who explore limb development in the aspect of age and sex [3,4,6,8,9,10,11]. During the growth period, limbs change their initial proportions most of all body parts. They have predominantly development still in the first years of life and in the end of puberty they almost reach their definitive length. Hereditary genetic information and endocrine glands are of great significance for the sufficient development and growth of limbs and that explains their rapid development during the puberty. In this aspect, there are very

interesting pieces of research referring the influence of the exogenous factors /ethno-territorial, climate-geographical, etc. / It is well known that a growing child organism is the most responsive as to the negative influences as to the positive ones of the surrounding environment [1,7]. It is also known that these processes are specific to definite territorial groups and they have their own characteristics [4]. Following the dynamic of the physical development and the growth of body parts, there is a special attention paid to the growth characteristics of limbs, sex differences in the absolute and relative growth, as well as the proportions and correlations of limb parts.

The purpose of the present study is to analyze the age and sex differences in the absolute and relative limb lengths and their segments in children and adolescents from the south-west regions in the Eastern Rhodope region.

Material and Methods

The subjects of exploration are 1480 children and adolescents /699boys and 781 girls/ at the age of 7-17 measured at schools of the counties Ljubimets, Svilengrad and Ivaylovgrad. It was done by the classical method of Martin-Saller, 1957 [2]. We analyzed height, absolute and relative lengths of limbs and their segments. The absolute and relative annual growth was calculated. The average value / \bar{x} /, the mean square deviation /SD/, minimum /min/ and maximum /max/ were calculated by mathematical-statistical data processing. For the purpose of finding the statistically significant inter-sexual and inter-group differences, we did Student's t-test at a standard of significance $p < 0,005$. The results are presented in 13 tables and 7 figures.

Results

Absolute growth

Height / Fig.1/.

The average absolute value of 7-year-old boys is 125,2 cm and of 17-year-old - 175 cm. During the growth period from 7 to 17 years the body height increased with 49,8 cm, or 40% more than its initial length. In 7-year-old girls the absolute value of

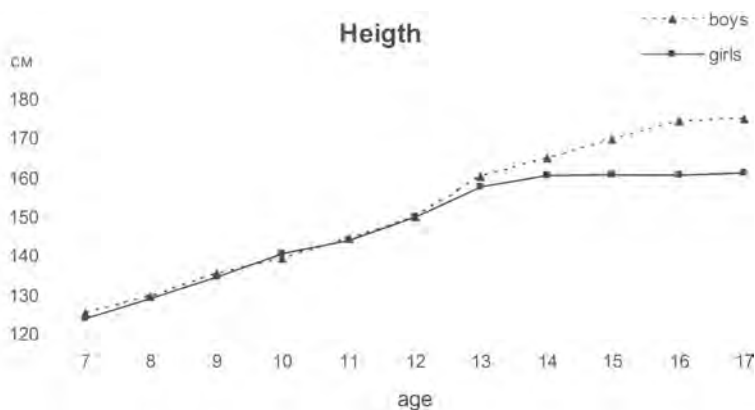


Fig.1

height is 123,7 cm, and in 17-year-olds - 161,3cm. During the explored age period from 7 to 17 years, the body height gets bigger in length with 37,6cm, or 30% more than its initial length. In both sexes the annual growth is the highest at the age of 12 and 13 / 9,9cm in boys and 7,7 cm in girls/. At every age the boys have higher absolute values of height than the girls, except the age of 10 when the girls are a little higher /1,1cm/. After the age of 13 up to the end of the growth period, the boys have statistically significant bigger height / $p < 0,05$ /.

Upper limb length /Fig.2/.

The average absolute length of the upper limb of 7-year-old boys is 54,6cm, and of 17-year-olds it reaches 77,9cm. In the period from 7 to 17 years, the upper limb length becomes 23,3cm longer, which is 43% of the output length of the upper limb in 7-year-old boys. In 7-year-old girls, the average absolute length of the upper limb is 53,7cm, and in 17-year-old girls - 71,2cm. Throughout the explored age period, the upper limb length becomes 17,5cm longer, which is 33% of its output length. The annual growth of boys is the highest between the 12th and 13th year – 4,4cm, and of girls it is a year early - 3,3cm. Inter-sexual differences show that boys have a longer upper limb and the differences are statistically significant after the age of 12 / $p < 0,05$ /.

Throughout the age period in both sexes, the percentage part of the arm in the total length of the upper limb is bigger than the part of the forearm /average 39,6% and 33,4% /

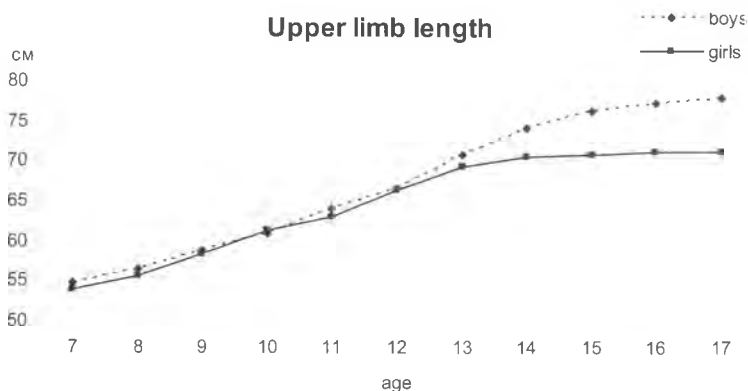


Fig.2

Arm length /Fig.3/

The average absolute length of the arm in 7-year-old boys is 21,1cm, and in 17-year-olds – 30,8cm. During the growth period from 7 to 17 years, the arm becomes 9,7cm bigger in length, which is 46% of the output arm length in 7-year-old boys. In girls, in the beginning of the growth period, the average absolute arm length is 20,9cm, and in 17-year-olds - 28,9cm. In the period from 7 to 17 years, the arm becomes 8cm bigger in length, which is 38% of the output arm length in 7-year-old girls. In both sexes, the annual growth is the highest between the 12th and 13th /2 cm in boys and 1,8cm in girls/. After the age of 15, the arm stops getting longer in girls, while in boys it continues its growth, though less intensively /0,3cm a year/. At every age, the values of the arm length are higher in boys and the differences are statistically significant after the age of 14 / $p < 0,05$ /.

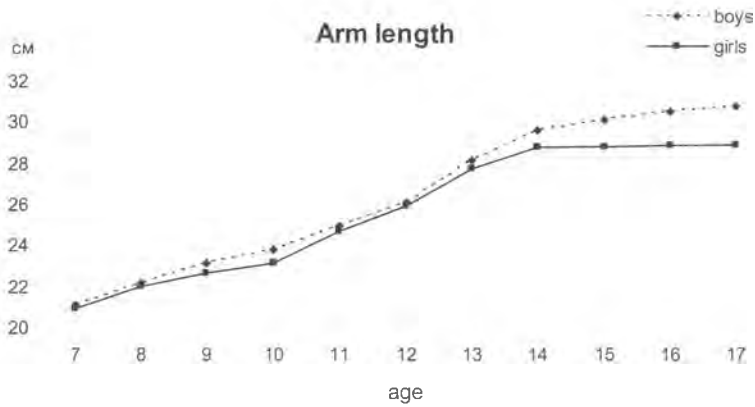


Fig.3

Length of forearm with the hand /Fig.4/

The average absolute length of the forearm with the hand in 7-year-old boys is 33,5cm, and in 17-year-olds - 46,9cm. During the explored time period, the forearm with the hand becomes 13,4cm longer, which is 40% of its output length in 7-year-old boys. In 7-year-old girls, the average absolute length of the forearm with the hand is 32,7cm, and in 17-year-olds - 42,2cm. During the growth period from 7 to 17, the length of the forearm with the hand in girls becomes 9,5cm longer, which is 30% of its output length. The annual growth is the highest between the 12th and 13th year in boys /2,5 cm/, but in girls - between the 8th and 9th year / 2,2cm/. After the age of 16, the forearm with the hand in girls stops its growth. The values of the forearm length are bigger in boys, and the inter-sexual differences are statistically significant at the age of 7 and after the 13th year up to the end of the age period / $p < 0,05$ /.

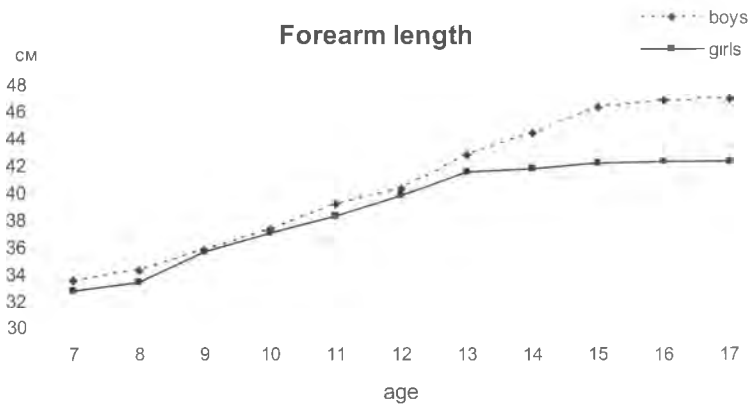


Fig.4

Lower limb length /Fig.5/

The average absolute length of lower limb in 7-year-old boys is 62,8cm, and in 17-year-olds - 92,8cm. During the time period from 7 to 17 years the length of lower limb becomes 30cm longer, or 48% of the output length. In 7-year-old girls, the average absolute length of lower limb is 64,1cm, and in 17-year-olds - 85,6cm. During the age period from 7 to 17 years, the lower limb increases its length with 21,5cm, which is 34% of its output length. The percentage part of the thigh in the total length of lower limb, in age-sexual aspect, is bigger than that of the calf /average 51% and 40%/. In both sexes, the absolute annual growth is the highest between the 9th and 10th year /4,3cm in boys and 5,5 cm in girls /and between the 12th and 13th year /5,1cm in boys and 3,4 cm in girls/, and it is the lowest after the age of 16 /0,1 cm in both sexes/. Inter-sexual differences are statistically significant in 10-year-old children and after the age of 13 up to the end of the age period / $p < 0,05$ /.

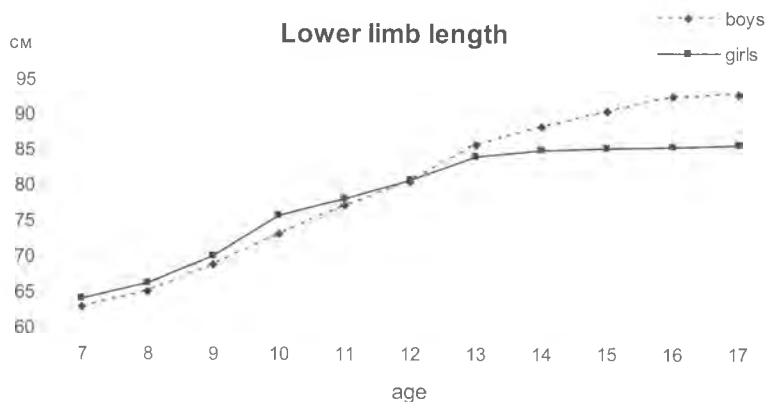


Fig.5

Thigh length /Fig.6/

The average absolute length of the thigh in 7-year-old boys is 30,3cm, and in 17-year-olds - 47,9cm. During the explored period the absolute growth is 17,6cm which is 58% of the output thigh length in 7-year-old boys. In 7-year-old girls, the average absolute length of the thigh is 31,5cm, and in 17-year-olds - 44,5cm. During the age period from 7 to 17 years, the thigh length becomes 13cm longer which is 41% of its output length. After the age of 14, the values of thigh length remain permanently higher in boys. The maximum annual growth, in both sexes, is between the 9th and 10th year /3cm in boys and 3,3 cm in girls/. After the age of 15, the thigh length increases much less intensively - 0,1cm in girls and 0,6 cm in boys. Inter-sexual differences are statistically significant at the age of 7, 9, 10, 11, 12 and after the 15th year up to the end of the growth period / $p < 0,05$ /.

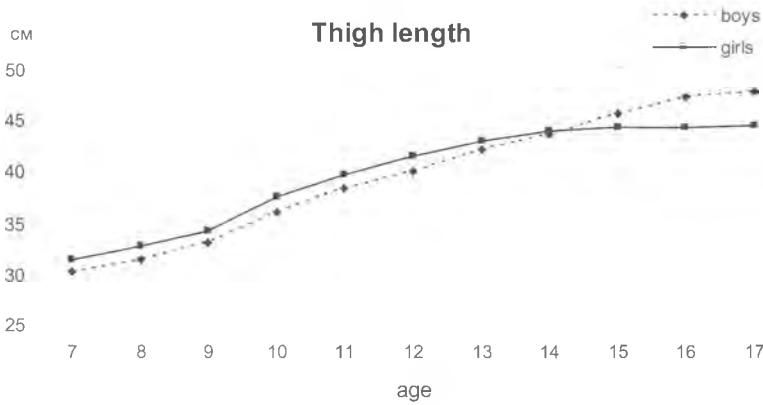


Fig.6

Length of calf with the foot /Fig.7/

The average absolute length of the calf with the foot in 7-year-old boys is 32,5cm, and in 17-year-olds - 45,6cm. During the growth period from 7 to 17 years the calf with the foot increases its length with 13,1cm or 40% of its length in 7-year-old boys. The average absolute length of the calf with the foot in 7-year-old girls is 32,5cm, and in 17-year-olds - 45,6cm. During the age period from 7 to 17 years it becomes 13,1cm longer which is 40% of its output length. After the age of 11, the values of calf length, up to the end of the age period, are constantly higher in boys. The maximum annual growth, in both sexes, is the highest between the 12th and 13th year /2,9cm in boys and 1,8cm in girls/, and the lowest after the 16th year. The inter-sexual differences in the length of the calf with the foot are statistically significant at the age of 10 and after the 12th year up to the end of the growth period / $p < 0,05$ /.

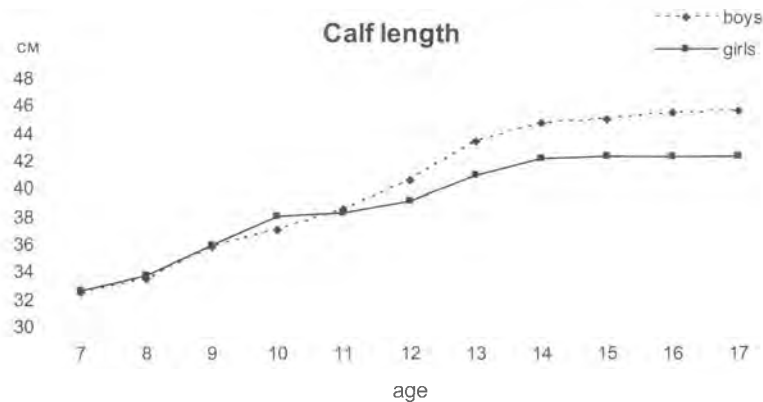


Fig.7

Relative growth

It was of great interest to follow the changes in limb proportions and their segments in boys and girls in the age period 7-17 years.

The relative length of the upper limb in 7-year-old boys is 43,6%, and in 17-year-olds - 45,1%. In 7-year-old girls, the proportion of the upper limb constitutes 43,3% of the body length, and in 17-year-olds it is 44,7%. The relative growth, in the explored age period, of 1,5% in boys and 1,4 % in girls presents the gradual annual lengthening of the upper limb.

The relative arm length in 7-year-old boys is 17,1%, and in 17-year-olds - 18,3%. In 7-year-old girls, the arm length constitutes 16,9% of the height, and in 17-year-olds it reaches 18,3%. The total relative growth of the proximal segment of the upper limb, in both sexes, is 1,4%. After the age of 15, in both boys and girls, the arm practically does not change its proportions.

The relative length of forearm with the hand in 7-year-old boys is 26,4%, in 17-year-olds it reaches 27,5%. The total relative growth of 1,1% presents the gradual lengthening of its relative length up to the age of 16, when it reaches its maximum. After this age, the relative length of forearm with the hand gradually decreases. In 7-year-old girls, the relative length of forearm with the hand constitutes 26,1% of body height, and in 17-year-olds it is 26,7%. During the explored age period, the forearm with the hand grows with 0,6%. It means that the height and the length of forearm with the hand keep almost without change their proportions i.e. they grow in parallel. Practically, after the age of 14, the relative length of forearm with the hand does not change.

The relative length of lower limb in 7-year-old boys is 50,2%, and in 17-year-olds - 52,4%. In the 11th year, boys have the same relative length of limb as those at 17. After this age, the relative limb length increases and reaches its maximum in the 13th - 14th year. Since the 15th year, the relative length of lower limb decreases to get equal with the proportions of 11-year-old boys. In 7-year-old girls, the relative length of lower limb constitutes 51,8% of the height, and in 17-year-olds - 52,7%. Throughout the growth period, proportions of lower limb change. The relative length of lower limb increases up to the age of 11, when it has the highest values - 54,3%. After this age the proportion of lower limb does not change up to the 15th year, and after that it gradually decreases. These changes in proportions of lower limb toward the height can be explained with the uneven growth of lower limb and trunk during age periods.

The relative thigh length in 7-year-old boys is 24,8%, and in 17-year-olds - 26,5%. The relative thigh length is the highest in the 16th year, when it reaches its maximum of 27,2%, because of the intensive growth of thigh in this period. In girls, the relative thigh length is the highest in the 11th year - 27,8%. To the age of 15, its proportion towards the height almost does not change, and after this age it gradually decreases. The maximum annual growth in both sexes is the highest between the 9th and 10th year /1,4% in boys and 1,2% in girls/.

The relative length of the calf in 7 and 17-year-old boys is 25,9% of height. After the seventh year, the relative length gradually increases to reach its maximum in the 13th - 14th year - 27,1%. After this age the proportion gradually decreases and in the end of the growth period, the values get equal to these of 7-year-olds. Throughout the age period the relative length of the calf in girls is different. It has the highest values in the 10th year, when the calf is 27,1% of height. The differences in the age dynamic of calf proportion can be explained with its uneven growth during the explored time period. In the beginning and end of the period, the relative calf length is the same - 26,2%.

Discussion

The problems connected to the age dynamic of morphological features are one of the important questions of modern anthropological science. It is well-known that the growth and development of a child's organism does not go evenly and it is a result of the interaction of hereditary and environmental factors. The age dynamic of height and limbs is different in children from different climate-geographical regions.

Height values, as proportion of body parts and mainly of lower limbs length and trunk, are used for determining the harmonious and proportional development of an individual. The results of our research showed that in every age group boys are taller than girls, except the 10-year-olds. This characteristic has also been confirmed in testing children and adolescents from other regions in Bulgaria [4,5].

The maximum growth rate at height did not show any sex differences and our results do not confirm the tests in other territorial groups, in which they are clearly manifested. [5]. As far as the peculiarities of growth processes in limbs length are concerned, the received data confirm this characteristic in Bulgarian children and adolescents where there is an intersection of growth curves. Girls have a longer upper limb at the age of 10, and they have a longer lower limb at the age of 12.

Conclusions

Analysis of the data allows us to draw the following conclusions:

1. There has been ascertained the specificity of growth processes in limb proportions of children and adolescents from the Eastern Rhodope region.

2. The proportion of upper limb increases in both sexes and it reaches its maximum at the age of 17, but the proportion of lower limb shows sex differences. It is the biggest in 14-year-old boys and 11-year-old girls

3. Lower limbs and their segments in both sexes are characterized with a more intensive growth compared to upper ones.

4. Limbs and their segments practically reach their definitive values at the age of 15-16 in girls, and in boys they keep growing after this age, though less intensively.

5. The growth of the proximal segment of upper limb goes in a relatively similar way in children of both sexes, but the growth of the distal segment shows sex differences which are well-manifested after the age of 13. These growth characteristics are to the contrary with lower limb segments.

References

1. Godina, E. Seasonal patterns of somatic changes Moscow schoolchildren. Coll. Anthropolog., 2002, vol.26.
2. Martin, R., Saller, K. Lehrbuch der Anthropologie. Band 1, p.661. Stuttgart: Gustav Fischer Verlag. 1957.
3. Nacheva, A. et al. Body Proportionality during the Growing up Period. Acta Morph. Anthropol. 2005, 10, 141-144.
4. Младенова, С. Антропологична характеристика на растежа и развитието на деца и подрастващи от Смолянски регион в съвременните условия на живот. Дис., 2003, Пловдив.
5. Николова, М. Возрастные изменения в пропорциях конечностей у детей и молодежи от 7 до 20 лет. Вторые антропологические чтения памяти академика В.П. Алексеева. Москва, 1999, с.121

6. Петров, И., Николова, М. Взаимоотношения между пубертет, степен на начална телесна височина и растеж на крайниците при деца от 7 до 22 години. Науч. тр. „ПУ П. Хилендарски“, 1979.
7. Петров, И., Николова, М. Телесни пропорции и корелации на 15 годишните младежи и девойки от Благоевград. Науч. тр. „ПУ П. Хилендарски“ 1984.
8. Семова, Н., и кол. Възрастова динамика на основните показатели на физическото развитие при деца и подрастващи от 3 до 17 години. Хигиена и здравеопазване № 5, 1983.
9. Слънчев, П., и кол. Физически развитие, физическа дееспособност и нервно-психическа реактивност на населението на България. НСА, 1992, София.
10. Станишев, Д., и кол. Антропометрична характеристика на пловдивските деца от 3 до 18 годишна възраст. Медицински архив, 1963, Пловдив.
11. Цировски, М. Върху някои страни от физическото развитие на деца от гр. Пловдив изследвани лонгитудинално от раждането им до навършване на три годишна възраст. Автореферат. 1976, Пловдив.