AGE DYNAMICS AND SECULAR CHANGES OF INDICES CHARACTERIZING THE NEUROCRANIUM AND FACIAL CRANIUM IN ETHNIC BULGARIAN 7-17-YEAR-OLD CHILDREN FROM THE REGION OF THE EASTERN RHODOPES

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ABSTRACT

BACKGROUND: It is impossible to give an objective anthropologic assessment of the overall physical development of a child’s body during the time of intensive growth (7-17 years) without taking into account the age and gender changes in the absolute and relative head and face measurements. Head growth has specific characteristics that makes it different from the growth of other parts of the body. The head of a child differs from the head of an adult not only by metric characteristics but also by the proportions between the different head measurements. Growth and proportionality of the head comply with the general growth pattern, but there are also certain regional, populational and temporal differences. That was the reason why we conducted a study targeted at children and adolescents from the region of the Eastern Rhodopes.

The aim of the present study was to determine the growth dynamics in between-gender and between-age aspects of the variables characterizing the neurocranium and facial cranium, and establish the tendency and direction of the secular changes.

MATERIAL AND METHODS: The study included 1481 children and adolescents (699 boys and 782 girls) aged 7 to 17 years that were examined using the classical methodology of Martin-Saller (1957). Head length, width, height and circumference, as well as face width, mandible width, morphological and physiognomic height of the face were measured. Head index, morphological face index and jugulormandibular index were calculated using standard formulas. The secular changes were analyzed comparing data from 1907 and 1960 with the data of the present study.

RESULTS: The head index classified the children from both genders and all age groups as mesocephals. The girls from the study region had a relatively greater mandible width and boys - relatively greater face width. In the beginning of the growth period wider face forms prevailed especially in the girls, while narrower face forms were more characteristic for the adolescence and postadolescence and better manifested in the boys.

CONCLUSIONS: Throughout the entire study period the boys presented with greater measurements of the neurocranium and facial cranium than the girls. For both genders the increase in the neurocranium measurements anticipates that in the facial cranium measurements. In the examined children and adolescents the width cephalometric variables complete their growth earlier than the height variables. The head circumference and head width decrease, while the differences in the head length and facial height increase in both genders and all age groups in the end of the 20th and beginning of the 21st century.

Key words: head length, head width, face height, head growth
INTRODUCTION

Head growth is closely associated with brain growth. From the earliest stages of embryonic development brain is fairly close to its ultimate weight. The brain of a newborn weighs 25% of the adult brain, and the body weight is 5% of that in adults. By the age of 10 years the brain is about 95% of the adult weight, while body mass is 50% of that of adults. Hence, the skull that encloses the brain attains its ultimate dimensions earlier than the rest of the skeleton. Accordingly, the head growth is most intensive in the early childhood period. The neurocranium of a 9-year-old child amounts to 92-95% of the size of a grown up subject. It is found that between 7 and 9 years of age the facial cranium shows a clear tendency to faster growth of the width compared with the height measurements. The mandible width is most rapidly increasing, followed by the face (bizygomatic) width.

Head growth concerns not only absolute increase in the particular measurements, but also changes in the proportions. If head measurements of adult are accepted as 100%, at birth the head width represents 55-60%, head height 40-45% and head length 30-35% of the values of adult individual. That indicates different duration of growth in the specific variables. It has been found that width measurements reach their ultimate dimensions faster, while height measurements have longer growth period.

The aim of the present study was to determine the growth dynamics in age and gender aspect of the variables characterizing the neurocranium and facial cranium and establish the tendency and direction of the secular changes.

MATERIAL AND METHODS

For the purpose of the study 1481 children and adolescents (699 boys and 782 girls) aged between 7 and 17 years were examined. The children were divided into 11 age groups and examined using accepted classical methodology and standard anthropometric set. Head length, width, height and circumference, as well as face width, mandible width, morphological and physiognomic height of the face were measured. Proportionality was analyzed using certain cephalometric indices obtained by standard formulas:

\[ \text{Head index} = \frac{\text{Head width}}{\text{Head length}} \times 100 \]

\[ \text{Morphological face index} = \frac{\text{Morphological face height}}{\text{Face width}} \times 100 \]

\[ \text{Jugomandibular index} = \frac{\text{Mandible width}}{\text{Face width}} \times 100 \]

The secular changes were evaluated by comparing the present study data with data available for 1907 and 1960. The data were analyzed using statistical package “STATISTICA 6.0”.

Between-gender and between-group differences were tested with Student t-test with level of significance for the null hypothesis set at \( P \leq 0.05 \). The results are presented as mean ±SEM.

RESULTS

The results of the cephalometric characteristic of the studied children and adolescents aged 7 to 17 years determined the specificity of the size, shape and proportions of the head during this period of intense growth and development and the strength of expression of the between-gender differences. Analysis of these variables gives essential morphotypological information for peculiarities of the growth periods in children from the East Rhodopes region.

The head index classified the children from both genders and all age groups as mesocephals. The girls from the study region had a relatively greater mandible width and boys - relatively greater face width. At the beginning of the growth period wider face forms prevailed especially in the girls, while narrower face forms were more characteristic for the adolescence and postadolescence and better manifested in the boys. Head widths showed marked rise during adolescence in the boys, and head heights markedly increased in the girls. In both genders head height undergoes most intensive growth between 12 and 13 years of age. Although the cephalofacial variables present with higher mean values in the boys during the whole period of growing, their growth continues after the age of 16, while in the girls the face variables reach their ultimate values by that age.
DISCUSSION

A characteristic feature of the postnatal development is that the growing lines of the cephalometric variables do not cross. The head length (Fig 1) presents with higher values in the boys than in the girls throughout the examined period. The difference in 7-year-old children is $0.52 \pm 0.10$ cm and at 17-year-old children $0.77 \pm 0.08$ cm. In all age groups the difference reaches statistical significance ($p \leq 0.05$). At insignificant annual growth the highest growth (0.29 cm) in the boys is from 10 to 11 years of age and in the girls from 12 to 13 and from 15 to 16 years of age (0.27 and 0.25, respectively). For the whole growing period (7 - 17 years) the measure of the examined cephalometric variables increases by 1.03 ± 0.11 cm for 7-year-old children and reach 1.12 ± 0.10 cm for 17-year-old children. Two growth peaks are found in both genders. The first one is between 7 and 8 years of age for both genders (0.68 cm for boys and 0.84 cm for girls). The second one is between 10 and 11 years of age for the boys (0.69 cm) and one year later – between 12 and 13 years of age – for the girls (1.12 cm). For the period from 7 to 17 years the head circumference increases by 3.70 cm for boys and by 3.59 cm for girls, which is 93.33% and 93.39%, respectively of the initial measurements and those in 7-year-aged children.

The facial cranium growth differs from that of the neurocranium due to differences in their formation. If the size of the neurocranium of 7-year-old children is about 95% of the size of 17-year-old adolescents, the width measurements of facial cranium are about 86% and the height measurements - 87%.

Ours results show similar pattern of the growing curves of the cephalofacial variables, which present again with significantly higher values in the boys than in the girls (Figs 5, 6, 7, 8). In the 7-year-old girls the face widths and heights constitute 90% of those measurements in the 17-year-old girls, while in the 7-year-old boys these are about 86%. The results definitively show that face dimensions increase more rapidly in girls, ceasing to increase after 16 years of age, while the growth rate for boys is relatively high even after turning that age. An interesting finding is that in both genders, but more evident in the boys, the width variables cease growing earlier than the height variables.

The comparative analysis of growth intensity shows that in boys the most intensive growth of head length and head circumference and mandible width occurs between 10 and 11 years of age, and that of head and face height measurements between 12 and 13 years of age. In girls the growth intensity of many of the head and face variables is the greatest in the age between 12-13 years.

Besides the complete values of the measured variables, anthropology also uses very much the proportionality indices, which indicate what the shape of the head, as well as certain head sections, can be. These findings are of particular importance in anthropological studies of children, for the head of children differs from the head of adults not only in the measured characteristics, but in the form and proportionality as well.

A special role in morphology is played by the
data of the head index, also called head length-width index, that represents the percentage of correlation between the length and width of the head, and gives a general idea of the head form.

Throughout the study period the boys and the girls present with comparable values of the index as only in the 15-year-old adolescents the differences reach statistical significance ($p \leq 0.05$). According to the head form categorization of Martin–Saller (1957) it appears that in all age groups in both genders the mean values of the head index fall within the limits of mesocephals, which represents the more accelerated growth of the head in height than in width.

The analysis of the morphological face index shows that at the beginning of the growth period wider face forms prevail in both genders yet more expressed in the boys, while during adolescent and post-adolescent period narrower face forms are more common and better manifested in the girls. The between-gender differences are statistically significant at 15 and 17 years of age ($p \leq 0.05$).

The index of width proportionality between middle and lower face shows that the girls have relatively greater mandible width and boys relatively greater face width. Statistically significant between-gender differences are found at 12, 15 and 16 years of age ($p \leq 0.05$). According to Lundborg-Linders-Saller categorization the boys from all age groups fall into the category middle face and the girls into the category wide face.

On the basis of our findings we can say that there are temporal and gender differences in the growth processes.

In terms of head circumference (Figs 9, 10) acceleration changes were present from the beginning of the century until the 60’s of the previous century, which is characteristic for both boys and
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CONCLUSIONS
Throughout the entire study period the boys present with greater measurements of the neurocranium and facial cranium than the girls.

For both genders the increase in the neurocranium measurements anticipates that in the facial cranium measurements.

In the study children and adolescents the width cephalometric variables complete their growth earlier than the height variables.

The head circumference and head width decrease, while the differences in the head length and facial height increase in both genders and all age groups at the end of the 20th and beginning of the 21st century.

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ВОЗРАСТНАЯ ДИНАМИКА И СЕКУЛЯРНЫЕ ИЗМЕНЕНИЯ ПРИЗНАКОВ, ХАРАКТЕРИЗУЮЩИХ МОЗГОВОЕ И ЛИЦЕВОЕ СООТНОШЕНИЯ ГОЛВЫ (ВОСТОЧНЫЕ РОДОПЫ) В ВОЗРАСТЕ ОТ 7 ДО 17 ЛЕТ

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РЕЗЮМЕ

ВВЕДЕНИЕ: Антропологическая оценка целостного физического развития детского организма во время активного роста (7 – 17 лет) не может быть объективной, если не прослежены возрастные и половье изменения в абсолютных и относительных стоимостях признаков головы и лица. Рост головы имеет специфику, отличающую его от роста остальных частей тела. Детская голова отличается от головы взрослых не только своей морфометрической характеристикой, но и соотношением между отдельными размерами головы. Рост и пропорциональность головы подчиняются общим закономерностям роста, но наблюдается ряд территориально-популяционных и временных различий. Именно этот факт мотивирует авторов предпринять целенаправленное исследование детей и подростков (район - Восточные Родопы).

ЦЕЛЬ: Характеризовать динамику роста в межвозрастном и межполовом аспектах признаков,
которые характеризуют мозговую и лицевую части головы, как и установить тенденцию и направление секулярных изменений.

Материал и методы: Трансверсально, по классической методике Martin R. и K. Saller (1957 г.) проведены антропометрические измерения детей и подростков (1481 – 699 мальчиков и 782 девочки) в возрасте от 7 до 17 лет. Измерены длина, ширина, высота и горизонтальная окружность головы, как и ширина скул, ширина нижней челюсти, морфологическая и физиогномическая высота лица. По стандартным формулам вычисляют морфологический и югомандибулярный индексы и индекс головы. В целях оценки секулярных изменений использованы данные от 1907 и 1960 г., которые сравниваются с данными настоящего исследования.

Результаты: Во всех возрастных группах и при обоих полах форма головы определяется категорией "мезокефал". Лица женского пола исследуемого региона имеют относительно большую нижнечелюстную ширину, а лица мужского пола относительно большую ширину скулы. В начале периода роста преобладают более широкие лицевые формы, что лучше выражено у мальчиков, а в пубертатном и постпубертатном периодах преобладают более узкие лицевые формы, особенно у лиц женского пола.

Выводы: В течение всего исследуемого возрастного периода у мальчиков наблюдаются большие размеры признаков, характеризующих мозговую и лицевую части головы. И при обоих полах размеры мозговой части опережают в своем развитии размеры лицевой части головы.

Во всех случаях кефалометрические признаки ширины заканчивают свой рост раньше признаков высоты.

И при обоих полах в конце XX и в начале XXI века во всех возрастных группах окружность и ширина головы уменьшаются, в то время как различия в длине головы и в высоте лица увеличиваются.