RIGA STRADINS UNIVERSITY
INSTITUTE OF ANATOMY AND ATHROPOLOGY

ZELTITE CEDERSTREMA

EVALUATION OF PARAMETERS OF PHYSICAL DEVELOPMENT OF RIGA SCHOOL AGE BOYS AT THE TURN OF THE CENTURY

Summary of Doctorate study

Speciality – morphology

Scientific supervisors:

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Dr. med., assistent professor *Ilva Duļevska*

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Doctoral study has been held in the Department of Anthropology of the Institute of Anatomy and Anthropology Riga Stradins University

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Presentation of doctoral study will bee held on the …24 february.., 2010
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Riga Stradins University, Dzirciema str. 16, Riga, Hippocrates Auditorium.

Doctoral study is available in the library of the Riga Stradins University.

Secretary of Promotional Council:

Dr. habil. med., professor ***Līga Aberberga-Augškalne***

Introduction

Life is constantly changing, bringing with it the development of the society and changes in the attitudes to different spheres of life, such as social, economic, psychologic, emocional, spiritual, physical and intellectual. It is the interaction with the external world. Health is the grounds for our routine life, which provides social, personal and physical abilities. As a result of present constant industrialization, urbanization, economic development and market globalization, the people's life styles have changed, which, in turn, influence an individual's development, health and morbidity rate.

Man's development is a ongoing process, the quantitative changes of which are periodically changed by faster, qualitative changes of the body structures and functions. Any new qualitative development stage is characterized by certain morphological and functional specificities. Physical development is the parameter of health of a growing organism.

According to the declaration, adoped in 1948 by the World health Organization (WHO), health is described as a man's physical, psychic or spiritual and social welfare. These three health aspects are being realized by interrelationship and interaction.

Physical development is characterized by the processes of the body formation, its maturation and development, corresponding to its biological age, and also its morphofunctional status at a definite period of time. The physical development of the body is subject to biological laws and depicts the overall regularities of growth and development. When analyzing the regulation of growth and development in tissues and at the level of organ systems, we have to note that there exist a lot of external and internal environmental factors, which are responsible for a variety of growth mechanisms. Gowth and development of separate organs and organ systems are characterized, first of all, by the speed of this process and its length. The growth rate, better than the body height, shows the child's physical development and the health status in each specific case. The genotype determines not only the definitive parameters of the body height, but also the growth rate and the body's maturation. It is confirmed by varieties as to the age when puberty starts in healthy children, it being from 8 – 14 years of age. Essential changes in physiological processes also coincide with the start of puberty.

Actually, a man's health is formed in childhood, and resulting from the fact, to what extent we will be able to maintain it, depends the future of other generations. The study of a child's body specificities at various ages, genders and ethnic groups allows to evaluate an important relationship of signs of biological status. Although the children's physical development has been investigated, in the research work dealing with the investigation of the children's morphological signs, however, only single development parameters in dynamics and absolute values of the growth rate have been studied so far, not considering the interrelationship of single physical development parameters within the process of growth. No analysis, or evaluation of the body proportions, or changes of morphological status within a certain time period have been done, neither the evaluation of the start of puberty in boys.

Hypothesis of research

1. Physical development of Riga school- age boys proceeds according to certain regularities.
2. Anthropometric parameters of Riga school-age boys in the study of 2005-2007 differ, comparing to the analogous research results of the 20th century in Latvia, Europe and the world.

Aim of research

To assess the morphological status and the time of the beginning of puberty of 7 to 18-year-old Riga boys at the time of century changes.

Objectives of research

1. To characterize the socially economic conditions of Riga school-age boys under research and some specific biological signs of parents.
2. To analyze the mean values of characterizing parameters of physical development in school-age boys.
3. To determine the body framework in boys, analyzing growth dynamics and interrelation of separate parameters.
4. To investigate and assess the occurrence of boys' sexual maturity, including the most significant sexual signs: degree of pubic hair (P), degree of development of testicles, axillary hair (Ax), as well as to state the time of occurrence of sexual maturity in boys with various morphological status..
5. To state the constitutional type of boys in the definitive age.
6. To assess the possible tendencies of acceleration process of school-age boys and to compare them from the ethnoterritorial aspect.
7. On the basis of the acquired data, to work out the scale of physical development and sexual signs to be applied in practice for evaluating them in reference to Riga school-age boys.

Aim of research

To assess the morphological status and the time of the beginning of puberty of 7 to 18-year-old Riga boys at the time of century changes.

Practical significance of research

Up to now, only few studies had been done on the investigation and wider analysis of parameters of physical development of schoolchildren and adolescents, especially, boys. In the literature one can find the data on the study of some parameters, like the body height, body mass and the chest circumference. In oder to have an opinion on the population and the nation's health status and physical development, the studies have to be carried out regularly, thus allowing to compare the present data with those of scientists in other countries.

The assessment of the boys' morphological and anthropological signs allows to find out the tendencies connected with the century change processes in Latvia and to include them into the average level of European standarts.

On the basis of research results, the tables drawn demonstrate the relationship of the body height and body mass of the boys from 7 to 18 years of age.

The data on the body parameters and shift in proportions from norm, detection of secondary sexual development stage play a significant role for the clinical studies of boys and grown-up males, for timely diagnostics of endocrine disorders, treatment, and also in urology of children and adolescents.

If during measurements a deviation from norm or a pathology was diagnosed in boys, then the school nurse and the boys' parents got informed about it. In case of need a respective specialist's consultation was recommended.

Norms and pathologies in the physical development can be applied in the teaching process, making up a stand and placed at the RSU Institute of Anatomy and Anthropology and Jēkabs Prīmanis Museum of Anatomy.

Practical tables and parameters of physical development are recommended for medical workers, in order to follow up the boys' growth and development process.

Reasearch structure and size

Promotion work is written in the Latvian language. It comprises 8 parts: introduction, literature survey, materials and methods, results, discussion, conclusions, list of literature. Promotion work comprises 180 pages, including tables and pictures, in the appendix - 58 tables and 79 pictures. The list of literature includes 293 references. There are more than 22 publications on the promotion work, 7 of them in journals in the English language.

Material and methods

The anthropometric measurements of Riga schoolboys carried out from 2005 to 2007 were taken for the basis of the research work..

Schools where measurements were done, were chosen by their territorial location within the Riga city – Riga centre, Sarkandaugava, Ķengarags, Jugla, Pārdaugava. There were included also Rīga Stradiņš University (those boys were measured who live in Riga), Rīga 3rd, 28th and 49th secondary schools, Natālija Draudziņa gymnasium, Jugla secondary school, Valdorf school, Valdis Zālītis school and Rīga Applied Art school, and also several pre-school institutions – 46, 65, 169, and 196th kindergarten (Table 1). On the school director's permission and coordination by the teaching manager, the school nurse got informed and agreed to participate in the process of anthropometric measurements.

A week prior to making the measurements, the nurse, together with the class teacher, distributed thye questionnaire forms to boys to be handed to their parents. The boys were informed about the day and the time when the measuring is going to take place. After getting a consent from the boy and his parents, the boy arrived to do the measurements, bringing the filled in form and parents' signature on it. With the directors and the teaching manager's permission, the measurements were done during the class time.

Table 1. Distribution of boys under study by the teaching institution.

Schools	N	Per cent
Riga Stradins University (RSU)	63	4,6
Riga secondary school Nr. 3	289	21,3
Riga secondary school Nr. 28	106	7,8
Valdorf's school	70	5,2
Riga secondary school Nr. 49	215	15,8
Natālijas Draudziņas secondary school	218	16,0
Valda Zālīša primary school	107	7,9
Centra Daiļamatniecības primary school	87	6,4
Juglas secondary school	146	10,7
Kindergarten Nr. 169	12	0,9
Kindergarten Nr. 173	14	1,0
Kindergarten Nr. 46	7	0,5
Kindergarten Nr. 65	11	0,8
Kindergarten Nr. 196	14	1,0
Total:	**1359**	**100,0**

In total 1359 boys from 7 to 18 years were investigated. The programme of morphological status deals with research aim and objectives, such as: inquiry and questionnaire, anthropometric measurements, data mathematical-statistical processing, analysis of results, comparison of results and working out the standarts of physical development for school-age boys. The data acquired during the

survey and from the measurements are fixed in our protocols – questionnaire forms. In the anthropometric measurement programme are included the longitudinal and width measurements, the body circumference, body mass and four skin and subcutaneous fat (adipose) folds (above *m. biceps brachii*, *m. triceps brachii*, *m. subscapularis* and above *regio suprailiaca* region), total sum of four skin and subcutaneous fat folds, body framework (active and passive mass), sizes of external sexual organs, applying the following relative sizes and indices.

All anthropometric measurements were performed using by R. Martin (1914, 1928), K. Saller (1957, 1966) un J. Prīmanis (1937) methodological guidelines, and Swiss company's "*Siber-Hegner & Co*" measuring instruments. All in all, 29 measurements were done. In total, 37 197 measurements.

The body framework is calculated on condition by equalizing the total adipose mass to that of subcutaneous fat amount (Durnin J. Y. G. Et al., 1967; Slamka M. et al., 1983; Shutte J. E., 1984).

For determining the body framework, the method was used to describe the human's growth and development, and it was found in Cambridge encyclopaedia. First of all, this method describes the boy's body density (D) according to the sum total of four fat fold density, using the following connectedness:

D = 1,1690 – 0,0788×$\log_{10}\Sigma$(4 fat fold density (mm)) – at the age till 11 years;

D = 1,1533 – 0,0643×$\log_{10}\Sigma$(4 fat fold density (mm)) – at the age from 12 till 16 years;

D = 1,1620 – 0,0630×$\log_{10}\Sigma$(4 fat fold density (mm)) – at the age from 17 till 19 years.

Then, the percentage of body fat amount is calculated (*T*%), absolute fat mass or passive mass (m_T) and active body mass (m_A), using the connectedness:

$$T\% = \left(\frac{4{,}95}{D} - 4{,}5\right) \times 100,$$

$$m_T(\text{kg}) = T\% \times m(\text{kg}),$$

where *m* – body mass is expressed in kilogramms

$$m_A(\text{kg}) = m(\text{kg}) - m_T(\text{kg}).$$

Absolutely passive mass (kg) = passive mass % x body mass/100

Absolutely active mass (kg) = active mass % x body mass/100.

The puberty stage is used, applying J. Tanner's (1962) method. In the evaluation of puberty are included the family history data on the break of the voice, pollutions and assessments of somatoscopic signs. The boys were assessed for the degree of the body hair on the face (B), axillary hair (Ax), pubic hair (P). The onset of the break of the voice and pollutions in boys was fixed by *Status Quo* method.

The degree of the development of puberty signs, the break of the voice and pollutions were determined by clusterization of correlation coefficient matrix, performed by an average distance method. Clusterization dendrogrammes are shown in the correlation coefficient scales.

Mathematical processing of the acquired data was done by using computer programme statistical analysis package *SPSS Statistics 17.0, PASW Statistics 18.0, MS Excel, CIA* at Rīga Stradiņš University, Institute of Anatomy and Anthropology and Department of Physics. For the comparison are used absolute numbers and percentage rate. The acquired results are put in the order numerically and graphically.

Results

Characteristics of social status of Riga school-age boys on the basis of the study data of 2005-2007

According to the questinnaire data, characteristic parameters of boys and their family conditions and the social economic status correspond to the average situation in Riga in 2005 – 2007. The boys included into the study were from the families where both parents and all grandparents were Latvians -552 (71,7%), one of the parents or some of grandparents of other nationality – 105 (13,6%),

one of the parents or two grandparents were of a different nationality – 79 (10,3%), both parents or all grandparents were of a different nationality – 34 (4,4%).

Father of 420 (48,9%) boys had the higher education, 1 (0,1%) – with a scientific degree, 210 (24,4%) – incomplete higher education, 213 (24,8%) – completed secondary education, 4 (0,5%) incomplete secondary education, 10 (1,2%) – completed primary education, but 1 (0,1%) – incomplete primary education. Mothers of 578 (63,4%) boys had a completed higher education, 1 (0,1%) – with a scientific degree, 176 (19,3%) – incomplete higher education, 148 (16,2%) – completed secondary education, 4 (0,4%) – incomplete secondary education, 4 (0,4%) –completed primary education.

Boys were from the families with the following number of children: 1 child – 319 (23,5%), 2 children – 683 (50,3 %), 3 children – 266 (19,6%), 4 children – 52 (3,8%), 5 children – 20 (1,5%), 6 children – 4 (0,3%), 7 children – 1 (0,1%), 8 children – 2 (0,1%). Like the first child in the family - 760 (55,9 %) boys, the second – 431 (31,7%), the third – 129 (9,5%), the fourth – 24 (1,8%), the fifth – 6 (0,4%), the sixth – 1 (0,1%), the eighth – 1 (0,1%) boy.

The greater part, i.e., 92,9% families lived in flats with sewarage, hot water and a bath.

Average family income in a month per a single family member was as follows: till 50 Lats - comprised 6,1%, from 50 till 100 Lats – 18,7%, from 100 till 200 Lats – 37,3%, more than 200 Lats – 38,0%.

According to LR Central Statistics Bureau data, the subsistence minimum for one inhabitant in January (in Lats) in 2005 was Ls 100,42, in 2006 – Ls 111,97 and Ls 124,33 – in 2007. Thus, 24,8% (about one fourth) boys were from the families, whose incomes per one family member were lower than that determined by LR subsistence minimum.

Father's age at the boy's birth was from 17 till 54 years, mean age – 28,0 ± 6,0 years. Mother's age at the boy's birth was from 16 till 44 years, mean age – 25,9 ± 5,1 years.

Minimum value of father's body height of the boys under study were 160,0 cm, maximum value - 206,0 cm, mean value – 181,5 ± 6,0 cm, but minimum body mass was 50,0 kg, maximum – 160,0 kg, but mean value - 87,2 ± 13,1 kg. A close and statistically significant positive correlation was found between the mean value of fathers' body height and mean value of boys' body height. The difference was not found between the boys' definitive age body height mean values depending on the father's age at the moment of the boy's birth.

Mean value of mother's body height was 148,0 cm, maximum value – 190,0, but the mean value– 167,6 ± 9,4 cm, but the maximum value of the body mass was 42,0 kg, maximum value - 164,0 kg, but the mean value - 66,3 ± 12,7 kg.

Doing the linear regression analysis, we found that there exists a close significant correlation ($r=0,737$; $p<0,01$) between mother's and father's age at the moment of the child's birth. The equation of linear regression is as follows:

Mother's age (years) = (8,705 ± 0,556) + (0,614 ± 0,092) × father's age (years).

Characteristics of morphological status of Riga school-age boys

In order to characterize the morphological status of school-age boys, we analyzed several morphological parameters, their changes and interconnection in the growth process. The main growth and development parameters were assessed, such as, body longitudinal and width parameters, as well as body circumference, which are typical for accelerated and delayed growth periods, which very well characterize the course of the growth process.

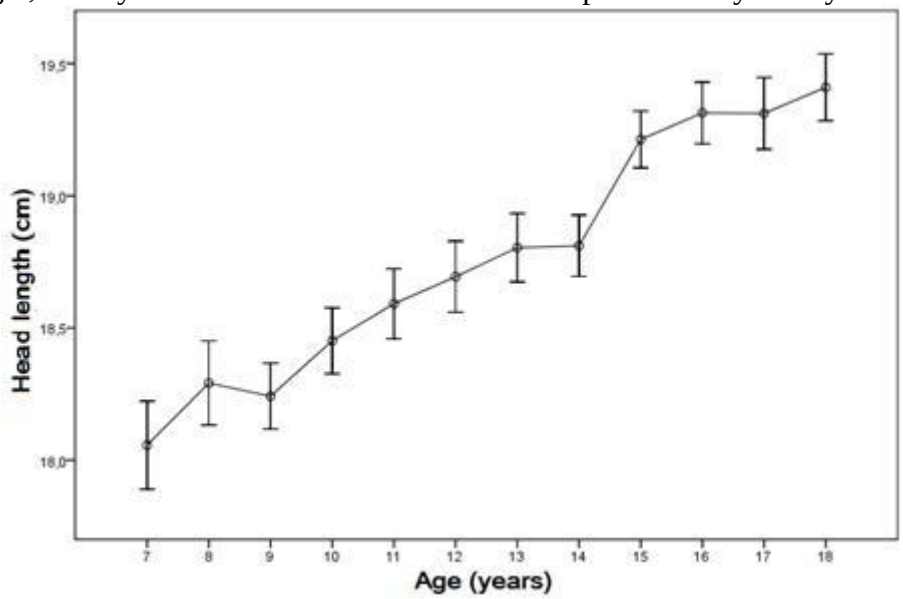
Head parameters

The head growth and development differ from the body growth and development, since the head growth is closely connected with the development of the brain. In comparison to other organs, the

brain, already in its early embryonal period, reminds its definitive parameter. This is the explanation, why the brain reaches its final size faster in comparison to other parts of the skeleton.

The greatest length of head

The mean value of the greatest head length for seven-year old boys is 180,6 ± 7,0 mm (Picture1). At the age of 18 years this size is 194,1 ± 7,5 mm. At the age from 7 till 18- year-old boys it increases on average by 13,0 cm. By 14 years of age this size grows on average by 1,0 līdz 2,0 mm per year. At the age of fifteen years, there is the fastest growth rate: the head length grows by 4,0 mm per year. Then this size continues gradually growing by 1,0 mm per year, reaching its maximum at the age of 18 years – on average 194,1 mm, which is estimated as a very long head. It demonstrantes that by the head length, all boys are included into the Nordic European country family.



Picture 1. Mean values and 95% confidence interval of head length (cm) of boys and adolescents in relation to the age

The greatest head width

The greatest head width for seven year old boys vary from 127,0 mm till 160,0 mm, mean value - 142,1 ± 6,1 mm (Picture 2). At the age of 18 years the greatest head width vary from very narrow (100,0 mm) till a wide head (167,0 mm), on average - 150,6 ± 7,9 mm, which corresponds to a moderately wide head. This size is gradually growing – within a year from 0,3 mm till 1,6 mm. The boys at the age from 12 to 13 years are seen to have the fastest growth of the average value of the head width, i.e., 2,0 mm per year. The head width continues growing with the rate 0,1 – 0,7 mm per year, reaching the maximum – 150,6 mm at the age of 17 years.

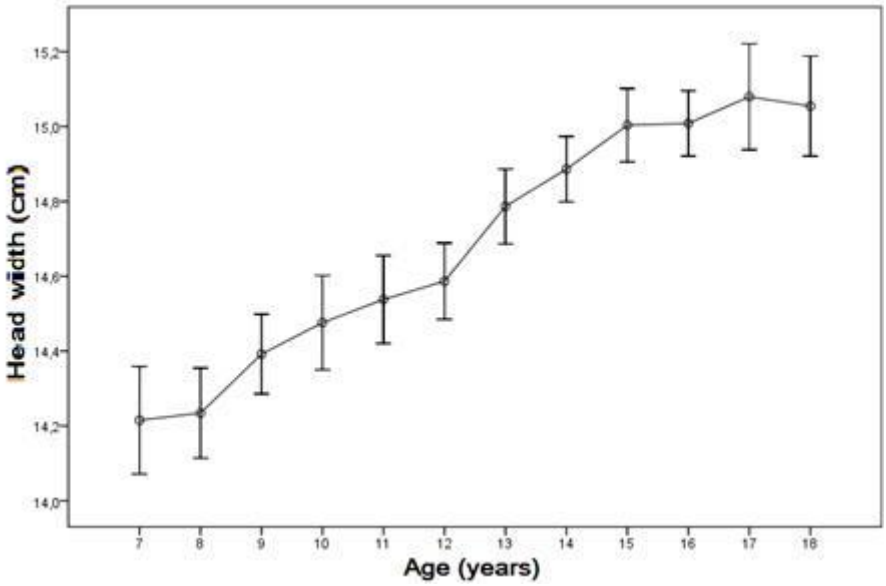
The greatest growth of head width is stabilizing from 15 years of age, when the curve does not show a statistically significant increase of this parameter, respectively, slight deviations are of accidental character.

Head index

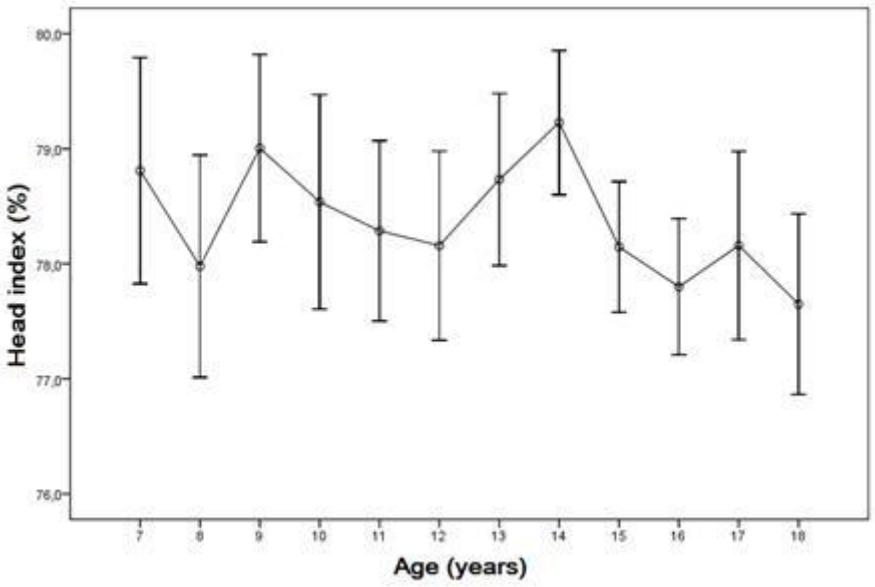
The head index or head length – width index is calculated by the formula:

Head length-width index = the greatest head width/greatest head length × 100.

The head index of boys at 7 years of age varies within 68,9 till 91,4%, on average - 78,8%. The head index at 18 years of age varies from 64,5 till 88,9 %, on average - 77,7% (Picture 3).



Picture 2. Mean values and 95% confidence interval of head width (cm) of boys and adolescents in relation to the age



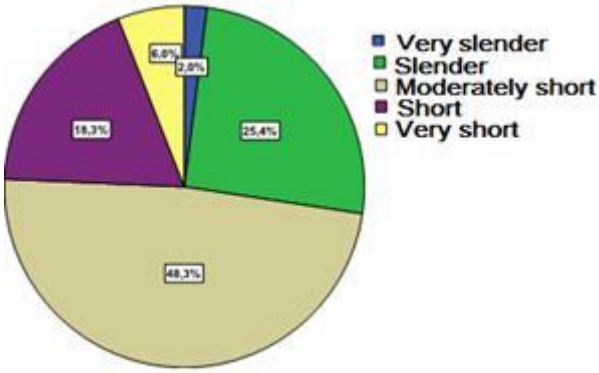
Picture 3. Mean value of Head index of boys and adolescents (%) and confidence interval 95% in relation to the age

By head index variation, the boys' heads are hyperdolychocephalic up to brachycephalic head, however, on average, all age group boys, by their head index fall into mesocephalic head form group (Picture 4).

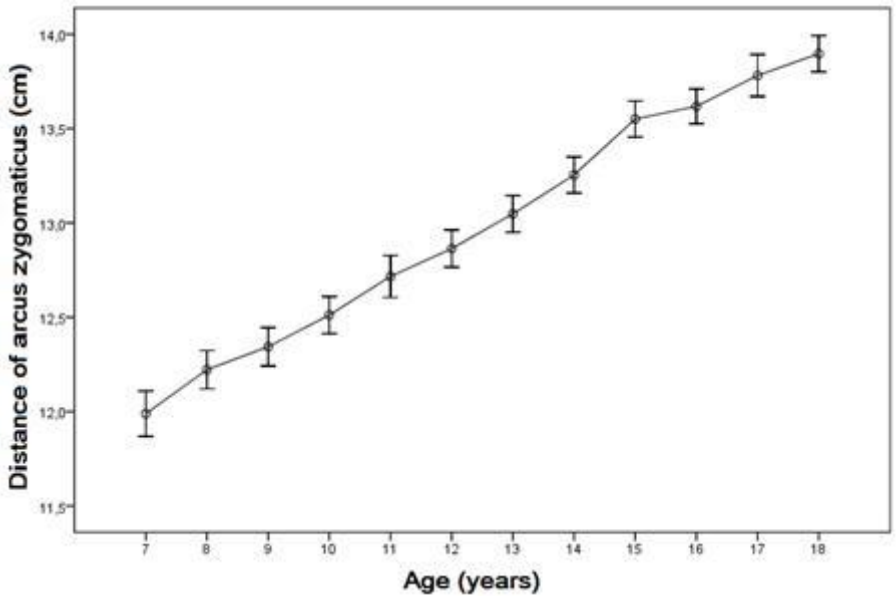
It is quite evident that about half of boys (48,3%) has a moderately short head form, about one fourth (25,4%) of the head form can be estimated as slender, and one fifth (18,3%) – a short head form.

The greatest width of the face (distance of *arcus zygomaticus* or superior width of the face)

At the age of seven years the boys' width of the face or the distance of *arcus zygomaticus* varies from 105,0 mm till 132,0 mm (Picture 5). At the age of 18 years this size varies from 115,0 mm till 160,0 mm, reaching, on average,139,0 ± 5,7 mm. The width of the face is gradually increasing with a rate from 0,7 till 1,6 mm per year, reaching its maximum at the age of 18 years.



Picture 4. Distribution of boys and adolescents by head form



Picture 5. Mean values of boys' and adolescents' distance of *arcus zygomaticus* (cm) and 95% confidence interval in relation to the age

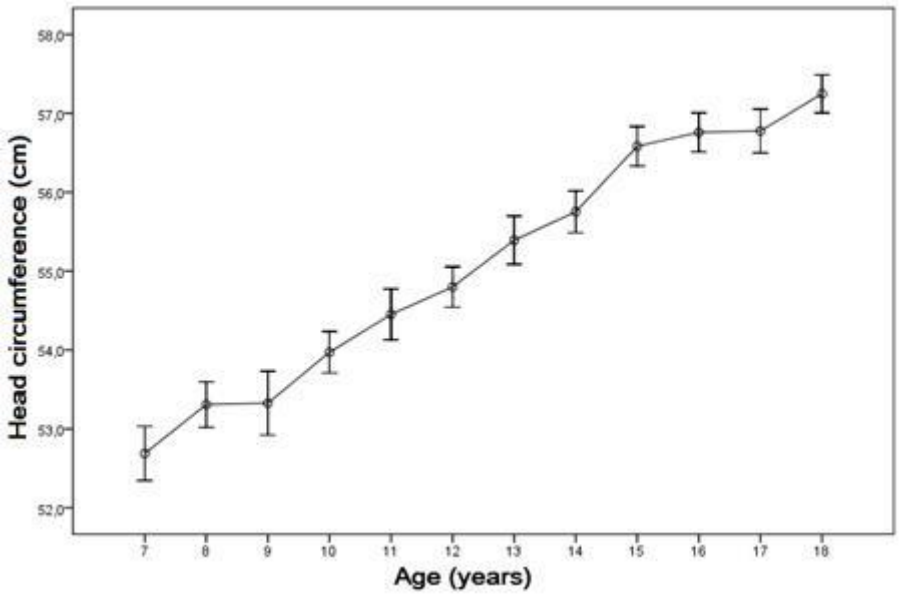
Morphological length of the face

At the age of seven years the morphological length of the face varies from 81,0 till 112,0 mm, on average - 97,5 ± 5,6 mm, which has to be evaluated as a low face. At the age of 18 years the variations of this size are 95,0 – 135,0 mm, on average – 115,5 ± 7,3 mm. From 7 till 9 years of age this size is growing very gradually with the rate from 1,0 till 0,7 mm per year. From 10 till 11 years of age the mean value of this size increases by 2,5 mm, at the age of 12 years – 1,6 mm, at the age of 13 years – 2,9 mm, at the age of 14 years – 1,0 mm, at the age of 15 years – 3,3 mm. Stabilization of the length of the face is observed from 15 years of age. Morphological length of the face objectively depicts the dynamics of longitudinal sizes. From 7 years till 18 years of age the morphological length of the face increases by 18,0 mm, and the mean geometrical value of the growth rate is 1,4 mm per year.

Head circumference

Head circumference (Picture 6) at the age of seven years varies from 49,7 till 56,0 cm, mean value is 52,7 ± 1,5 cm, which is growing in the following age groups, reaching its maximum at the age of 18 years, when it is 57,2 ± 1,4 cm. The most radical and maximum increase is observed at the age of 14 – 15 years, when the boys' circumference grows by 0,8 cm per year.

The growth of the mean value of the head circumference in boys at the age from 7 till 18 years is 4,5 cm.



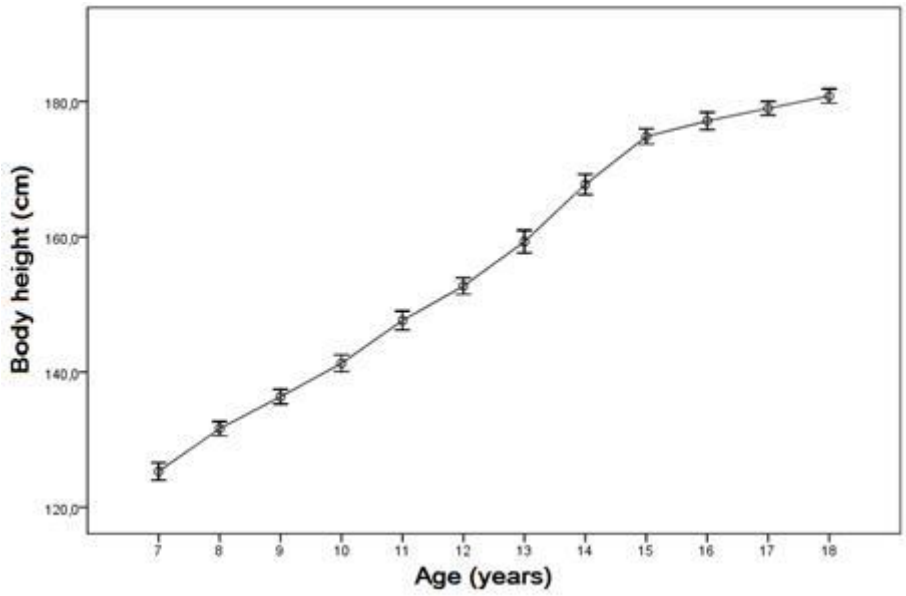
Picture 6. Mean values of boys' and adolescents' head circumference (cm) and 95% confidence interval in relation to the age

From 7 till 18 years of age the head circumference increases by 8,0 mm and the mean geometric value of the growth rate is 2,6 mm per year. The growth is continuing for about the same rate in all age intervals included in the research.

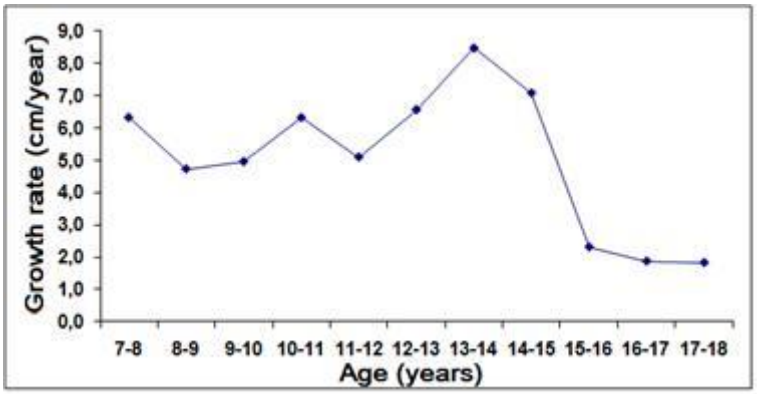
Longitudinal sizes of the body

Body height

The body longitudinal sizes are typical for accelerated and delayed growth periods, which well characterize the growth process. The body height for seven year old boys is 125,3 cm (Picture 7). Accelerated puberty (PAP) is observed at the age from 13 till 14 years of age, when the increase of the mean value of the body height reaches 8,5 cm per year. Absolute and relative growth rate decreases at the of 16-17 years (Picture 8). In this research it was found that the growth period stops at the age of 18 years, when the body height reaches 180,8 ± 6,3 cm. The greatest variations in the growth process are seen at the age of 16 years, when the minimum body height is 159,30 cm, the maximum body height – 193,4 cm, but the dispersion amplitude – 64,1 cm. At the age of 18 years the achieved body height is 180,8 cm, which by R. Martin, K. Saller and J. Prīmanis classification, can be considered as a very tall.



Picture 7. Mean values of boys' and adolescents' body height (cm) and 95% confidence interval in relation to the age



Picture 8. Mean values of boys' and adolescents' Growth rate (cm/year) of body height in relation to the age

In Picture 8 one can see that the growth rate of the body height reaches its maximum at puberty age, and about the age of 15 – 16 years the mean value of the growth rate is still 1,0 cm per year. Therefore, we can admit that the body growth in height has stopped and the increase is provided by individual differences. In the whole period the mean geometrical value of the growth rate is 4,5 cm/per year.

Body width sizes

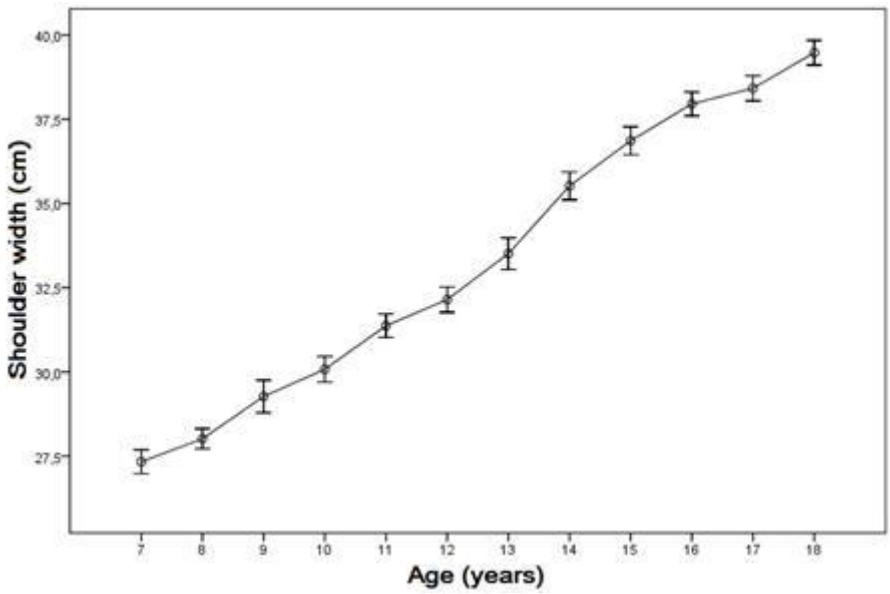
In the study of 2005 – 2007 the analysis was done of several sizes of the body width – shoulder width, *distantia spinarum* and *distantia cristarum.*

Shoulder width

At the age of seven years the boys' shoulder width varies from 24,30 till 30,80 cm, on average - 27,3 cm, standard deviation - 1,5 cm (Picture 9).

At the age of eighteen years the boys' shoulder width varies from 27,5 till 45,5 cm, the mean value is 39,5 cm, standard deviation – 2,2 cm. The maximum shoulder width is observed at the age of 13 – 14 years, when it increases by 2,0 cm. Characterizing the tendency of the shoulder witdth, we can mention that the 8-year-old Riga school boys' shoulder width makes 70,9% of the 18-year-old

adolescent's shoulder width, at the age of 10 years – 76,2 %, at the age of 12 years – 81,3 %, at the age of 14 years – 89,9% and at the age of 16 years – 96,2% of the 18 year-old boy's shoulder width.



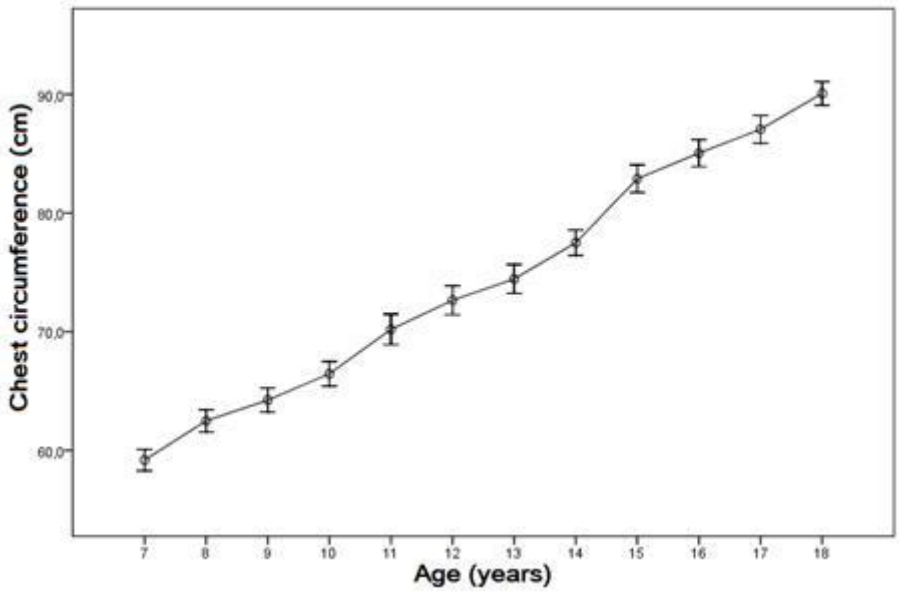
Picture 9. Mean values of boys' and adolescents' shoulder width (cm) and 95% confidence interval in relation to the age

Body circumference

In the study were analyzed several body circumferences – chest, waist and hips.

Chest circumference

Chest circumference of seven year old Riga school boys varies from 52,0 cm till 75,5 cm, on average it is 59,2 ± 3,8 cm (Picture 10).



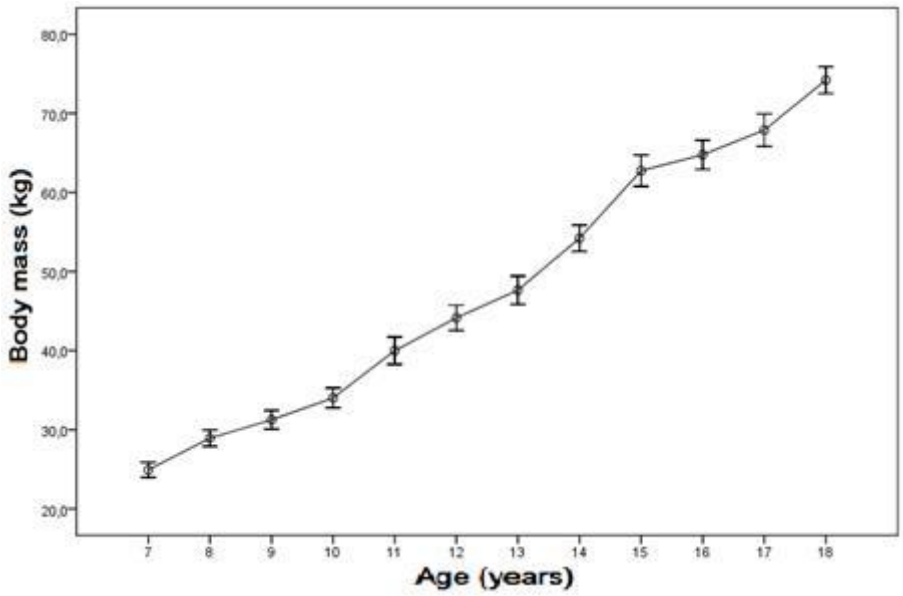
Picture 10. Mean values of boys' and adolescents' chest circumference (cm) and 95% confidence interval in relation to the age

At the age of 18 years the chest circumference varies from 78,0 till 115,0 cm, on average it is 90,1 ± 5,9 cm. The increase of the mean value of the chest circumference from 7 till 18 years is 30,9 cm.

From the age of 7 till 9 years the chest circumference increases on average by 5,0 cm. The first radical increase was seen at the age of 11 years, which in comparison to 9- year-olds has increased by 3,7 cm. From 12 till 13 years of age the chest circumference grows unevenly - 1,7 – 3,1 cm per year. The most radical and maximum increase value is observed in 14 and 15-year-old boys, when the chest circumference increases by 5,4 cm. At this age a part of boys reaches the greatest value of this size (113,1 cm), later the individual maximum value drops very fast, however, at the age of 18 yeara it reaches its maximum– 115,0 cm. The relative chest circumference in 13 – 14-year-old boys varies from 45,2 till 51,9, which, according to the classification, corresponds to a narrow chest. The boys at the age of 17 and 18 years have their chest relative circumference variations from 44,9 līdz 57,5, and it corresponds both to narrow, normal and wide chest size.

Body mass

In children and adolescents there are observed the growth periods, in which the body mass in connection with the physical developmental indices is more pronounced, and the periods, in which this connection is less oobserved. Seven-year-old boys' mean body mass index is 24,9 ± 4,1 kg. At the age of 18 years the mean body mass index is 74,2 ± 10,1 kg, but dispersion – from 55,0 till 129,0 kg. The increase of the mean body mass index in boys from 7 till 18 years of age is 49,3 kg. The increase of mean body mass index is not even, it is changeable in various age groups. The most radical body mass increase is at the age of 13 – 14 years, when it increases by 6,5 – 8,6 kg. After that the increase decreases, reaching its maximum mean value - 74,2 kg – at the age of 18 years (Picture 11).



Picture 11. Mean values of boys' and adolescents' body mass (kg) and 95% confidence interval in relation to the age

Density of skin adipose tissues

The density of skin adipose tissues in boys at different age periods markedly varies. Up to 11 years of age the mean value of the density of four various adipose tissue folds is fastly growing, when the start of puberty is marked.In the middle stage of puberty (12 – 15 years) one can observe the sharp decrease of mean parameters, which go hand in hand with the fast increase of the body height and mean body index. After 15 years of age one can observe the gradual increase of the mean value of skin

adipose tissue folds till 18 years of age. In boys the mean value of this parameter is 4,7 mm, which increases by 0,3 mm per year. The gradual increase of this parameter concides with the age when boys stop growing in height.

Changes of body proportions in growth process

By the body proportion we understand the head and neck sizes, as well as the trunk and extremity parameters, which are expressed in per cent of the total body height. A human body proportions are determined by the sizes of the skeleton, which are the variables. There is also a different growth rate for various body parts.

Interrelated proportions of the body parts are gradually changing. One of the indices of a growing human proportions is the ratio of the head circumference in relation to the body height.

In Riga boys at the age of 7 years, the head circumference makes 92,13% of 18-year-old adolescent's head size, but in relation to the body height at the age of 7 year, it is 42,1%. It shows that this age boys are characteristic of typical body proportions. By growing up, the boys' head circumference till 17 years of age is gradually decreasing in relation to the body (from 42,1 to 31,7%). At the age of 17 years the head circumference stabilizes and its relation to the body height is about 32%.

According to the relative signs in the growth period, Riga boys, on reaching seven years of age, have the fastest increase in the head width. By 11 years of age the fastest is the growth of the leg length, also the feet length, slightly increases the arm and trunk height and the shoulder width. At the age of 16 years the closest sizes to the definitive parameter are the head sizes, leg and feet lengths (Table 2).

Table 2. Changes of body proportions in relation with age (% of body height).

Age group (years)	N	Head perimeter	Trunk length	Lower extremity length	Upper extremity length	Shoulder width	Ship width
7	73	42,1	29,9	49,0	43,6	21,8	15,9
8	105	40,5	29,6	49,5	43,3	21,3	15,9
9	112	39,2	29,2	50,7	44,0	21,5	15,9
10	79	38,2	29,0	51,3	44,3	21,3	16,0
11	108	36,9	29,1	51,5	44,4	21,3	15,8
12	113	35,9	29,0	51,9	44,7	21,1	15,9
13	106	34,9	28,9	52,0	44,6	21,0	15,9
14	137	33,3	28,9	52,5	44,9	21,2	15,6
15	131	32,4	29,5	52,1	45,0	21,1	15,7
16	154	32,1	29,4	52,2	44,8	21,4	15,8
17	103	31,7	30,0	51,2	44,8	21,5	15,9
18	136	31,7	29,8	51,2	44,8	21,8	15,9

Maximum trunk height is reached at the age of 17 years (30,0% of body height), and it is closer to the dolychomorphous type parameters. The leg length reaches its maximum value at the age of 14 years when it is on the border between brachimorphous and mesomorphous structure type. The shoulder width reaches its maximum value at the age of 18 years, which is more characteristic for dolychomorphous type representatives.

Interrelated dynamics of longitudinal body parameters

The first changes in the dynamics of the body longitudinal parameters is observed in 8-9-year-old children, when the increase in the body height in a year is 6,3 cm and 4,8 cm. At this age the increase in the leg length is one of the greatest – i.e. - 3,8 cm and 3,6 cm. In the further years, up to 17 – 18 years of age, these parameters grow evenly. After that the increase of the body height and the leg length is comparatively little. The study found that other longitudinal parameters start increasing at the same age, i.e. at the age of 8–9 years. For instance, the arm length in a year increases respectively by 2,4 cm and 3,0 cm, the shoulder width - by 1,3 cm, the trunk height - by 1,5 cm.

At the beginning of puberty, at the age of 10–11 years, one can observe even increase of longitudinal body parameters. In the middle period of puberty (at the age of 13–14 years) one can observe the growth rate development by leaps with a gradual decrease of these parameters at the end-stage of puberty (at the age of 16–17 years). At the age of 17–18 years the relative trunk height against the relative body height is 29,8 %.

The relative mean leg length maximally evenly increases from 7 till 16 years of age, but the accelerated growth rate is observed at the age of 8–9 years and 13–14 years.In 17–18-year-old adolescents the relative mean leg length makes 51,2% of the relative mean body height.

Thus, relative mean arm length increases evenly up to 15 years, then the growth rate stops and reaches 44,8% of the relative mean body height.

The trunk length sizes influence the children's body height from 14–15 years of age. At the age of 17–18 years the varieties of the body height are determined by the leg length. Considering the measurement results and analyzing the acquired data, we can conclude, that the definitive factor in the body height variations is the leg length.

The leg length and the trunk length influence the body height differently. The body height in separate age groups increases relatively – it is more dependant on the leg length, rather than the trunk length parameters.

Analyzing the acquired research data of the growth dynamics of longitudinal parameters, we can conclude that the growth process proceeds harmoniously (evenly) and proportionately.

Up to 15 years of age, when one can already observe the body's constitutional type, by using the values of this parameter, the body proportions can be related to the body mass and the chest circumference growth tendencies and mutual dynamics in relation to the body height.

Starting period of boy's puberty

Puberty is the body's morphofunctional transformation and readiness to produce offsprings. The main importance lies on nervous, endocrine and sexual systems. Sexual maturity is introduced by intensified activity of nervous and endocrine systems, which include an accelerated growth in length (annual increase in growth). Puberty signs at teenage appear in a certain sequence. The development of sexual maturity can be judged by the appearance of secondary sexual signs, for instance, axillary hair and hair growth in pubic area, as well as the development of mammary gland. The boys at the age of 10-13 years develop testicles and the the first body hair. At the age of twelve and fourteen years the production of steroid hormones get activized, as a result the external genital organs start growing faster, the body hair in the pubic area become dark and curly

In boys the androgeous hormones stimulate lipolysis, therefore the boys' subcutaneous adipose tissues do not accumulate. In muscular-type boys the sexual maturity sets in earlier than in astenoide type teenagers. At the age of 13–16 years the boys are seen to have maximum androgenous and growth hormone production, which causes a faster development of secondary signs. At the age of fifteen till seventeen years the boys keep a complete development of sexual signs.

Secondary sexual signs

Face hair (B)

In the 7-11-year-old boys are not found the face hair. At the age of 12 years, four boys out of 113 or 3,7% are found B_0 or initial face hair.

At the age of 14 years all hair development stages are found. The mean age when B_0 or initial face hair is 15,7 years, B_1 degree – 17,0 years, but B_2 – 18,4-year-old adolescents (Table 3).

Hair in the arm-pits/axillary hair (*Axillares*, Ax)

The first degree (A_1) axillary hair develeopment was seen in three boys or 2,86% from 108 eleven- year- old boys. At the age of 18 years all boys had these signs in A_3 and A_4 development stage. We must note that one boy at the age of 17 years did not have axillary hair. The mean age when the boys did not have any axillary hair was 10,1 years. A_1 degree was observed on average at the age of 13,5 years, A_2 – 15,0 years, but A_3 degree – 16,8 years.

Pubic hair

The boys under study were found to have the first degree pubic hair (P_1) at the age of 11 years, i.e. 6,1% cases. Fifteen-year-old boys had all developmental stages of hair. In one case the boy at 17 years of age did not have the pubic hair. The mean age when the boys did not have the pubic hair - Po,was 9,82 years. P_1 degree was observed on average at 12,64 years of age, P_2 – 14,17 years, P_3 – 16,22 years, but P_4 – 16,88 years.

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Table 3. Development degree of secondary sexual signs (% of total number).

Age group (years)	N	Face hair			Axillary hair				Pubic hair				
		B_0	B_1	B_2	Ax_o	Ax_1	Ax_2	Ax_3	P_o	P_1	P_2	P_3	P_4
11	108	–	–	–	97,2	2,8	–	–	86,1	5,6	–	–	–
12	113	3,5	–	–	83,2	15,0	1,8	–	63,7	27,4	2,7	0,9	–
13	106	5,7	–	–	56,6	32,1	10,4	0,9	34,9	16,0	24,5	3,8	–
14	138	34,1	3,6	0,7	18,7	31,2	31,9	17,4	6,5	13,0	29,7	26,1	–
15	131	56,5	9,2	1,5	3,8	5,3	39,7	51,1	4,6	0,8	10,7	59,5	3,8
16	154	37,7	26,0	6,5	1,9	3,9	16,9	76,6	4,0	0,8	7,3	79,0	8,9
17	103	44,7	34,0	8,7	1,0	1,9	12,6	84,5	1,4	-	5,3	78,9	14,7
18	137	19,0	27,7	51,1	–	–	5,1	94,9	–	–	–	84,0	16,0

Break of the voice

According to the questionnaire data, from 677 boys surveyed, the beginning of break of the voice was seen in one 9-year-old boy or 0,1%. There was also a boy who had the break of the voice at the age of 10 years (0,1%). Then there follows a gradual increase in the number of boys with the break of the voice, which reached its maximum at the age of 13 years. Such an age is seen in 241 boys or 37%. At the age of 14 years the break of the voice had started in 219 boys or 32,4%. At 15 and 16 years of age it had started in a lesser number of boys, but at 17 years of age the break of the voice was mentioned only in one boy.

According to the research data of 2005/07, the boys' mean age when the break of the voice had started was 13,5 ± 1,1 years.

Table 4. Age when break of the voice started (per cent of total number of age group).

Age group (years)	N	Per cent of total number of age group
9	1	0,1
10	1	0,1
11	22	3,3
12	89	13,2
13	241	**35,7**
14	219	32,4
15	86	12,7
16	16	2,4
17	1	0,1

Pollutions

From the boys under study, pollutions were mentioned to start at 12 years or 0,9% cases. With growing up, the incidence rate of pollutions increases: at the age of 13 years - 2,8% cases, but at 14 years – 10,9%. Reaching 15 years of age, the incidence rate of pollutions is greater, and at the age of 18 years, more than a half of boys under study mention pollution frequence (53,7%)

Table 5. Incidence rate of pollutions in boys at various age groups.

Age group (years)	N	Per cent of total number of age group
12	1	0,9
13	3	2,8
14	15	10,9
15	43	32,8
16	64	**41,6**
17	35	34,0
18	73	53,7

According to the research data of 2005/07, the mean age of the boys when pollutions had begun was 13,8 ± 1,3 years.

Table 6. Age of starting sexual life by retrospective inquiry method.

Age group (years)	N	Per cent of total number of age group
12	2	1,2
13	9	5,5
14	22	13,4
15	40	24,4
16	49	**29,9**
17	30	18,3
18	12	7,3

The age of starting sexual life was determined by the retrospective inquiry method.According to the research data, the earliest age of starting sexual life was 12 years, which is low percentage – 1,2%, but the mean age of starting sexual life was 15,6 ± 1,4 years (Table 6).

Length of penis

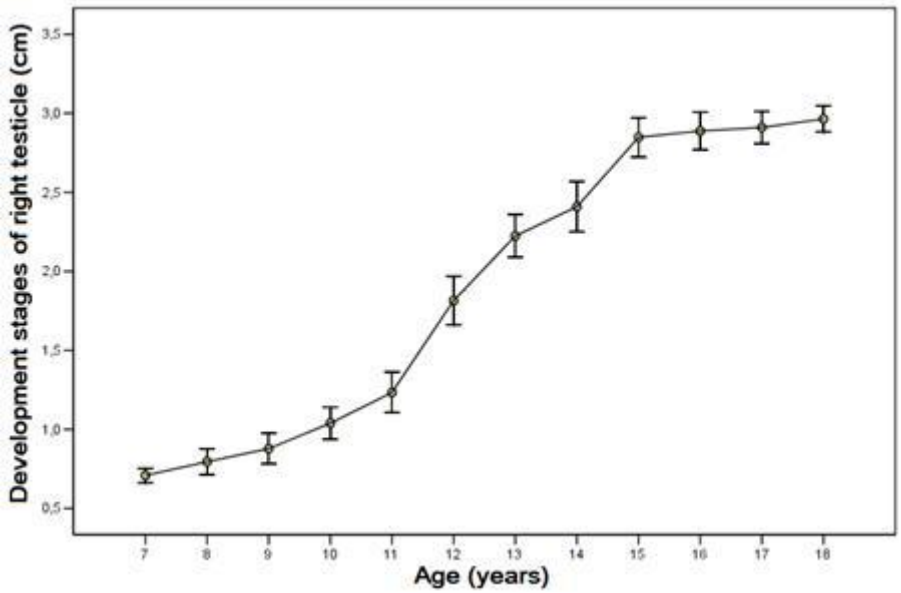
The mean size of the penis of seven-year-old boys was 2,9 cm, the variations of this parameter were from 1,5 till 4,0 cm. With the growth in age, one can observe the growth of the gradual increase of the mean value, in a year it is on average increasing by 0,5 till 0,6 cm, which reaches its maximum at the age of 18 years, when its mean value is 8,1 cm, but the variations in size - from 6,5 cm till 10,2 cm. A faster growth of the penis is observed at the age of 11 - 15 years, when the mean value of the size increases on average by 1,1 - 1,2 cm in a year.

Diameter of penis

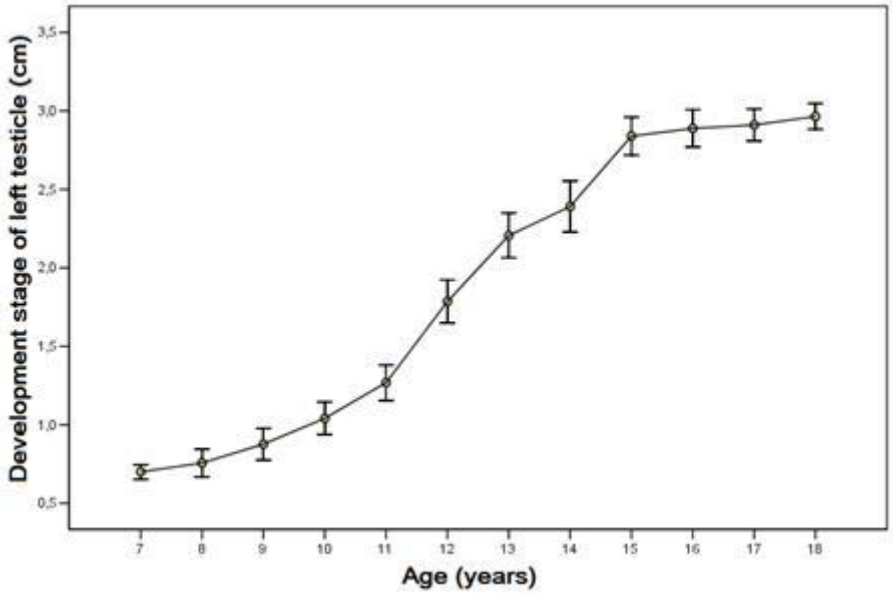
From the 7-year-old boys included into the study the mean value of the diameter of the penis was 1,1 cm, but the variations of this size – from 0,7 till 1,6 cm. Fast increase of the mean value of this size is observed at the age of 11 – 12 years, when it has increased by 0,3 cm. The fast growth continues till the age 15 years. At the age of 18 years the mean value of the diameter of the penis is 3,1 cm, but the variations of the size is from 2,5 till 3,5 cm.

Testicle sizes

The sagittal size of the right testicle of 7-year-old boys is 0,71 cm, but that of the left side – 0,70 cm. With the growth in age, there is an obvious gradual increase in the size of both testicles. Fast increase in size was observed at the age of 11 – 12 years, when testicles increased, on average, by 0,58 cm in a year. At the age of 18 years both testicles reach their maximum size: mean value is 2,96 cm, but the variations of the size are from 2,6 cm till 3,3 cm (Pictures 12 and 13).



Picture 12. Mean value of development stages of right testicle of the boys under study (cm) and 95% confidence interval in relation to age



Picture 13. Mean value of development stage of left testicle of the boys under study (cm) and 95% confidence interval in relation to age.

Table 7. Incidence rate of testicle pathologies in boys and adolescents.

Clinical status of testes	Age group (years)												**Total**
	7	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	
Normal	57	60	58	47	52	60	48	53	56	83	45	28	647
Cryptorchism (bilateral)	1	4	5	1	1	3	1	0	0	0	0	0	16
Cryptorchism (right side)	1	1	0	1	1	2	0	0	0	0	0	0	6
Cryptorchism (left side)	1	3	2	0	0	0	0	0	0	0	0	0	6
Pseudocryptorchism (bilateral)	0	1	0	1	1	1	0	0	0	0	0	0	4
Pseudocryptorchism (right side)	0	0	2	0	1	1	0	0	0	0	0	0	4
Pseudocryptorchism (left side)	0	0	1	0	0	0	0	0	0	0	0	0	1
Other patology	0	0	0	1	0	1	0	1	0	2	3	0	8
Status post operation	0	0	0	0	1	0	1	0	0	0	0	0	2
Total:	60	69	68	51	57	68	50	54	56	85	48	28	694

Intercorrelation of secondary sexual signs

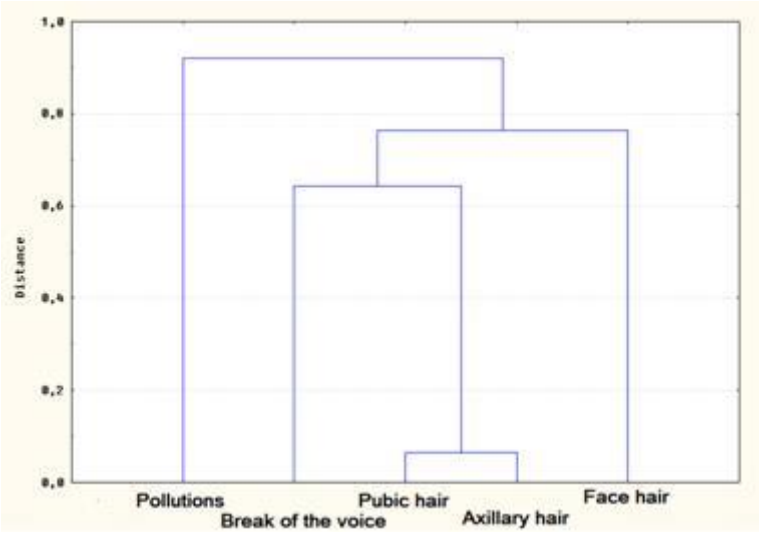
In the acquired dendrogrammes of the research programme *STATISTICA* module "*Cluster analysis*" the cluster formation method was used – Pearson's correlation coefficient clusters. This method has been used in other authors' work, which allows to compare the results acquired in the research work.

One of the advantages of the cluster analysis is the fact that it does not require to advance a hypothesis. That is why the cluster analysis is used to advance a hypothesis and to search for intercorrelations between the development degrees of secondary sexual signs.

Till the age of 10 years the secondary sexual signs in boys are mainly observed in the initial stage, therefore the variation values at this age are practically similar and are of no use for the analysis. Also at the age of 17 years, the characteristic values of secondary sexual signs, reach its maximum development degree, i.e. these values for all boys are similar, therefore the analysis of interrelation of secondary sexual signs after the age of 16 years lose sense. It means that the cluster analysis has to be done at the age from 11 till 16 years.

In 11-year-old boys the dendrogramme is designed differently from the others, because Euclide distance is calculated by a different formula. Correlation distance prrogramme cannot be calculated because there are too little data at this age.

At the age of 12 years the closest sign of development degree is the pubic hair (P) and axillary hair (Ax), which is seen in the dedrogramme as a combination of clusters, where the distance of correlation coefficients is the least (Picture 14). The cluster of the break of the voice is added to this combination of P and Ax clusters. There is a great distance as to the face hair (B) and pollutions. Thus, from all the secondary sexual signs at the age of 12 years, the most interrelatedly develop the pubic hair and axillary hair degree.

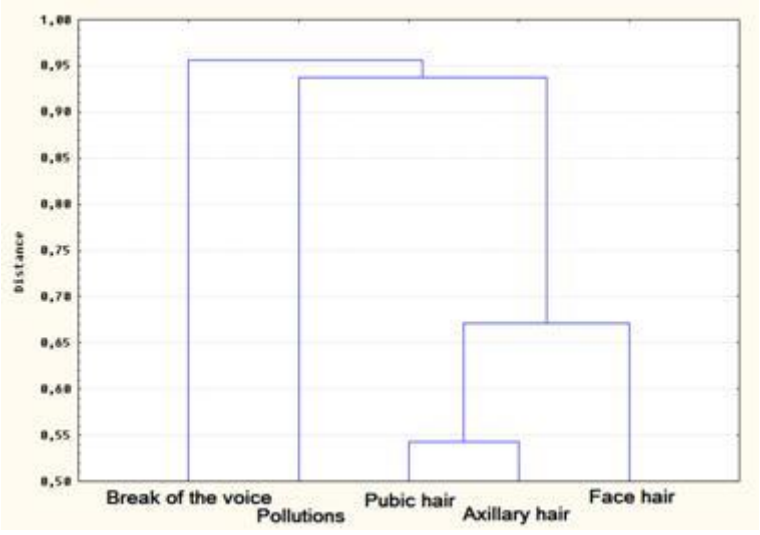


Picture 14. Dendrogramme of secondary sexual signs in 12-year-old boys

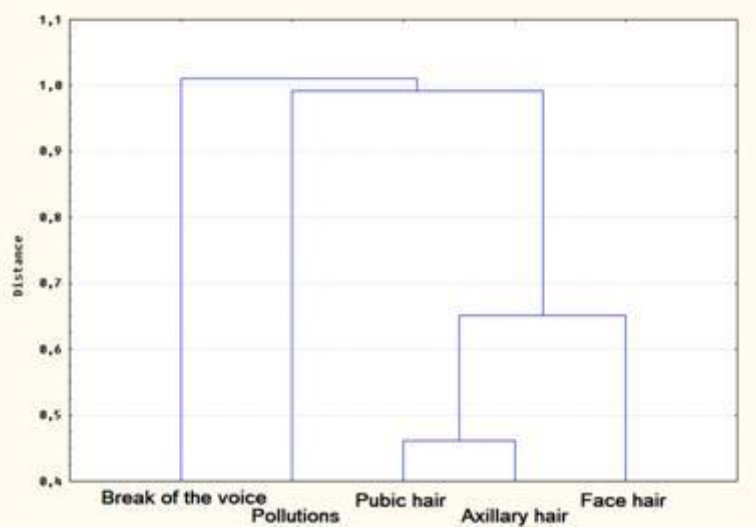
Comparing the dendrogramme of secondary sexual signs of 12-year-old boys with the same of 13- and 14-year-old boys, we see that the distribution of clusters has remained the same.

To the cluster of pubic hair and face hair of 15-year-old boys are simultaneously added axillary hair and the break of the voice cluster.

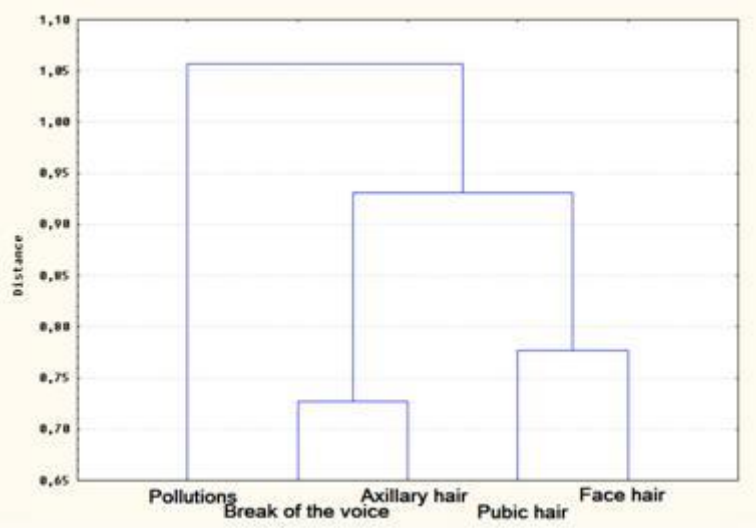
To the cluster of pubic hair and axillary hair of 16-year-old boys are added face hair cluster, which is followed by pollutions and only then the break of the voice (Picture 15).



Picture 15. Dendrogramme of secondary sexual signs in 16-year-old boys



Picture 16. Dendrogramme of secondary sexual signs in 17-year-old boys



Picture 17. Dendrogramme of secondary sexual signs in 18-year-old boys

In 17-year-old boys (Picture 16) the distribution of clusters has remained the same as at the age of 16 years.

At the age of 18 years (Picture 17) there are formed two subclusters – between the pubic and face hair, as well as between the axillary hair and the break of the voice. To both subclusters are added a pollution subcluster.

Chronology of development of secondary sexual signs

Analyzing the acquired data of the research of 2005/2007, there is observed a certain chronological sequence in the boys' sexual development. The mean values of puberty are different.

Determining the face hair development degree (B) in boys, each stage is referred to by a definite mean age (M):

B_0 – initial face hair M = 15,7 ± 2,7 years;
B_1 – moustache and beard round the mouth M = 17,0 ± 1,5 years;
B_2 – moustache and beard also on cheeks M = 18,4 ± 1,4 years.

Degree of axillary hair (A) is marked at the following mean age:

A_1 – some hair	M = 13,5 ± 1,1 years;
A_2 – hair in axillary centre	M = 15,0 ± 1,3 years;
A_3 – long, curly hair along the whole of axilla	M = 16,8 ± 1,6 years.

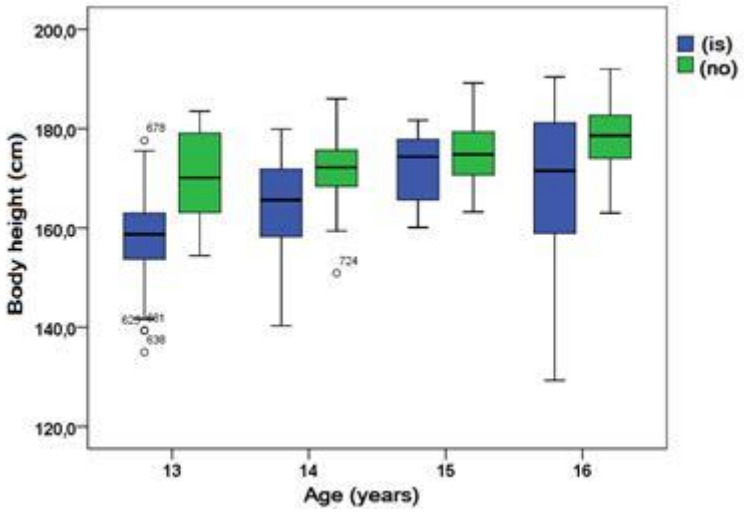
Degree of pubic hair (P) is marked at the following mean age:

P_1 – separate short hair	M = 12,7 ± 1,0 years;
P_2 – in the centre thicker, longer and straight hair	M = 14,2 ± 1,1 years;
P_3 – Marked, curly hair along the whole pubic triangle	M = 16,2 ± 1,5 years;
P_4 – hair passes along the white line to the abdominal wall	M = 16,8 ± 1,1 years.

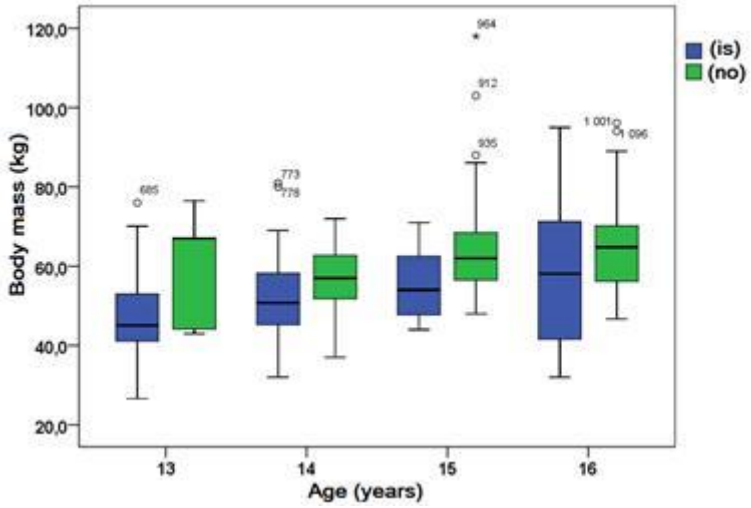
Time of developing sexual maturity in boys of various morphological status

The time of developing sexual maturity in boys can be determined by exploring several secondary sexual sign complex. The time for developing sexual maturity in the research was considered the time when there were noticed several secondary sexual signs, at least in the second development stage.Analyzing the data in such a way, we learned that the transition period is from 13 to 16 years of age. Similarly to the girls in I. Duļevska's study, the boys were also found correlations between the boys' morphological status and the time for starting the sexual maturity time. i.e., the boys at similar age whose sexual maturity has already developed, have a bigger body height and greater body mass.

The boys' body height in relation to the age and developing of sexual maturity or its absence is shown in Picture 16. In the diagram we can see that in 13-year-old sexually mature boys the median of the body height is 170,1 cm, but in boys who are not yet sexually mature the median of the body height is 158,7 cm. By Mann-Witney test the median differences in groups are statistically confident (Z = 2,646; p = 0,008). Statistically confident differences in the median of the body height are still observed in boys only at the age of 14 years of age (Z = 4,422; p = 0,001). At the age of 15 years there already cannot be observed a statistically confident difference of the median of the body height (Z = 1,574; p = 0,115). Similarly at the age of 16 years of age no statistically confident difference in the median of the body height are observed (Z = 1,768; p = 0,077).



Picture 18. Correlation of boys' body height with the age and presence of sexual maturity (is) or its absence (no)



Picture 19. Correlation of boys' body mass with the age and presence of sexual maturity (is) or its absence (no)

The boys' body mass in relation to the age and development of sexual maturity or its absence are shown in Picture 17. In the diagram we can see that in 13-year-old sexually mature boys the median of of the body mass is 67,0 kg, but in boys who are not yeat sexually mature the median of the body mass is 45,1 kg. By Mann-Witney test the median differences in groups are statistically confident (Z = 2,069; p = 0,039). Statistically confident differences in the median of the body weight are observed also in boys at the age of 14 years (Z = 2,860; p = 0,004). At the age of 15 years there is observed a statistically confident difference in the median of the body mass (Z = 3,078; p = 0,002). At the age of 16 years no statistically confident difference in the median of the body mass is observed (Z = 1,119; p = 0,263).

Change of boys' morphological status in the aspect of secular trend

Century tendencies in relation to physical development, called also as a secular trend, can be evaluated as acceleration-retardation process, the causes of which are still not clearly explained. They are evident as a sum total of environmental and genetical factors, therefore the changes of the century are evaluated as pheotypical and microevolutionary changes. They are subject to the influence of social (by J. Tanner – psychologic) stress, social and economic changes, as well as environmental pollution and transformation.

Changes of head sizes

Since no head parameter investigations,in fact, were not included in the studies of previous years, therefore it is impossible to analyze the growth and development tendencies of the boys' heads during the century. The first news on the changes of Latvia's boys' head sizes in the growth period is given by J. Vilde in his study done in 1922. More extended studies in the second part of the 30ties of the 20th century were carried out under supervision of Jēkabs Prīmanis in various Latvia's regions, for instance, in 1936 in Vidzeme seaside and Vecpiebalga, in 1937 - in Jaunpiebalga, in 1939 – in Zemgale. From the head parameters there were included the following ones: the biggest length and width of the head, the biggest width of the face, the distance between the angles of the mandible and morphological length of the face. This anthropological material is found in the funds of Jekabs Prīmanis Museum of Anatomy.

Changes of the body height

Many scientists, like A.Plūme, K.Ādamsons, G.Fedders, L.Jēruma-Krastiņa in the 20th century, paid attention to the physical development, and considered the body height (Picture 21) to be one of the most significant parameters of children's physical development. In A.Plūme's study in 1921/22 the mean value of the body height in 7-year-old boys was 117,0 cm, in the study of 1929/30 it was – 118,3 cm. In K. Ādamson's study in 1926 it was – 116,3 cm, in G. Fedder's study in 1936– 123,9 cm, but in L. Jēruma–Krastiņa's study in 1936 – 127,9 cm. According to the study of 2005/2007 the mean body height was 125,3 cm. In A. Plūme's studies the mean body height of 8-year-old boys was 122,5 cm and 124,0 cm, in K. Ādamson's study – 123,3 cm, in G. Fedder's study – 126,5 cm, but in L. Jēruma–Krastiņa's study - 133,9 cm. In the study of 2005/2007 the mean body height was 131,6 cm.

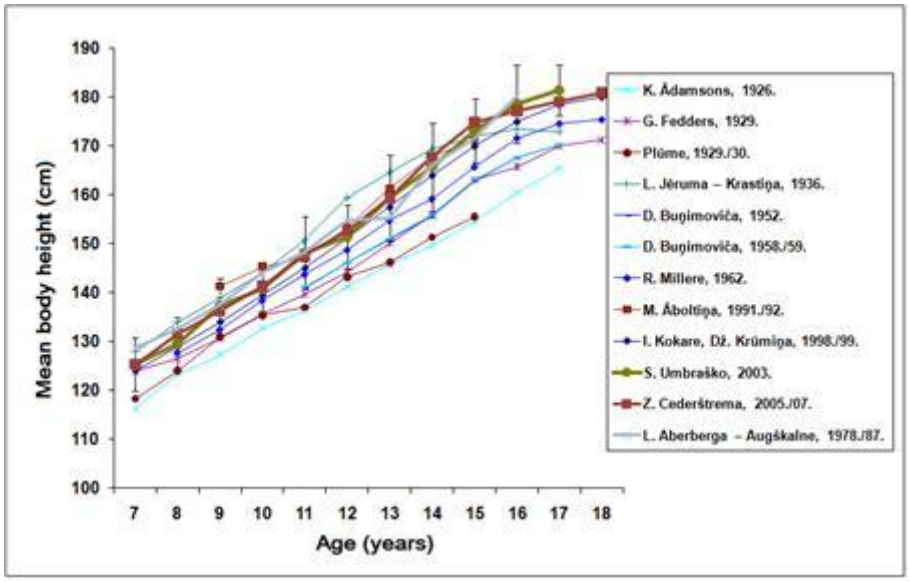
Analyzing various scientists' study data, we can see that the intensity of the body growth is varied. In A. Plūme's studies the highest increase in the body height is observed at the age of 8–9 years, when the difference reaches 5,7 cm, and at the age of 11–12 years, when the difference reaches 6,2 cm. In K. Ādamson's study the highest increase of the body height is at the age of 7–8 years – 7,0 cm, but in L. Jēruma–Krastiņa's study – at the age of 7–8 years, it is – 6,0 cm, but at the age of 11–12 years – 9,0 cm. In D. Buņimoviča's repeated measurements in 1947, 1952 and 1958/59 the increase of the body height was by 7,3 cm at the age of 14–15 years. According to R. Millere's results of study in 1960/62, one can observe the highest increase of the body height – 6,0 cm in boys at the age of 12–13 years. In the study of 2005/ 2007 the highest increase of the body height is observed at the age of 7–8 years and at the age of 13–14 years – (respectively by 6,3 cm and 8,5 cm).

According to the study data of the 20th century, in children at the age of 7 years, one can observe the manifestations of the acceleration process, which reaches its maximum at the beginning of the midstage of puberty period. The difference of the mean values of the body height in Fedder's study in 1936 and 2005/07 measurements of boys at the age of 14 years, reaching 12,0 cm, but the difference between the measurements done in 1960/62 and 2005/07 is 8,6 cm. No difference is observed in the measurements of 1991/92 and 2005/07. The body height in both studies of 14-year-old boys is 167,8 cm. The difference between the measurements carried out by S.Umbraško in 1998/03 and 2005/07 was 2,1 cm. At the puberty end-stage, the mean body height decreases.

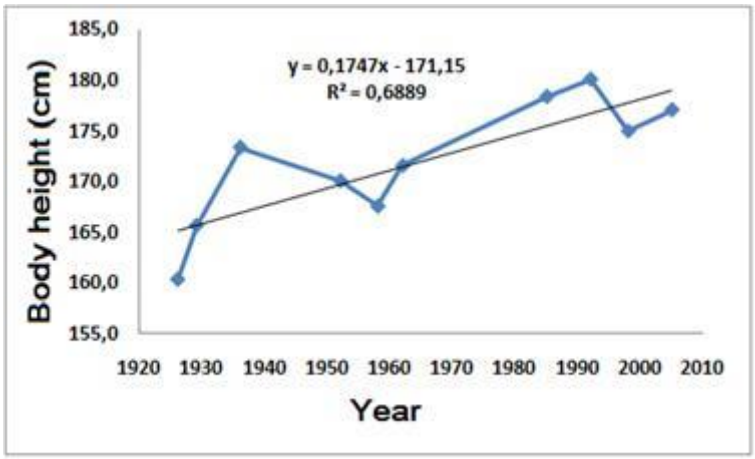
The acceleration tendencies of the body height are seen, comparing the mean measurement values of L. Jēruma–Krastiņa's studies in 1936 and 2005/07, when the difference of the mean body height of 18-year-old boys reach 7,88 cm.

Measurement results show that the mean value of the body height in various age groups during the century has increased (Picture 19). The mean value of the body height of 8-year-old boys was different in different studies: in 1921/22 - 122,5 cm, in 1929/30 – 124,0 cm, in 1936 (in G. Fedder's publications) – 128,3 cm, in 1960/62 – 127,7cm, in 2003 - 129,6 cm, but in 2005/2007 – 131,6 cm. We found such comparative data of 18-year-old boys: in L. Jēruma–Krastiņa's study in 1936 the mean body height was 172,9 cm, in G. Fedder's publication in 1936 – 171,2 cm, in R. Millere's study in 1960/62 – 175,4 cm, in I. Kokare ans Dž. Krūmiņa's study in 1998/99 – 180,0 cm, in S. Umbraško's study in 2003 – 181,4 cm, but in the study of 2005/07 – 180,8 cm.

Analyzing the data of these studies, we can find that the body height in the last century had greatly increased, however, the studies in the second part of the century and at the beginning of the 21st century point to the stabilization of the increase in the mean value of the body height. Since the body height in the first part of the 20th century studies was depicted only till the age of 17 years, then, according to the study results, we can conclude, that the boys had grown only till the age of 17 years. According to the studies carried out in the second part of the 20th century, we see that adolescents continue growing still at the age of 18 years.



Picture 20. Comparative curves of boys' and adolescents' mean body height in studies done in Latvia



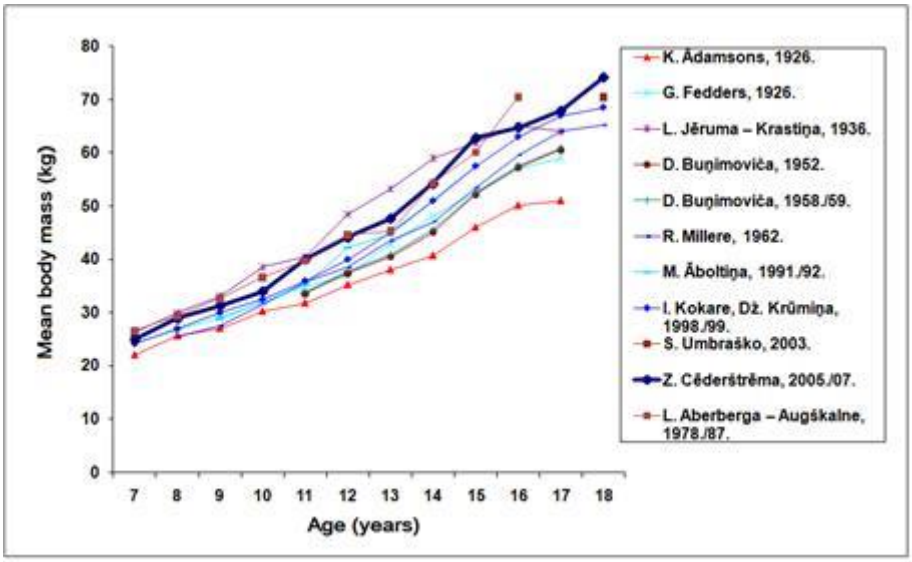
Picture 21. Mean values of 16-year-old boys' body height in studies done in Latvia, linear trend diagram and equation of linear regression

Equation of linear regression (general tendencies) shows, that the increase in the body height of 16-year-old boys is equal to about 0,15 cm per year. Determination coefficient shows, that the linear regression model explains 83,2% of dispersion (Picture 21).

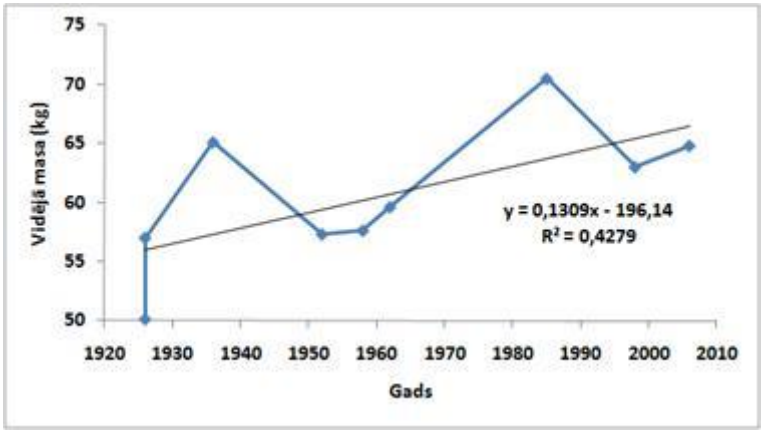
Changes of body mass

Inspecting the study results of the 20th century , one can conclude that the increase of the boys' body mass is even till the age of 15 years (Picture 22).

The mean body mass of 7-year-old boys in K. Ādamson's study in 1926 is 23,5 kg, in G. Fedder's publications in 1936 – 24,4 kg, in 1936 in L. Jēruma–Krastiņa's study– 26,24 kg, in the study of 1998/99 – 24,2 kg, in the study of 2003 – 25,4 kg, but in the study of 2005/07 – 24,9 kg. The mean value of the body mass of 18-year-old boys, according to the data of 1936 is 64,0 kg, in the study of 1960/62 – 65,24 kg, in 1998/99 – 68,5 kg, in 2003– 70,5 kg, but in 2005/07 – 74,2 kg.



Picture 22. Comparative curves of mean body mass of boys and adolescents in studies done in Latvia



Picture 23. Mean value of 16-year-old boys' body mass in studies done in Latvia, linear trend diagram and equation of linear regression

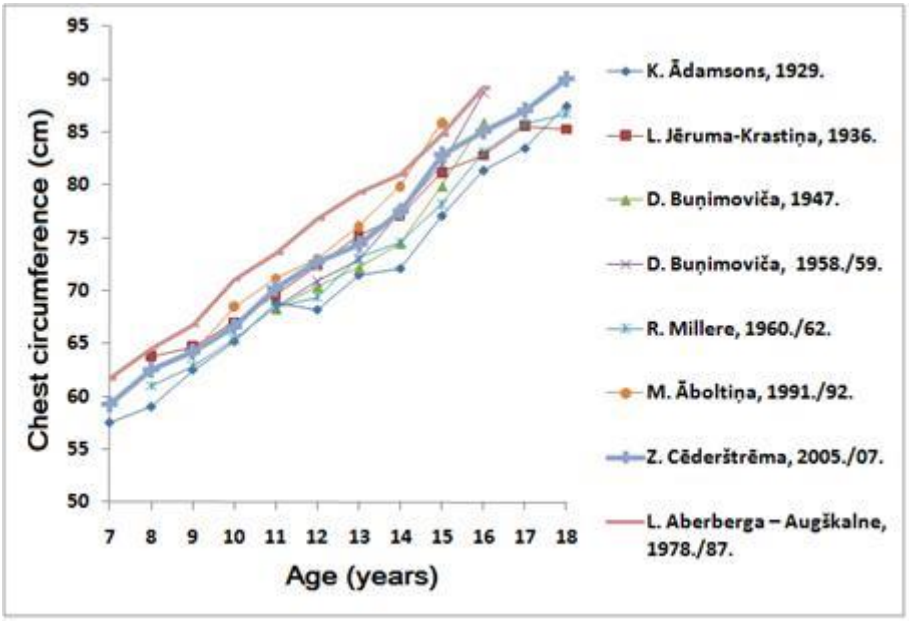
Equation of linear regression (general tendencies) shows, that the increase in the body mass of 16-year-old boys is equal to 100 g per year. Determination coefficient shows, that the linear regression model explains 39,1% of dispersion (Picture 23).

Measurements show that the mean values of the boys' body mass in 2005/07 are greater in comparison to those of the previous studies. Boys are taller and with a correspondingly greater body mass. According to the study data of the 20th century we can conclude that the boys' body height and the body mass reach its definitive value at the age of 17–18 years. According to the material of the study in 2005/2007, we see that the boys' body mass starts to stabilize at the age of 16 years, however, it still continues to grow at the age of 17 years on average by 3,1 kg per year and at the age of 18 years, on average by 6,3 kg per year.

Changes of chest circumference

According to the study data of 1929, the mean value of the boys' chest circumference at the age of 17 years is 59,0 cm, in 1933 – 60,5 cm, at the age of 8 years in 1929 - 62,5 cm, in 1933 – 60,0 cm, in 1936 – 63,8 cm, in 1960 – 61,0 cm. According to the study data in 2005/07 the mean value of the chest circumference at the age of 7 years is 59,2 cm, but at the age of 8 years – 62,5 cm.18-year-old

boys' chest circumference in 1936 is 85,38 cm, in 1960– 86,72 cm, but in 2005/07 – 90,1 cm (Picture 24).



Picture 24. Mean value of Riga boys' chest circumference in various studies in relation to the age

Analyzing the study results, we can conclude, that the mean value of the chest circumference during the century has grown evenly, but the maximum increase of the mean value is from 14 to 15 years. The difference between the mean values of the chest circumference in 1936 and in the study of 1960 is 1,3 cm, but between the studies of 1960 and 2005/07 is 3,4 cm.

Comparison of specificities of Riga boys' morphological status to ethnoterritorial group boys

From the neighbouring countries there is a methodologically precisely described the morphological status of Estonian and Lithuanian school-age boys. That is why we compared Riga boys' physical development parameters to one of these countries, it is – Estonia.

Doing the comparative analysis with measurements done in Tartu, we found out that the mean values of the body height of Estonian boys are greater than those of Riga boys at the age of 17 years by 2,4 cm. The mean value of the body mass of 17- year-old Estonians boys is greater by 2,8 kg in comparison to the mean values of the body mass of Riga boys at the same age.The body mass index of Estonian boys is higher by 0,3 than that of Riga boys (Table 8).

Comparing the measurement data of Latvia and Estonia, we have found out, that Riga boys are slightly shorter and more slender than Estonian boys.

Table 8. Mean values of anthropometric measurements in comparison to studies done in Estonia.

Age group (years)	Body height, cm		Body mass, kg		Body mass index, kg/m^2	
	Latvia	Estonia	Latvia	Estonia	Latvia	Estonia
7	125,3	125,5	24,9	25,5	15,7	16,1
8	131,6	131,7	28,9	28,7	16,6	16,5
9	136,4	136,7	31,3	31,5	16,7	16,8
10	141,3	143,0	34,0	35,8	16,9	17,3
11	147,6	149,6	40,0	41,0	18,1	18,1
12	152,7	157,1	44,1	46,7	18,8	18,7
13	159,3	164,9	47,7	53,0	18,6	19,2
14	167,8	171,4	54,2	59,4	19,1	20,0
15	174,8	175,9	62,8	64,7	20,4	20,8
16	177,1	179,0	64,8	68,2	20,5	21,2
17	179,0	181,4	67,9	70,7	21,1	21,4
18	180,8	–	74,2	–	22,6	–

Conclusions

1. Characteristic parameters of family conditions of boys involved in the study of 2005–2007 and socially economic status correspond to the average situation in Riga at the time of doing research.
2. Growth of mean longitudinal parameters of the height of Riga boys continues till 18 years. The accelerated growth period is observed from 13 to 14 years of age. In the current research the boys' definitive body height is 180,8 ± 6,3 cm.
3. Until the age of 12 years the passive body mass grows evenly, but later there is a tendency of for this parameter to decrease.
4. The mean age of occurrence of puberty in Riga boys is 13 – 14 years, which is evident by mean age when the breaking of the voice is marked – 13,5 ±1,1 years and the mean age of pollutions – 13,8±1,3 years. The main parameter of puberty is – size of testicles – which reaches its maximum growth rate at the age of 13 – 14 years. Clusterization of the correlation coefficient of secondary sexual signs is seen between the face hair (B), pubic hair (P), axillary hair (Ax) and the break of the voice with its maximum correlation at the age of 13 years.
5. The constitutional type of boys at 17 – 18 years of age corresponds to dolychomorphous, except for the leg length, which are shorter and corresponds to the mesomorphous type.
6. There is a tendency of the morphological status in school-age boys of the 20th and 21st century to differ. In the research done in 2005 – 2007 the body height of Riga boys at puberty and the definitive age is greater in comparison to the study data of the first half pf the 20th century; the mean value of the body mass increases; as to the constitutional type changes, there is observed the decrease of the mean values of the shoulder width and chest circumference. The boys become taller and more slender.
7. In comparison to boys of other ethnoterritorial groups, the Riga boys are taller. According to this parameter, they are more identical to the boys in Estonia.

Approbation of the study

1. V Congress of International Latvian Physicians, Riga (Latvia), June 16 – 18, 2005.
2. VI Scientific conference in biology, Tartu (Estonia), September 23 – 24, 2005.
3. RSU Scientific medical conference, Riga (Latvia), March 3, 2006.
4. XV Congress of European Anthropological Association, Budapest (Hungary), August 31 – September 3, 2006.
5. RSU Scientific medical conference, Riga (Latvia), March 29 – 30, 2007.
6. XI International Congress of Auxology, Tokyo (Japan), September 9 – 12, 2007.
7. International conference „Anthropology and Medical Practice", Vilnius (Lithuania), September 20 – 23, 2007.
8. IV Baltic morphological scientific conference, Riga (Latvia), November 19 – 20, 2007.
9. RSU Scientific medical conference, Riga (Latvia), March 13 – 14, 2008.
10. 2nd International Congress on Physical Activity and Public Health, Amsterdam (Netherlands), April 13 – 16, 2008.
11. XVI Congress of European Anthropological Association, Odense (Denmark), August 28 – 31, 2008.
12. RSU Scientific medical conference, Riga (Latvia), April 2-3, 2009.
13. V Congress of International Latvian Physicians, Riga (Latvia), June 19 – 21, 2009.
14. International conference „Growth charts: Local versus international, counted versus calculated", Vilnius (Lithuania), September 29 – October 01, 2009.
15. Meeting of Association of Clinically Integrated Morphology (KIMA), Riga (Latvia), November 4, 2009.

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EVALUATION OF PARAMETERS OF PHYSICAL DEVELOPMENT OF RIGA SCHOOL AGE BOYS AT THE TURN OF THE CENTURY

Summary

Basically, the human health is formed in childhood and, relying on the fact to what extent we will be able to maintain it, depends the future of generations. Investigation of a child's body specificities at different ages, sexes and ethnic groups, allows us to assess the interrelation of the most significant signs of biological status. Although the physical development of children has been studied, the study of morphological signs done so far, however, had referred only to dynamics of separate parameters of physical development and absolute values of the growth rate, not considering the correlation of separate parametrs during the course of the growth process. No analysis and no assessment have been done of the body proportions, changes of morphological status within the period of time, as well as no evaluation has been done as to the occurrence of puberty in boys

The aim of research work was to evaluate the morphological status and the occurrence of puberty of 7 to 18-year-old Riga boys during the change processes in the turn of century.

For the first time in Latvia there was characterized the Riga school-boys' morphological status, the intensity and the growth rate of various morphological signs were assessed, as well as the changeability of these signs during centuries. It was the first time when the boy's puberty time was defined, including various puberty development signs.

1359 boys at the age from 7 to 18 years were questioned and measured.

The growth in height of the mean longitudinal parameters of Riga boys continues till 18 years of age. Accelerated growth period is observed from 13 till 14 years of age. The definitive body height in this research for boys was180,8 ± 6,3 cm.

Till 12 years of age the passive body mass increases evenly, later there is anevident tendency for this parameters to decrease.

The mean age of occurrence of puberty in Riga boys is 13 – 14 years of age, which is seen by the mean age of the breaking of voice – 13,5 ±1,1 years and the mean age for occurrence of pollutions – 13,8±1,3 gadi. The main parameter of puberty – thickness of testicles – reaches its maximum growth rate at the age of 13 – 14 years. Clusterization of the correlation coefficient of secondary sexual signs is observed between the face hair (B), pubic hair (P), axillary hair (Ax) and the breaking of voice with its maximal correlation at the age of 13 years.

The constitutional type of 17 – 18-year-old boys corresponds to dolychomorphous, except the leg length, which are shorter and correspond more to the mesomorphous type.

The morphological status in school-age boys in the 20th and 21st century has a tendency to differ. In the research of 2005 – 2007 the body height of Riga school-boys at puberty and definitive age is higher in comparison to the study data of the research of the first half of the 20th century; the mean body mass value increases; the constitutional type changes are observed in the decrease of of mean values of the shoulder width and the chest circumference. The boys grow taller and more slender.

In comparison to other ethnoterritorial group boys, the Riga boys are taller in height. This parameter is the closest to that of the boys in Estonia.

Оценка показателей физического развития у мальчиков школьного возраста из Риги на рубеже столетий

Резуме

Здоровье человека создается, в основном, в детстве, и от того, насколько мы сможем его сохранить, зависит будущее поколений. Исследование особенностей тела ребенка в различных возрастных, половых и национальных группах позволяет оценить важные закономерности изменения признаков биологического статуса. Несмотря на то, что физическое развитие детей исследовано, в ранее проведенных исследованиях морфологических признаков у детей была оценена динамика только отдельных параметров физического развития и абсолютные значения скорости роста, не принимая во внимание взаимосвязь отдельных показателей в процессе роста. Не были проанализированы и оценены изменения пропорций тела и морфологического статуса в течение времени, а также не было оценено наступление полового созревания.

Целью работы является оценка морфологического статуса и времени наступления полового созревания 7-18 летних мальчиков из Риги.

Первый раз в Латвии характеризован морфологический статус мальчиков школьного возраста из Риги, оценена интенсивность прироста морфологических признаков и скорость роста, а также изменчивость этих признаков в течение столетия. Впервые определено время наступления полового созревания у мальчиков, включая различные признаки полового развития. В исследовании было анкетировано и измерено 1359 мальчиков в возрасте от 7 до 18 лет.

Увеличение в длину средних продольных параметров роста у мальчиков из Риги продолжается до 18 лет. Период ускоренного роста наблюдается от 13 до 14 лет. В данном исследовании дефинитивная длина тела 180,8±6,3 сантиметра.

До 12 лет пассивная масса тела увеличивается равномерно, затем наблюдается тенденция уменьшения этого показателя.

Средний возраст становления пубертатного периода у мальчиков из Риги 13-14 лет, о чем свидетельствует средний возраст изменения голоса – 13,5±1,1 года – и средний возраст появления поллюций – 13,8±1,3 года. Главный показатель полового развития – толщина яичка – достигает максимальной скорости роста в возрасте 13-14 лет. Кластеризация коэффициента корреляции вторичных половых признаков наблюдается между появлением волос на лице (В), на лобке (Р), в подмышечной ямке (Ах) и изменением голоса с максимальной интеркорреляцией в 13 летнем возрасте.

В 17-18 летнем возрасте тип конституции мальчиков соответствует долихоморфному, кроме длинны ног, которые короче и более соответствуют мезоморфному типу.

Морфологический статус мальчиков школьного возраста в 20-м и 21-м веке имеет тенденцию различаться. В исследовании 2005-2007 года у мальчиков из Риги длина тела в пубертатном и дефинитивном возрасте больше по сравнению с данными исследований первой половины двадцатого века; среднее значение массы тела увеличивается; изменение типа конституции мальчиков наблюдается в уменьшении ширины плеч и среднего значения окружности грудной клетки. Мальчики становятся длиннее и стройнее.

В сравнении с мальчиками других этнотерриториальных групп, мальчики из Риги выше. По этому показателю они ближе всего к мальчикам из Эстонии.