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## MAIN DIRECTIONS IN THE STUDY OF SCHOOLCHILDREN AND YOUTH' GROWTH IN RUSSIA: A REVIEW BASED ON THE ARTICLES PUBLISHED IN «MOSCOW UNIVERSITY ANTHROPOLOGY BULLETIN» FOR THE LAST 15 YEARS

**Introduction.** *This review is a continuation of the research devoted to the assessment of the development of auxology in Russian anthropology. The first part was devoted to a comprehensive assessment of the processes of growth and development of children from birth to 3 years old, living both in our country and in the countries of the near abroad. The analyzed sources describe factors influencing growth processes (evolutionary, climatic, geographical, ethnic and genetic factors, constitutional features of mothers, circumstances of intrauterine growth) [Permiakova, 2023]. This article examines and describes in more detail the main activities of auxologists, as well as physicians and psychologists working both within our country and in cooperation with foreign researchers from various academic institutions.*

**Materials and methods.** *In this part of the work, the author analyzed articles devoted to the comprehensive assessment of physical development (as well as factors affecting it) of the school and student contingent living in Russia and some other countries. All these articles were published in Moscow University Anthropology Bulletin from 2009 to 2022.*

**Results and discussion.** *Works in the designated area, on the one hand, analyze the physical development of children and youth of the Moscow region, on the other hand, assess the differences in the rates and dynamics of growth processes of residents of different regions of our country and abroad, including the secular aspect. In addition, representative samples are used to analyze socio-economic factors affecting these processes and determining the features of their course in a particular territory. Complex studies involving the relationship of somatic development indicators not only with socio-economic or environmental parameters, but also the psychological characteristics of the subjects are also important.*

**Conclusion.** *The number of works devoted to the subject under study is quite numerous, which allows us to speak about the undiminished interest of domestic anthropologists in studying the problems of growth and development. The complex nature of most of them, among other things, indicates an integrative approach to solving the problems posed to this field of science.*

**Keywords:** biological anthropology; anthropological variability; human populations; environmental impacts

DOI: 10.32521/2074-8132.2023.2.030-046

### Introduction

As noted in the previous part of this review, an assessment of the processes of growth and development of children and adolescents is the fundamental basis of auxology [Godina, 2010]. One of the basic directions of the work of Russian anthropologists is the analysis of the growth and devel-

opment of schoolchildren and adolescents, as well as factors influencing these processes (socio-economic, climatic etc).

The aim of the present work was to picture the main directions in the study of schoolchildren and students' growth at Russian school of anthropology. This article examines and describes in more

detail the main activities of auxologists, as well as physicians and psychologists working both within our country and in cooperation with foreign researchers from various academic institutions.

### **Study of indicators of physical development in children and adolescents of the Moscow region**

The peculiarities of the organization of auxological research and the specifics of the journal in question determine the existence of a large number of publications devoted to the study of various aspects of growth processes in schoolchildren of the Moscow region.

First of all, this concerns working with archival materials that allow analyzing trends in the variability of anthropometric parameters of children and adolescents 30–50 years ago as a foundation for further research.

Thus, the study of the morphology of girls born in the difficult war and post-war years, and examined during the period when representatives of the most accelerated generation in Russia were born (1961-1962), allows us to talk about the stabilization of average body height, chest girth and body weight after reaching 14 years with a simultaneous gradual increase in BMI. As for the timing of puberty, the average age of menarche is recorded at the age of 13 years. As the author notes, despite the difficult living conditions in the hungry post-war Moscow, the human body's reserve of resistance to the effects of adverse environmental conditions turned out to be enough to fully implement the appropriate growth and development program [Zadorozhnaya, 2018].

The analysis of 7–17-year-old schoolchildren of the Moscow region (1976–1985 survey) suggests that the changes in physical development indicators that have occurred over 10 years are multidirectional: girls have a slight decrease in body height, boys, on the contrary, its increase. At the same time, in terms of chest circumference, children of both sexes of the 1976 survey have smaller sizes compared to children of 1985. In terms of shoulder and, especially, pelvic diameters, children of the 1976 survey overtake their peers at the entire age range with a high degree of reliability. The analysis of the natural growth rate of the population, which has been con-

tinuously decreasing since the early 1980s (which is associated with an increase in the mortality rate), allows us to link the results obtained with the deterioration of the socio-economic situation in the country as a whole, which manifests itself in a slowdown in the longitudinal growth of girls and some "asthenization" of the generation of the 1980s. The results obtained indicate the heterochronicity of the processes of the secular trend in the examined group [Zubareva, Permiakova, 2015].

A study devoted to the assessment of the somatic development of Moscow children and adolescents aged 3–17 years surveyed in 2005–2006, in comparison with similar materials collected by Moscow anthropologists in the 1960s, 1970s, 1980s and 1990s, revealed the absence of distinct differences in the size and shape of the longitudinal dimensions of modern Moscow children in combination with a significant increase in the level of subcutaneous fat deposition. Analysis of the secular dynamics of the body height and weight of newborns in Moscow for the period from 1988 to 2003 suggests a significant decrease of these parameters in 1993–1998 compared with the previous five years and subsequent recovery and even an increase in the value of indicators in 1998-2003 relative to the level of the late 1980s – early 1990s [Gorbacheva et al., 2009].

The analysis conducted for one age group (9 years), but with a large number of time "slices" (1996, 1998, 2005, 2006 and 2007) indicates a decrease in the prevalence of normal physical development of children during the period under review with an increase in overweight, on the one hand, and the unfavorable nature of demographic indicators, a significant decrease the "age of survival" and the absence (and even the decline until 2012) of the "dynamics of growth" of the population, on the other hand. The data obtained do not give grounds to speak about the real connection of changes in the physical development of Moscow children of the late XX – early XXI century with demographic shifts characterizing the population of the country at the same time. However, in the nature of the variability of these indicators, there is a certain measure of consistency, mainly related to male representatives [Zubareva, 2016]. Evaluation of the physical development of children on the scales of regression of body weight along the body height allowed us to

establish that the changes that occurred in the physical development of 9-year-old Moscow schoolchildren during the period under review have fairly clear features of sexual dimorphism. The proportion of children with normal physical development has decreased, and in boys this decrease is statistically real and mainly occurs due to a three-fold increase in the prevalence of overweight [Yam-pol'skaya et al., 2009].

A similar assessment of the consistency of the rates of puberty with the dynamics of changes in somatic characteristics was carried out in 2013. The authors of the study used an integrative indicator of puberty (PII), built taking into account the mutual correlation of its particular indicators. The work was carried out based on the materials of the longitudinal data series of the 1982–1991 survey. It was shown that most somatic sizes, excluding fat folds, demonstrate low levels of connections with PIIs in the period of second childhood, in adolescence the closeness of these connections increases markedly, in some cases approaching the level of 0.7 at the peak of puberty. Then there is a gradual decrease to the minimum values by the age of 17, which is especially pronounced for girls. There is a very weak connection between the acceleration of development with the average values of the development of adipose tissue, while the low tempo of growth is accompanied by some hypoadoposity. The main conclusion made in the work is focused on the meaningfulness of PII, which consists, on the one hand, in its close connection with the age dynamics of the musculoskeletal body size, on the other – in relative autonomy from the development of fat deposition [Fedotova, Chtetsov, 2013].

The results of a study devoted to the study of the variability of growth and development indicators in Russian Moscow schoolchildren with tallness are also interesting. For comparative analysis, a representative contingent of 7–17 years of Moscow was involved, surveyed in 1982–1984 and in 1996–2000 twice with an interval of several months to a year. The authors developed individual graphic percentile standards, which allow us to conclude that for tall girls, a significant excess of body height relative to the average values in the control groups was revealed. The minimum values of body height do not fall below the 50th percentile against the background of the standards of 1982–1984 and 1996–

2000, the maximum values are significantly higher than the 97<sup>th</sup> percentile. Individual estimates of body mass and BMI vary greatly relative to the graphic percentile standards; the greatest spread of minimum and maximum values falls on the puberty period. By the end of puberty, the growth process stabilizes and increases in body height and weight decrease. Tall boys have a similar pattern. In terms of chest circumference and shoulder diameter, tall boys and girls also outperform children from control groups. Analysis of the process of puberty in tall adolescents revealed the usual sequence of the appearance of secondary sexual characteristics. At the same time, the appearance of all secondary sexual characteristics in tall girls and boys occurs much earlier than in the control group, regardless of the year of examination. The early onset of puberty in combination with intensive growth and tallness allows us to conclude about the overall acceleration of the examined children at the intra-group level [Stepanova et al., 2012].

Generalization of a large block of studies of Moscow children and adolescents, affecting the time interval from the end of the XIX to the beginning of the XXI century, allowed us to assess the intensity of secular changes in basic anthropometric indicators. To achieve this goal, the authors used the indicator "the average value of the temporary increase of a trait over a decade", which is the ratio of growth changes over the entire historical period of observations to the number of decades that it includes. Expressed in the sigma measure (as a percentage of the standard deviation of the size averaged over the entire observation interval) these indicators allow us to conclude that the intensity of secular changes in body height increases with age for children of both sexes. For body weight, it is less pronounced, which is especially clearly seen in the interval up to 6 years, after which it increases again by adolescence. For chest circumference, the lowest comparative intensity of secular size changes was recorded in all sex and age groups, not exceeding 10% of the average sigma, for girls aged 17, zero total epoch-making dynamics was noted. The authors conclude that the secular dynamics of weight and chest circumference in the historical period under consideration has an almost continuous upward character for most age and gender groups, interrupted by the economic crisis of the 1900s and

the military events of the 1940s. The intensity of changes increases from the period of newborn to adolescence and higher for body height compared with body weight and especially with the indicator of transverse development of the body – chest circumference [Fedotova, Gorbacheva, 2019].

If we evaluate the physical development of Moscow schoolchildren in the longitudinal aspect, it is necessary to mention the results of the work of specialists of Research Institute of Hygiene and Health of Children and Adolescents Federal State Autonomous Institution "NMIC for Children's Health" of the Ministry of Health of the Russian Federation. The number of such studies in our country is not so large, which is due to a number of organizational and bureaucratic issues, so the results obtained by the authors are of great interest to specialists in various fields of biology and medicine. The work included 3 examination intervals: 1960–1969, 1982–1991 and from 2003 to 2010, in which the indicators of body height and weight, chest circumference, proportions, biological development and dynamometry of the right hand were evaluated. According to the results obtained, modern schoolchildren surpass their peers of the 1960s and 1980s in basic anthropometric indicators (body height and weight, chest circumference) and the level of biological development (menarche age and the degree of severity of secondary sexual characteristics at an earlier age). There was also a change in the proportions of the body in modern schoolchildren: an increase in body height is combined with a significant increase in leg length. At the same time, however, a significant decrease in functional indicators (dynamometry) was found in all age groups of modern schoolchildren. The data obtained indicate positive changes in physical development, and, possibly, a "new round" of the activity of the acceleration process, which dictates the need to revise the standards of biological development of schoolchildren and search for reasons for the decline in functional indicators [Kuchma et al., 2013].

Work with standards of physical development in comparative and methodological directions is also of constant interest for domestic research. The need for this kind of work is dictated by secular changes in the somatic status of children and adolescents. The works published in our journal are mostly devoted to the study of the Moscow sample.

For example, based on the materials of 2005–2006 (3–17-year-old children and adolescents), tables were developed and percentile curves of body height, chest and waist circumference were constructed, used to diagnose the somatic status of the contingent analyzed in other studies [Fedotova, Gorbacheva, 2014].

Special attention should be paid to the development of BMI percentile standards for Moscow children and adolescents and the comparison of the results obtained (using z-scores) with WHO data. The shift of median BMI values in domestic schoolchildren of both sexes is shown. The boundaries of variation of the absolute values of the indicator in girls are significantly shifted for the upper boundary of the distribution towards its higher values in primary school ages, and, starting from 14.5 years, on the contrary, towards lower ones; in boys, a positive shift of the lower boundaries of the variation of the trait was recorded against the background of the control group, for low and average values of the indicator, these differences they are smoothed out by the age of 16 (the exception is variants with an increased BMI). The totality of these facts allows us to conclude that the changes occurring in the physical development of Moscow schoolchildren in the boys' group are more pronounced. According to the author, in our country it is necessary to use national standards of physical development, allowing to give us a more adequate assessment of the ongoing processes [Permiakova, 2018; 2020].

### Regional aspects of auxological research

In addition to studying the peculiarities of physical development of children and adolescents living in the Moscow metropolis, a separate interest for auxologists of our country is the assessment of differences in the rates and dynamics of growth processes of schoolchildren from different regions in a comparative aspect.

Thus, an analysis of the anthropological characteristics of urban and rural schoolchildren of the Arzamas district of the Nizhny Novgorod region allowed us to conclude that rural students show a greater percentage of harmoniously developed children, and urban children are characterized by an increased percentage of representatives with low



body weight values and high body height values. Physiometric parameters (dynamometry of the hand), as expected, are characterized by large values in schoolchildren of less urbanized settlements, while the hemodynamic system is in a more critical condition among citizens. The dependences of the values of functional indicators on the group of physical development were revealed: in students with low body weight and height, they are lower than in peers with normal physical development [Kaluzhny, 2017].

As for the other group – the population of the Chuvash Republic (Chuvash), in this case, in the context of studying the time and age dynamics of a number of morphophysiological features in rural children in the XIX and XX centuries, we can talk about the uneven growth rates in the studied interval. At the first stage, for 75 years from the beginning of observations and up to the mid-30s of the XX century, there were no changes in the growth rate in ontogenesis and maturation rates in the child population. The following 2 samples, 1962 and 1966, demonstrate an acceleration in the rate of ontogenesis and an increase in longitudinal growth, from 1982 to 2002, the intensity of the increase in longitudinal body size noted at the previous stage decreases. The intensity of the growth of body height is the main factor determining the corresponding changes in other particular longitudinal dimensions and, to a lesser extent, body weight, therefore circumferences and transverse body parameters show different development trajectories. The given data on the body height at the final time stage confirm the attenuation of the increase in the longitudinal dimensions of the Chuvash since about the 1980s [Batsevich, Yasina, 2018].

Comparison of the results of the examination of the two groups described above (modern population) suggests that the latter (regardless of gender and age) are characterized by large average values of total body size, pronounced in the case of body height and chest circumference. The analysis of the percentile curves of the BMI of the examined contingent indicates a shift in the boundaries of variation of the indicator in the greater direction in Russians, especially in the area of increased values of the indicator corresponding to overweight and obesity. For the same group, earlier puberty was confirmed, but an intergenerational analysis of its rates

confirms the continuation of acceleration processes in the Chuvash group, while no similar trend was found in Nizhny Novgorod residents. Based on the results obtained, the authors make a cautious conclusion about the similarity of the shifts in physical development in the groups of Chuvash and Russian schoolchildren. The continuation of acceleration processes in the Chuvash group indicates that this group is in conditions of less social stability [Permiakova et al., 2022].

The identification of regional features of anthropometric indicators of urban and rural Russian schoolchildren living in the territory close to the regions of the Ulyanovsk region described above showed the presence of reliable statistical differences in the magnitude of most of the surveyed parameters. However, at older ages, the differences become less pronounced, which is especially pronounced for body height and weight. The intersex differences are that urban boys have larger limbs' circumference than rural schoolchildren, while urban schoolgirls are characterized by an increase in fat deposition on the body and a decrease in it on the limbs. In general, the difference in the average values of indicators is less pronounced in girls. With age, there is a decrease in the proportion of students with satisfactory adaptation and an increase in the proportion of adolescents with stress adaptation mechanisms and unsatisfactory adaptation. Girls are more resistant to environmental influences and have greater adaptive potential than boys in most age groups. Comparison of the anthropometric parameters of the surveyed schoolchildren with those for the Nizhny Novgorod region, Saratov and Arkhangelsk region indicates the absence of fundamental differences in the magnitude of the indicators [Ermolaeva, Khayrullin, 2017].

The analysis of the child and adolescent contingent of the North-west of Russia (Arkhangelsk region) is one of the key areas of work of the laboratory of auxology of the Research Institute and the Museum of Anthropology (Lomonosov Moscow State University), since this region is the birthplace of the founder of Moscow University. In 2009–2010, as part of a project dedicated to the 300th anniversary of the founder of Moscow University M.V. Lomonosov, a comprehensive anthropological survey of the children's population of the villages of Kholmogory (the birthplace of M.V. Lomonosov), Matig-

ora and Yemetsk, as well as the city of Arkhangelsk was conducted. In total, about 2,000 children and adolescents aged 7 to 17 years were examined. The obtained materials were compared with the survey data of 1988 (about 1,500 boys and girls in total) collected by the same authors in the same localities, using the same anthropological methods. A comparison of modern rural and urban youths showed that the residents of Arkhangelsk slightly surpass their peers from rural areas in body height, practically do not differ from them in body weight, chest circumference and BMI. In older girls, a tendency to lower body weight, chest girth and BMI was found in residents of Arkhangelsk, compared with their peers from rural areas. This can serve as an indicator of the previously identified trend towards leptosomization of the physique in modern urban women. According to the terms of puberty, the residents of the city overtake the villagers. The analysis also found that modern urban and rural schoolchildren outperform children surveyed in 1988 in terms of body height, weight and BMI, which is especially pronounced in boys in the puberty period of development. For modern children, it is typical to change the proportions of the body in the direction of increasing the body height. Significant differences were revealed in the values of girth dimensions and indicators of subcutaneous fat deposition. Modern children and adolescents at all ages are distinguished by large chest and shoulder circumferences, thick skinfolds. Boys and girls are characterized by changes in the topography of fat deposition towards greater trunkality. The conducted research testifies to the ongoing processes of the secular trend among the residents of Arkhangelsk and the Arkhangelsk region. This is expressed in a change in the shape and proportions of the body, earlier puberty, a change in the distribution of the subcutaneous fat layer. There were no significant differences in body height in 17-year-old boys and girls, which allows us to talk about the stabilization of the processes of longitudinal growth in modern youth [Permiakova, 2010; Godina et al., 2011]. An assessment of the consistency of changes in fat deposition and body composition components with the rates of puberty in the same groups (when compared in parallel with residents of Moscow) indicates compliance with standard patterns: urban children go through the stages of puberty ear-

lier than their rural peers. The consistency of the changes occurring with the maturation of the mammary glands in girls and the appearance of pubic hair in boys is also confirmed. In the former, the amount of body weight and its fat component, as well as the thickness of the skinfolds, are more dependent on the stage of puberty; in the latter, the girth dimensions. Regardless of the sex of the subjects, the studied signs in their absolute magnitude show a tendency to increase, while the relative body fat mass decreases with the development of the mammary glands in girls. In young men, the alternation of the processes of its increase and decrease was recorded as the development of pubic envelopment progressed from stage to stage. The exception is Muscovites, in whom, with the appearance of this sign, there is a sharp significant increase in body fat mass with a further slight fluctuation during puberty [Permiakova, 2022].

Analysis of data on the prevalence of overweight and obesity in school-age children in the Urals and the north-west of the European part of Russia suggests that there are no significant differences in the proportion of children with a body weight higher than recommended between students of urban and rural schools. Among the examined children, the proportion of children with a BMI below the standard was 1–3%. The main part of deviations falls on exceeding WHO standards, indicating overweight and obesity. For comparison, in 1994–2005, children with such deviations accounted for 4–9%, while in 2008–2018 the indicator increased to 12.9–26.1%. Within localities, differences by year are significant ( $p < 0.01$ ). The authors postulate that it is correct to compare data on the prevalence of overweight and obesity in the population of different regions of Russia only in samples obtained in chronologically close periods [Lir et al., 2018].

Studies of the North-East of Russia are not so numerous, but no less interesting, because here, with the preservation of the indigenous population, a stable population of Caucasians is formed, representing the alien population. Monitoring of the physical development of girls born and permanently residing in this region has established a high variability of anthropometric indicators, most clearly manifested in older schoolgirls, for whom a higher percentage of disharmonious development was also recorded. The entire surveyed contingent was di-

vided into 2 groups: the first generation, including schoolgirls whose parents came to the Magadan region from other regions of the country, and the second – uniting all those born already in this territory. It was found that the maximum annual increases in total body size in girls of the 1<sup>st</sup> generation occurred at 11–12 years, and in girls of the 2<sup>nd</sup> generation shifted a year later – 12–13 years. The rates of growth processes in the younger school ages are higher in the representatives of the 1<sup>st</sup> generation, and the duration of growth processes is more prolonged in the 2<sup>nd</sup> generation. According to the authors, the high variability of the main somatometric indicators, age-related features of growth rates, the formation of somatotypes and the harmony of physical development in each generation may indicate adaptive reactions of the growing organism of children to a complex of extreme environmental factors in the process of forming a new human population in the North-East of Russia [Karandasheva, Grechkina, 2021].

Traditionally, studies in Siberia are of interest to domestic auxologists. For example, since the 70s of the XX century, active work has been carried out in the Republic of Tyva (Eastern Siberia) and involves the study of the growth and development of both the aboriginal and the alien Russian-speaking population. First of all, this concerns a comparative assessment of the dynamics of a number of anthropological features in urban and rural schoolchildren belonging to the same adaptive type of the republic against the background of the "transformation" of the traditional way of life. Schoolchildren examined in the capital of the republic (Kyzyl city), at the place of birth and residence, can be classified as conditionally urban. This is the first generation born already in the city, or who moved to the city with their parents from different rural areas of the steppe zone of Tuva. In contrast, the rural population represents the indigenous inhabitants of the Todzhinsky district. According to the results obtained, the total size and composition of the body practically do not show significant differences across the age range. Of all the analyzed indicators, only the values of the muscular radii of the shoulder and lower leg in children examined in rural areas, at almost all ages, significantly exceed the values in children examined in the city. The observed differentiation at individual age points for other traits is rather related to the

numerical characteristics of the samples. When comparing the growth curves for body height according to the data of 1978 and 2019, the presence of accelerated processes and a secular trend in the population of the Todzhinsky district was revealed. The age of menarche does not differ in urban and rural groups: for urban girls, it was 13.1 years, for rural girls 13.0. In 1978, the average age of menarche for schoolgirls of the Todzhinsky district was 13.9 years. The authors postulate significant maladaptive changes, expressed in the acceleration of ontogenesis, among the Tuvan indigenous population: both among the rural and the emerging urban contingent [Batsevich et al., 2020a].

If we talk about the secular trend and the change in the adaptive potential of Tuvians over the past 40 years, it should be noted the work on the analysis of anthropometric and functional indicators (cardiovascular system) of 17–18-year-old students. The obtained data on the temporal dynamics of body height indicate significant adaptive shifts and the presence of a secular trend in all the studied samples. The results of the research made it possible to determine insignificant intergroup differences in the variability of the characteristics of male and female somatotypes in the examined modern young generation of Tuvans in different environmental conditions. In men, intergroup variability is more pronounced in body height, and in women – in chest circumference. Based on the results obtained, it can be assumed that the increase in body height found in a number of populations in the modern Tuva is characteristic of most of the population of the republic. This indicates that the transformation of traditional culture and lifestyle affected almost the entire Tuvan population and entailed significant changes in the adaptive characteristics of the indigenous population, and hence in the state of health at all stages of ontogenesis. The morphological status changes found at this stage are not associated with noticeable changes in the physiological parameters of the cardiovascular system in the same groups. The obtained results revealed a tendency manifested in higher adaptive reserves in girls compared to boys [Batsevich et al., 2020b].

A slightly different aspect was affected by the work on the study of the student contingent of the Republic of Tyva (average age 18.8 years). The analysis included residents of 3 districts that differ in

climatic, but not in socio-economic factors. It is shown that students from high-altitude areas are characterized by smaller longitudinal body sizes (especially among young men) and better physiometric indicators of the respiratory system, residents of the mid-mountain area are characterized by tallness and high specific gravity. The last two groups have functional tension in the indicators of the respiratory system, which is explained by the body's reaction to unfavorable climatic and environmental conditions. The contingent living in a low-mountain area shows a more pronounced dolichomorphy. The authors conclude that in this case, in the most extreme climatic conditions, there is a decrease in the longitudinal dimensions of the body, especially in the male population, and an increase in the functional reserves of the cardiorespiratory system [Krasil'nikova, Budukool, 2018].

It should also be noted comprehensive studies of physical development and adaptive capabilities of students from different cities of Russia. For example, one of them is based on the materials of comprehensive anthropological surveys of students from different cities of Russia (Moscow, Arkhangelsk, Saransk, Samara). The results of the study show that modern youth in the surveyed cities are characterized by similar total body size indicators (the average body height of boys is 177.3 cm, girls – 164.5 cm, the average body weight of boys – 71.7 kg, girls – 57.4 kg). At the same time, Muscovites turned out to be the tallest among both boys and girls (the average body height is 179.1 cm and 166.2 cm, respectively), and the lowest indicators of power capabilities were noted for them. It was revealed that over a 15-year period (from 2002 to 2016), the physical development of Moscow youth (both boys and girls) remained at the same level: approximately one third of the surveyed is characterized by average physical development. In Moscow and Samara, there were a greater number of students with high and above average indicators of the level of functional state and a smaller number of representatives with unsatisfactory adaptation and failure of adaptation compared to the surveyed boys and girls in Arkhangelsk and Saransk. Thus, young people living in millionaire cities (Moscow and Samara) demonstrate better indicators of physical development and adaptive capabilities of the body compared to the youth of Saransk and Arkhangelsk,

which, in all likelihood, is due to a complex of socio-economic conditions [Sineva et al., 2017]. As a continuation, a screening assessment of the morphofunctional adaptation features of the same contingent should be indicated. It is shown that Moscow boys and girls are characterized by relatively less subcutaneous fat deposition compared to the youth of other cities. The young men of Arkhangelsk have the highest functional indicators of the cardiovascular system, which indicates an increase in energy costs among young people of northern latitudes and the tension of adaptive regulatory systems of the body. The lowest functional indices of the respiratory system were noted for boys and girls in Moscow, which probably indicates the body's reaction to a high degree of atmospheric air pollution in the Moscow region. It is shown that in the surveyed urban populations, a morphofunctional ecological profile characteristic of this region is formed, the structure of which is based on the most informative signs that determine the features of the physical condition and adaptive reserves of the organism [Negasheva et al., 2018].

Meta-analysis of the long-term time dynamics (1880–2010s) of somatic indicators of young men and women of our country showed that against the background of an increase in the level of anthropogenic load (an increase in the number and density of the population of urban agglomerations, the level of man-made environmental pollution, the level of information stress) there is a significant increase in the indicators of body height and weight, chest circumference of the examined of both sexes. According to the materials of studies conducted in Russia and the former USSR, the greatest contribution to the secular dynamics of definitive somatic status in comparison with the youth is made by the adolescent period of ontogenesis: the intensity of secular changes in body size in 13-year-olds is higher than in 17-year-old boys and girls. They also show more pronounced secular changes compared to their peers against the background of continuing rather active processes of morphofunctional differentiation, which have almost ended in 17-year-old girls. The most intense secular changes in the historical interval of the 1880s–2010s were recorded for the index of longitudinal skeletal development – body height. Less intense temporary changes were noted for body weight, the smallest for chest circumference,



and these changes are less pronounced in girls than in boys. The combination of time dynamics of different anthropometric indicators shows an epochal increase in leptosomal physique, primarily of girls [Fedotova, Gorbacheva, 2020].

The field of interests of domestic anthropologists, in addition to our country, also affects neighboring states. For example, it should be noted the work on the assessment of morphophysiological parameters of girls of low-mountain and high-mountain regions of Kyrgyzstan, surveyed in 1968-1969. According to the results obtained, the specificity of the growth and development processes depending on the altitude above sea level of the region of residence is confirmed for this group. A slowdown in growth processes for transverse, longitudinal, girth dimensions, indicators of bone massiveness and the development of fat deposition in children in the highlands, especially in the pubertal growth phase, was revealed. At the same time, the proportions of the body of girls of the highlands compared to girls of the low mountains are characterized by a relatively longer trunk, short lower limbs, a more prominent chest (the result of adaptation to hypoxia). The study of the process of puberty in girls of the low mountains and highlands revealed the usual sequence of the appearance of secondary sexual characteristics. At the same time, the analysis of the values of middle age and the first cases of the appearance of the initial stages of the development of these signs revealed a significant backlog of girls from the high altitudes. The results of this study in the context of the causes of stunting of children in the high-altitude regions (moderate hypofunction of the thyroid gland, isolation of groups, nutritional characteristics, inbreeding, climatic factors, ultraviolet radiation) are of great interest for anthropological studies in other territories [Stepanova, Godina, 2015].

A separate extensive block of research is devoted to the study of the growth and development of children and adolescents in Mongolia. In cooperation with the Mongolian National Institute of Physical Education, an extensive contingent living in various parts of the country was surveyed. A comparative study devoted to the analysis of growth and development indicators of Mongolian and Kalmyk children and adolescents (historically and ethnogenetically related) revealed significant differences in

most anthropometric indicators. So, almost throughout the entire age range, Kalmyks are higher than their Mongolian peers. Mongolian boys at most ages have lower values of chest circumference and BMI, in girls the situation is quite opposite. Also, this group is characterized by lower values of the thickness of fat skinfolds. Significant and unidirectional differences in functional indicators were revealed: the dynamometry of both hands was significantly higher in Mongols, and the total puberty score was higher in Kalmyks. The results of discriminant analysis confirm the ethnogenetic proximity of the studied samples with differences in the level of acceleration [Godina et al., 2016].

The analysis of the patterns of secular variability of anthropo-physiological indicators (using samples examined in the late 1980s and 2010–2011) revealed significant differences between Mongolian children and adolescents in two series of measurements. The revealed patterns of secular variability of body size are a clear illustration of the ratio of "«tempo and amplitude» in auxology [Auxology ..., 2013] – changes in growth and development rates when achieving the same average indicators in 16–17-year-old boys and girls. The observed differences arise as a result of achieving the same average values of the trait in modern adolescents 1–2 years earlier than in the 1980s. The scale of secular changes in the indicators of "growth" and "development" is different for boys and girls: the average size changes more in boys, and the timing of the development of sexual characteristics in girls. The increase in girth sizes observed in modern schoolchildren in Mongolia is primarily due to an increase in the fat component, which, in general, coincides with global trends on a global scale [Godina et al., 2017].

It is also interesting to study in which the temporal dynamics of the total body size of the Abkhazian population over 30 years (1980, 2005 and 2012) was analyzed. A tendency to increase the body height of boys and girls with slightly earlier pubertal growth spurt was revealed. In terms of body weight, there is a significant increase in the indicators of boys in the 2012 survey at the entire age segment. According to the values of the chest circumference for boys, there is a tendency to increase in size over the surveyed period of time. Abkhazian girls of the 2012 survey have the same

mean values of chest circumference as their peers of the 1980 survey over the entire age range, with the exception of 16- and 17-year-old girls who have lower average values of this trait. During the time period under consideration, changes in the timing of puberty in the direction of its acceleration were noted in Abkhazian adolescents. And if for girls the decrease in the average age of the onset of secondary sexual characteristics is observed at the trend, then for boys these terms have decreased significantly. The authors note that schoolchildren of the 2005 survey are characterized by lower values of total body size relative to their peers and peers surveyed in 1980 and 2012, which should be considered as a result of the impact of harsh living conditions during wars and social upheavals, especially affecting children who experienced these hardships in the first years of life. According to the BMI of Abkhazian schoolchildren surveyed in 2012, there is an increase in the occurrence of overweight and obese persons of both sexes, which confirms the global trend observed in many other populations [Kokoba et al., 2018].

### **The relationship between the variability of indicators of physical development of children and adolescents and some socio-economic factors**

Since changes in the prevalence of overweight and obesity are multidirectional in countries with different levels of economic development, an important milestone in the work of anthropologists around the world is to assess the relationship of physical development indicators with socio-economic indicators.

First of all, it is important to assess the degree of urbanization of the region on the growth processes of children and adolescents. An assessment of the prevalence of overweight and obesity in school-age children living in villages, small towns and megalopolises of the Perm region revealed increased body weight values in 23.6–26.3% of rural and urban children (including obesity in 8.3–10.2%), more common in groups of boys. At the same time, the differences in place of residence within the sex groups were not statistically significant. The peak occurrence of elevated BMI values was recorded for 11-year-olds of both sexes. According to these data, the prevalence of overweight and obesity in school-

children of the Perm region in 2019–2020 is high and close to that in children of Komi, Udmurtia, Bashkiria and Moscow; it does not depend on the place of residence (megapolis, small town, village) and depends on the sex of the child [Kozlov et al., 2022].

A detailed study of the growth and development indicators of urban children and adolescents from the families of urban parents and parents who moved to the city from rural areas to assess the contribution of migration processes to the change in morphological characteristics of the Arkhangelsk region was conducted by the laboratory of Auxology of the Research Institute and the Museum of Anthropology (Lomonosov Moscow State University). The study was conducted in a comparative aspect and also affected the population of the cities of Saratov and Moscow. It was found that in Arkhangelsk, girls whose both parents were born in rural areas have almost all the indicators characterizing the strength of the addition compared to girls whose parents were born in the city. In boys, the differences are much less pronounced and have the character of a trend. In Saratov, no statistically significant differences were found in girls, and boys from families of newcomers from rural areas surpass urban boys in the 2<sup>nd</sup> generation in terms of the relative girth of the chest and waist and the shoulders and pelvis diameters. Moscow girls and boys, whose parents were born in rural areas, statistically significantly outperform urban children in the 2<sup>nd</sup> generation in terms of relative chest and waist girths, shoulder diameter. Regardless of the level of urbanization of the city, children of parents who came from rural areas growing up in urban conditions retain tendencies towards greater brachymorphism, they have on average more relative chest and waist girths, shoulder and pelvis diameters, the ratio of the sagittal diameter of the chest to the transverse, BMI, but less relative leg length. The results obtained generally demonstrate the stability of the complex of features characterizing the greater strength of the rural population compared to the urban population. The convergence of the physical characteristics of urban and rural residents in a number of ways may partly be a consequence of active migration processes leading to partial replacement of the population of modern large cities of Russia by immigrants from rural areas [Zadorozhnaya, 2017].

A comparison of the total body size and functional indicators of Mongolian children and adolescents revealed a lag in rural schoolchildren of both sexes in terms of the parameters under consideration (the trend is more pronounced in the case of girls, which refutes the data of earlier studies, according to which no significant differences between the groups under consideration were revealed). The results obtained indicate the active processes of urbanization, leading to significant changes in socio-economic conditions in various regions of the country, and, therefore, the physical status of children and adolescents. It is also shown that higher indicators of the dynamometry are recorded in rural boys at primary school age, which seems quite logical from the point of view of the amount of physical activity in rural groups, starting from early childhood. In the groups of girls, the gap in the value of the indicator in favor of urban women (especially since puberty) can be interpreted from the point of view of socio-economic differences that cause greater availability of sports in the capital. The change in hemodynamic indicators towards their increase in the urban group is also evidence of the influence of urbanization. If in groups of boys, large values of characteristics in this group are fixed after the age of 14, then urban schoolgirls throughout the age range demonstrate significantly higher average values, which may be a manifestation of urban stress and should be considered as a negative trend in the psycho-emotional state in cities [Godina et al., 2019].

An interesting contribution to the growth processes is the level of education of parents, the number of children and the financial status of the family. Evaluation of the variability of body composition indicators of schoolchildren in the Saratov region revealed the following pattern: the higher the family income indicators, the greater the value of morphological features. Boys from large families have the smallest body sizes and a very weak development of the fat component. With an increase in the educational and professional level of mothers, the sons' fat-free body weight, the total amount of water and the percentage of fat mass increase. In girls, with an increase in material wealth, educational and professional level of mothers, almost all indicators are growing, except for body density, percentage of lean mass and percentage of water.

Daughters of fathers with an average professional level have the highest rates of fat-free component development and average body size. The authors conclude that there is sexual dimorphism in the variability of body composition indicators of school-age children from families of different socio-economic status. In boys, there is a pronounced relationship between the absolute indicators of body composition, reflecting the size of the body, and the factors of material wealth of the family according to the traditional scheme. In girls, it is between the relative indicators reflecting the development of fat deposition and the professional level of parents. In children of parents with a high professional level, the ratio of the amount of fat and muscle component may indicate latent obesity. The method of calculating the ratio of body mass components does not significantly affect the results of the analysis [Zadorozhnaya et al., 2022].

A comparison of schoolchildren from the Saratov region and Moscow indicates that the set of signs describing the socio-economic status of the family of the examined child should correspond to the conditions prevailing in each specific situation, both in terms of meaningfulness and in terms of accessibility of information. For example, in Saratov, in families with three or more children, all indicators of physical development of boys are significantly lower than the average for the corresponding age groups. The greatest number of statistically significant differences are revealed between groups by the number of children, by profession and the level of education of the mother for boys. Girls show significant differences only in body height in all groups by the number of children and in one by the level of education of the mother. The materials obtained in the Saratov region made it possible to assess both the socio-economic conditions themselves and their impact on growth processes: with an increase in the educational and professional level of parents, the indicators of physical development of children also grow; and with an increase in the number of siblings – they decrease. At the same time, all socio-economic characteristics are reliably and highly correlated with each other, and with the higher level of mothers' education the number of children in the family decreases. In Moscow families, the picture is different: the number of children does not correlate at all with the level of education

of parents. Nevertheless, in girls, with an increase in the number of children, all indicators significantly decrease. The daughters of mothers without a specialty have relatively the smallest body height, as well as the daughters of fathers engaged in unskilled work. In boys, no significant differences were found between the sons of parents with different educational and professional levels or the number of children. The author links the change in the structure of the considered socio-economic factors and the decrease in the level of significant differences in body size in children and adolescents, depending on the number of siblings, with a successful social policy regarding the stimulation of fertility. In modern Moscow, in his opinion, the increase in the number of children ceases to be a factor that significantly reduces the economic status of the family [Zadorozhnaya, 2021].

The quantitative contribution of a large complex of family environment factors to the somatic variability of children was estimated and presented on the model of Muscovites 3–7 years old, surveyed on the basis of preschool educational institutions of the Moscow metropolis (2005–06). Factor analysis of family environment indicators revealed three sets of related factors: 1) housing conditions related to the educational level of the parents 2) the combination of the age of the parents and the number of children in the family 3) the educational level of the parents and the peculiarities of the child's lifestyle (passive smoking, computer use, outdoor/outdoor activities). The large acceleration of children of parents with higher education is manifested primarily for longitudinal skeletal dimensions, to a somewhat lesser extent for fat skinfolds and girths of limb segments. The differences in social affiliation are reduced to slightly smaller values of the longitudinal dimensions of unskilled workers' children compared with employees' children and an increase in the transverse development of the body in boys of unskilled working mothers. For preschool girls, it is shown that the more children there are in the family, the smaller their skeletal dimensions (body height, leg length, pelvic diameter). Such features of the child's lifestyle as passive smoking, the intensity of the use of computers as an alternative to outdoor/outdoor activities, being derivatives of the educational level of parents, enhance the somatic differences of children in the vector of education of

parents. It is assumed that the increase in the professional and educational level of parents is associated with the somatic enlargement of offspring, which is a consequence not only and not so much of the financial advantages of a higher social status of parents, but also the organization by educated parents of a healthy rational lifestyle in the family – an adequate nutrition structure, daily routine, exercise regime – and the creation of a favorable background for satisfactory adaptation to the stresses of the modern urbanized environment [Fedotova, Gorbacheva, 2022].

A comparative analysis of the physical development of children and adolescents living in rural areas of the Ulyanovsk region with varying degrees of environmental pollution and different levels of socio-economic well-being showed that the physical development of older children is associated mainly with the quality of the environment, while the physical development of younger children is associated with the level of socio-economic development. When comparing the correlation of indicators of physical development with the quality of the environment and socio-economic development depending on the gender of children, it should be recognized that the physical development of boys is more sensitive to environmental factors, and girls – to the action of social factors. Thus, environmental and social factors can cause multidirectional and (or) summing effects on the physical development of children of different ages and genders [Yermolaeva, Khayrullin, 2015].

The contribution of other factors is no less significant. For example, an assessment of the level of physical activity and daily calorie intake by modern children and adolescents of the Arkhangelsk region and Moscow revealed that urban children, on average, devote more time to work in conditions of hypokinesia (working at a computer, reading, watching TV, etc.), while consuming more calories with food. Positive correlations of these indicators with the development of the fat component (thickness of the skinfolds on the trunk and limbs, absolute and relative fat mass content) determine the somatic status of urban schoolchildren. Of great interest is the amount of time devoted by modern schoolchildren to physical activity. One would expect that rural children of the Arkhangelsk region would be ahead of urban children in these indica-



tors. However, the data obtained do not confirm this pattern. In Moscow children, the amount of time devoted for physical activity exceeds that of residents of the Arkhangelsk region, both urban and rural. This paradoxical conclusion can be explained by the fact that residents of Moscow have more opportunities, primarily financial, necessary for the realization of a healthy lifestyle. But the body fat component in the group of Moscow schoolchildren is still much higher, since positive changes in morphological indicators are leveled in this case by the largest caloric intake among the representatives of the three groups and, on average, a large amount of time spent on passive rest. The results obtained confirm the results of world studies explaining the recent sharp increase in the percentage of overweight and obese children from the standpoint of increasing caloric intake and reducing physical activity [Permiakova et al., 2012].

Also, out of connection with anthropometric characteristics, primary school students from cities in different regions of Russia and one of the parents of the respondent were questioned, some characteristics of their lifestyle were analyzed: frequency, composition and time of meals, sleep duration, number of school lessons, time spent at the computer or watching TV, frequency and duration of classes in sports sections. It is noted that already in elementary grades, the daily routine of schoolchildren is characterized by a significant contribution of activities associated with reduced physical activity – studying at school and at home, reading, playing on the computer and watching TV, Sports sections are attended by less than 46% of children and adolescents, the load is on average 1.5 hours 2 times a week. The duration of sleep is 8 or more hours a day, taking into account the fact that many go to bed at 11 p.m. and get up at 7:00 – 7:15 a.m. The organization of school meals has a significant impact on the diet of a student in primary school. The frequency of meals corresponds to modern recommendations – on average, 4 times a day. Lunch and dinner have the longest duration, ending, on average, at 7:45 p.m. Home meals for schoolchildren, especially on weekends, are more disorganized: the time regime is violated, children more often consume "fast food", carbonated drinks and confectionery. The analysis showed that the peculiarities of diet, sleep regime and physical activity of modern

Russian schoolchildren, starting from primary school, represent a complex of factors assessed by most modern studies as risk factors for the development of overweight [Zadorozhnaya et al., 2018].

The analysis of living conditions was carried out on a Mongolian sample of children and adolescents living in capitol city Ulaanbaatar. It is shown that children and adolescents living in apartments outperform their peers living in dormitories and yurts in terms of the majority of total body sizes and functional indicators (the exception is functional indicators in groups of girls). Since the living conditions can be associated with the socio-economic status of a particular family, the conclusion about the positive impact of these factors on the indicators of physical development of children and adolescents is obvious. Functional parameters showing differences in the groups of girls only for the respiratory system indicate a less clear dependence of functional characteristics on living conditions compared with morphological characteristics. Large values of indicators of the cardiovascular and respiratory systems in schoolchildren living in a well-maintained sector can be considered as an increase in the negative impact of urban stress on the processes of growth and development in this group, which indicates possible further complications in the state of health. Also, the improvement of hand dynamometry in this group may be evidence of positive changes in physical strength [Godina et al., 2020].

Separately, the results of comprehensive studies should be noted, in addition to the contribution of socio-economic factors to the growth and development of evaluators, including hormonal (thyroid profile) and psychological parameters. For example, on the example of Moscow students, their relationship with the integrative indicator of adaptive capabilities – PCL (the level of physical condition of the body calculated on the basis of indicators of the hemodynamic system and total body size) was evaluated. In girls, statistically significant associations of PCL were revealed with a cluster of morphological features, blocks of body component composition, functional indicators and physical activity, for the values of metabolism and the indicator of orientation to appearance. In the group of boys, there were significantly fewer reliable correlations: as in girls, a block of functional indicators and specific metabolism, as well as the level of total thyroxine in

the blood and satisfaction with body parameters were significantly associated with PCL. The structure of relationships between groups of traits is as follows: socio-cultural characteristics are associated with levels of anxiety, aggressiveness and depression; body component composition – with physique and functional indicators, which also correlate with social characteristics (education of parents, number of children in the family, level of family income). The closeness of the connections between the PCL and the blocks of the body's component composition and functional indicators is due to the commonality of their biological nature and the unity of subsystems in the structure of the general human constitution. A small but statistically reliable association between the PCL and the level of physical activity confirms the positive effect of daily physical activity on the adaptive capabilities of the body. The reliable connection with the PCL of individual socio-cultural features reflects the degree of importance of the perception of the features of one's own physique in the life of modern boys and girls and indicates the influence of self-esteem of appearance not only on the psychological state and quality of life, but also on the physical condition of the body and adaptive capabilities. The results obtained are consistent with the concept of intersystem integration of the organism and confirm the influence of socio-economic and socio-cultural factors on the processes of morphophysiological and psychosocial adaptation of modern youth to the conditions of the super-urbanized environment of the XXI century [Sineva et al., 2022].

Also informative are studies on the search for possible links between secular changes in body size and socio-economic, demographic and environmental indicators. Using the example of 17–18-year-old students of Moscow in the interval from the 1970s to the present, it was shown that in the second half of the XX century, boys and girls experienced a process of secular increase in body height with stabilization of this indicator in both sexes since the early 2000s. The average values of body weight and indicators associated with the development of fat deposition increased throughout the analyzed period with a statistically significant decrease in the massiveness of the skeleton. Along with secular changes in total body size, a tendency to increase the andromorphic component of the physique in

girls was revealed. According to the results of the correlation analysis, the largest number of reliable links were established with changes in socio-economic conditions (indicators of gross domestic product, per capita income of the population, meat consumption per capita). At the final stage of the study, an original model of the interrelationships of secular dynamics of body size with the influence of factors of various nature (variability of some environmental, socio-economic and demographic indicators changing over time) was built, based on statistically significant Spearman correlation coefficients and reflecting the dominant contribution of socio-economic indicators to secular changes in the parameters of the physique of modern Moscow youth [Negasheva et al., 2020].

## Conclusion

It can be concluded that the number of works devoted to research on the processes of growth and development of children and youth is quite numerous, which allows us to speak about the undiminished interest of domestic anthropologists in this topic. Most of the works are devoted to the problems of the secular trend with a simultaneous assessment of the peculiarities of its course in different regions of our country and abroad (over the past 50 years). Cross-sectional comparative studies devoted to the analysis of differences in the rates and dynamics of growth processes of children and adolescents are also of undoubted interest. And, of course, it should be noted that domestic auxologists use an integrated approach in solving the standard spectrum of auxological problems, including an analysis of the relationship between the variability of indicators of physical development of children and adolescents with socio-economic factors. The complex nature of most of them, among other things, indicates an integrative approach to solving the problems posed to this field of science.

## Acknowledgments

This work was supported by the Lomonosov Moscow State University, project No. AAAA19-119013090163-2 «Anthropology of Eurasian populations (biological aspects)».

The author expresses deep sincere gratitude to all colleagues who devote their scientific research to the problems of growth and development of children and adolescents.

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**ОСНОВНЫЕ НАПРАВЛЕНИЯ АУКСОЛОГИЧЕСКИХ  
ИССЛЕДОВАНИЙ ШКОЛЬНИКОВ И МОЛОДЕЖИ В РОССИИ  
(ПО МАТЕРИАЛАМ СТАТЕЙ В «ВЕСТНИКЕ МОСКОВСКОГО  
УНИВЕРСИТЕТА. СЕРИЯ XXIII. АНТРОПОЛОГИЯ»  
ЗА ПОСЛЕДНИЕ 15 ЛЕТ)**

**Введение.** Настоящий обзор является продолжением исследования по оценке развития ауксологии в отечественной антропологии. Первая часть была посвящена комплексному рассмотрению процессов роста и развития детей от рождения до 3 лет, проживающих как в нашей стране, так и в странах ближайшего зарубежья. В проанализированных источниках описаны факторы, влияющие на ростовые процессы (эволюционные, климато-географические, этнические и генетические факторы, конституциональные особенности матерей, обстоятельства внутриутробного роста) [Permiakova, 2023]. В настоящей статье более детально рассматриваются и описываются основные направления деятельности ауксологов, а также медиков и психологов, работающих как в пределах нашей страны, так и в кооперации с зарубежными исследователями из различных академических учреждений.

**Материалы и методы.** В данной части работы в качестве источника информации использованы опубликованные в «Вестнике Московского университета. Серия XXIII. Антропология» с 2009 по 2022 г. статьи, посвященные комплексной оценке физического развития (а также факторов, на него влияющих) школьного и студенческого контингента.

**Результаты и обсуждение.** Работы в обозначенной области, с одной стороны, анализируют физическое развитие детей и молодежи Московского региона, с другой – оценивают различия темпов и динамики ростовых процессов жителей различных регионов нашей страны и зарубежья, затрагивая, в том числе, и секулярный аспект. Кроме того, на представительных выборках анализируются социально-экономические факторы, влияющие на данные процессы и определяющие особенности их протекания на конкретной территории. Важными представляются также комплексные исследования, затрагивающие связь показателей соматического развития не только с социально-экономическими или экологическими параметрами, но и психологическими особенностями обследуемых.

**Заключение.** Количество работ, посвященных исследуемой тематике, достаточно многочисленно, что позволяет говорить о неснижаемом интересе отечественных антропологов к изучению проблем роста и развития. Комплексный характер большинства из них, помимо прочего, свидетельствует об интегративном подходе к решению поставленных перед данной областью науки проблем.

**Ключевые слова:** биологическая антропология; антропологическая изменчивость; популяции человека; средовые воздействия

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Поступила в редакцию 06.02.2023,  
принята к публикации 28.02.2023.