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MAIN DIRECTIONS IN THE STUDY OF INFANTS' GROWTH AT MOSCOW SCHOOL OF ANTHROPOLOGY: A REVIEW BASED ON THE ARTICLES PUBLISHED IN «MOSCOW UNIVERSITY ANTHROPOLOGY BULLETIN (MUAB)» FOR THE LAST 15 YEARS

Introduction. *The present study is of a complex nature and is devoted to the assessment of the main directions of the development of auxology in Russian anthropology. To a large extent, this work is a continuation of the review of the activities of the laboratory of auxology of the Anuchin Research Institute and the Museum of Anthropology of Moscow State University [Godina, 2010]. At the same time, the main directions of work are considered and described in more detail not only directly by the auxology laboratory, but also by other working groups of the same Institute, the Department of Anthropology of the Faculty of Biology of Lomonosov Moscow State University, as well as other academic institutions.*

Materials and methods. *Specifically, in this part of the work, articles devoted to the comprehensive assessment of the processes of growth and development of children from birth to 3 years old, which were published in the «Moscow University Anthropology Bulletin» from 2009 to 2022, were used as a source of information.*

Results and discussion. *The studies conducted in this area affect a large number of aspects of physical development in infancy and early childhood – for example, factors influencing these processes (evolutionary, climatic, geographical, ethnic and genetic factors, constitutional features of mothers, circumstances of intrauterine growth) are analyzed on representative samples. Special attention should be paid to the work on the evaluation in comparative and secular aspects of growth processes and indicators of sexual dimorphism of children under 3 years of age in the countries of the former USSR.*

Conclusion. *Despite the difficulties in working with a rather specific contingent, the fact that these works, together with the results obtained, lead us to conclude that this stage of ontogenesis is represented to a large extent in the works of domestic anthropologists, which allows us to use these data both in the field of interdisciplinary and interdepartmental research.*

Keywords: biological anthropology; human populations; auxology; infants; early childhood; growth and development; human morphology

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Introduction

Assessment of the processes of growth and development of children and adolescents using diverse approaches involving theoretical and methodological foundations of related fields of knowledge (psychology, medicine, genetics, ecology, etc.) is the fundamental basis of auxology [Godin, 1919; Godina, 2010]. Undoubtedly, this section of anthropology is perhaps the most complex and interdisciplinary part of it, since it evaluates the contribution of climatogeographic, socio-economic, hormonal, psychological and genetic factors to the formation of soma [for example, Hrisanfova, 1990; Nikityuk, 1991; Martynenko, 2021; Parfent'eva et al., 2022; Permiakova et al., 2022; Araos et al., 2016; Sheehan et al., 2021]. Among other things, an important aspect of auxology is also the study of the spatio-temporal aspects of development, i.e. the assessment of the secular trend, which allows

us to talk about the acceleration or, conversely, slowing down of growth processes from generation to generation [Vlastovskij, 1979; Batsevich, Yasina, 2015; Batsevich, 2022].

One of the basic directions of the work of Russian anthropologists is the analysis of the growth and development of infants, as well as factors influencing these processes. The importance of this kind of research is undeniable and is due to the fact that this period of ontogenesis is characterized by the highest rate of growth processes accompanied by active morphofunctional differentiation of individual body systems [Tanner, 1994; Fiziologiya rosta …, 2007].

The aim of the present work was to picture the main directions in the study of infants' growth at Moscow school of anthropology. Although publications on this topic are present in other journals, we have used for this work only those materials that had been published in the Moscow University Anthropology Bulletin. This choice can be explained by the reason that most of the founders of auxological studies in Russia worked at the Research Institute and the Museum of Anthropology of Lomonosov Moscow State University and paid much attention to children's growth during this particular period of ontogenesis. That is why extensive databases covering different regions and even countries of the former USSR exist and are also used in modern research.

Study of the growth patterns of infants

One of the leading places in this field is occupied by the work of the Laboratory of anthropoecology of the Anuchin Research Institute and the Museum of Anthropology (Lomonosov Moscow State University).

First, it should be noted the review of numerous literature data concerning the variation of the body size of newborn Russians. Analysis of the factors of evolutionary, climatic-geographical, ethhnic and genetic factors, assessment of the constitutional characteristics of mothers (first of all, the pelvis diameter), as well as the circumstances of intrauterine growth allows us to conclude that the positive relationship of body weight at birth with the geographical latitude of the population; negative relationship with altitude adjusted for the duration of adaptation populations to conditions of high-altitude hypoxia; seasonality of body weight fluctuations against the background of cyclic fluctuations in the level of insolation and vitamin D as well; cyclical fluctuations in the size of the newborn due to the dynamics of geomagnetic activity. An assessment of the temporal dynamics of the Russian newborns' parameters makes it possible to conclude that the processes occurring in our country and in Europe and Asia as well are similar, which manifests itself in an increase in body height while simultaneously reducing body weight and girths [Fedotova, Borovkova, 2011].

Further analysis is carried out on samples of Moscow children 0–36 months old, examined in the period from 1952 to 2015. The directions of research in this case are very multidirectional and affect, first of all, the specific features of growth in the infant period of ontogenesis and in early childhood.

Thus, the contingent surveyed in 2009 demonstrates quite standard changes in body height and weight, chest and head girths from the moment of birth, with increments gradually decreasing by 12 months. The intensity of size increase in the first year of life is maximum for body height compared to newborns (11–13 sigma), slightly less for body weight (10 sigma) and head and chest girths (7–9 sigma). According to the authors, individual growth channels that are not related to the patterns of embryonic development begin to clearly manifest themselves no earlier than 4–5 months of age. The most important factor in the formation of individual differences at this age in children of both sexes is the social status of parents. For more sensitive boys, the presence of other children in the family is also significant [Fedotova et al., 2010]. The obtained results were also presented in the form of percentile standards (body height and weight, girth dimensions), reflected both graphically and in tabular format, which determines the possibility of their use in work compared to the physical development of Muscovites and other young residents of Russia and foreign countries [Fedotova, Gorbacheva, 2015].

In addition, for the same group, the contribution of an extensive group of family and biological factors was analyzed (the course and order of pregnancy and childbirth, the type of feeding, the presence of certain diseases, hematological characteristics at the time of birth, the time of the appearance of the first teeth, the age and social status of

parents, the presence of hereditary diseases and the presence of other children in the family) in the variation of development in the first year of life. Based on the results of the variance and correlation analysis, the authors conclude that the connections (but with a low correlation coefficients) of soma indicators with the social status of parents in children of both sexes, as well as with blood indicators at birth and the number of other children in the family of boys are not accidental. The presence of various diseases during the infancy period of growth, the type of feeding, the course of pregnancy and the age of the parents affect the value of anthropometric parameters much less often. In any case, the values of the correlation coefficients obtained in the work can explain only 4-16% of the variation in body sizes, which confirms the control of growth processes in children by many independent factors, the effect of each of which is relatively small [Fedotova et al., 2012].

Special attention should be paid to the work devoted to the variability of the body size of newborns and the size of the pelvis of mothers, which is of undoubted interest, including for medical research. The analysis of 69 samples of newborns numbering more than 70 thousand people and 60 samples of women from Eurasia (former USSR countries) showed that centripetal trends prevail in the variability of both the body size of newborns and the diameter of mother's pelvis, directing the values of these parameters to a narrow specific norm. Within the framework determined by stabilizing selection, the entire spatial dynamics of the body size of newborns occurs: neither the climatogeographic, nor the degree of urbanization of the mother's place of residence, nor the anthropological specifics of the sampling of the newborns themselves individually make a significant contribution to the variations in their body size and are more mediated by the morphofunctional status of the mother. An interesting fact is that higher correlations with the size of the newborn's body are demonstrated not by its pelvic diameter, but by the body weight. Anyway, the most significant contribution is not even this indicator, but the family factor – the body weight of siblings and parents at birth, which is consistent with Tanner's results [Tanner et al., 1972]. At the same time, however, the authors note that in the temporal aspect, leptosomization and dolichocephalization of newborns are consistent with the tendency to decrease the pelvis diameter of mothers (especially in megacities), which, in turn, corresponds to the tendency to asthenization of modern women of reproductive age [Fedotova, Gorbacheva, 2016]. At the same time, the analysis of 3055 mother-child pairs of urban and rural populations of six ethnoterritorial groups: Mari, Komi, Buryat with Perm, Komi Republic and Buryatia Russians showed that the greatest statistical "weight" in explaining the variability of body weight at birth is characterized by the gestational age and body weight of a mother. An additional (modifying) influence is exerted by the marital status, height and place of residence (rural or urban) of the mother, the number of the child's birth, the hemoglobin level in mother's blood, the mother's age. The proposed model does not take into account such obviously highly significant indicators for the newborn's body weight as the state of health and contact with toxic substances of the mother, the quality of nutrition and medical support [Vershubskaya, Kozlov, 2020].

The intergroup diversity of growth processes of infants of the former USSR from birth to 12 months is also of particular interest in the context of assessing the influence of climatic and geographical factors, the degree of urbanization of the place of residence and ethnicity on growth processes. The implementation of this aim was carried out using data from surveys of 63 ethno-territorial groups conducted in the late 1960s – early 1970s (the total number is more than 70 thousand people). It is shown that among Slavic groups, body weight has the smallest range of intergroup variability, body height has the largest, chest girth occupies an intermediate position in terms of the severity of the differences found. A significant trend of increasing the body height of newborns from west to east with an increase in the geographical longitude of the place of residence was revealed. There is also a tendency to increase body height and chest circumference in children of both sexes with an increase in latitude, i.e. from south to north, in accordance with the Bergmann's rule. When comparing non-Slavic ethnic groups, the scale and patterns of intergroup variability of different body sizes are comparable to the picture of territorial variability of Slavic groups of newborns. Nevertheless, the indicators of the severity of the climate – the maximum temperature in

January, the average yearly temperature, the continentality of the climate – show connections not with body height, as it was in the analysis of Slavic groups, but with body weight and chest circumference in girls and boys. Comparing the body sizes of newborns of different ethnic groups living in the same territory does not fit into a coherent scheme, therefore, summarizing the results obtained, the authors conclude that neither climatic and geographical factors, nor the degree of urbanization of the place of residence, nor the actual anthropological specifics of the sample of newborns, considered separately, are absolutely unambiguous determinants in size variations of newborns [Borovkova et al., 2012]. The results of the survey of 12-month-old children (about 15 thousand people) also reveal the dependence of the magnitude of dimensional features and their ratios, or proportionality of physique, on the degree of discomfort of climatic and geographical factors of the niche of development. An increase in natural stress accompanies a decrease in the ratio of girth to body height and an increase in leptosomal physique, in fact, to a weakening of physical conditions and fitness [Gorbacheva, Fedotova, 2017]. The contribution of anthropogenic factors to variations in the main anthropometric indicators of children at the start of ontogenesis (12-36 months) turns out to be relatively small, which perhaps indicates that the age under consideration is not informative for studying the processes of adaptation of the child's body to the environment [Gorbacheva, Fedotova, 2018].

Subsequent work on the same sample is devoted to comparing the dynamics of the normalized values of the main indicators of physical development, as well as analyzing the secular variability of growth processes. It is shown that the structure of the intergroup variation of four body sizes in children of different ethnic groups at birth differs from that for 12 months of age. The stability of the growth channel for body height and weight is fixed only at 6 months and later, whereas the girth dimensions (head and chest girths) do not show a similar pattern in any of the examined ages. The scale of intergroup differences in body height and weight increases from birth to 12 months from one sigma to two sigma, and in head and chest girths, on the contrary, decreases. The analysis of the intergroup specificity of Russian infants of different territorial groups revealed a great similarity in the growth dynamics of the body size of children growing up in different climatic and geographical conditions. Children developing in the most urbanized environment (Moscow and Murmansk) are characterized by high rates of growth in body height and weight during the infancy period in the case of the Moscow sample and stable acceleration in all considered sizes in the case of the Murmansk sample. The distressing conditions of extreme ecological "overload" in the Donetsk region determine the significant lag of Ukrainian children in this region from other samples in the growth rates of total body sizes. Thus, the intergroup specificity of somatic status is formed gradually during the infant period of ontogenesis. Age-related changes in body height and weight, on the one hand, and head and chest girths, on the other, occur heterochronously [Gorbacheva, 2015].

Similar work is being carried out in other regions of our country. Thus, the analysis of the influence of the quality of the natural environment on the physical development of newborn children born in 1987 and 2007 in Mendeleevsk suggests that the trends of secular changes in the indicators of physical development of the studied groups of newborn children are diverse and are due to the complex action of environmental and socio-economic factors. The authors postulate that in small towns (with a population of less than 50 thousand, as in Mendeleevsk), the influence of environmental conditions on the physical development and health of newborns is determined by both the level of environmental pollution and the solvability of socio-economic, demographic issues of city residents, as well as the level of healthcare [Chernysheva, Islamova, 2014].

As for the study of secular aspects of growth processes, the analysis of samples of all ethnic groups characterizing the status of physical development of newborns and infants throughout the Soviet and post-Soviet space, presented in the form of scattering diagrams, confirmed the acceleration of skeletal development of children at the start of ontogenesis, characteristic of both sexes in different periods of ontogenesis, with simultaneous temporal stability of body weight. The different direction of the temporal dynamics of the breast circumference in newborns and infants is also shown. As for head circumference in newborns from the 1950s to the

2000s, it decreases by 1.1–1.2 cm, which corresponds to the trend of narrowing of the pelvic diameter of mothers repeatedly noted in the literature. For 12-month-old children, there is a temporary stability of this size for 40 years from the 1950s to the 1990s. The secular lag in the growth of the head circumference of newborns is compensated by the end of the first year of life. The heterochronous temporal dynamics of different indicators of physical development of newborns and infants leads to a secular increase in the leptosomality of their physique. It is also shown that the secular dynamics of the increase in body height indicates a secular acceleration of skeletal development of children at the start of ontogenesis, characteristic of both sexes in different periods of ontogenesis: newborns (about 2 cm) and infants (3.8–4.7 cm). This trend is combined with the stability of the body mass index in children of both sexes in the neonatal period and infancy, indicating a temporary increase in the leptosomality of children at the start of ontogenesis. The different direction of the secular dynamics of the chest circumference in newborns and infants is shown. In newborns from the 1950s to the 2000s, the head circumference decreases by 1.1–1.2 cm, which corresponds to the trend of narrowing of the pelvis diameter of mothers repeatedly noted in the literature. For 12-month-old children, there is a temporary stability of this size for forty years from the 1950s to the 1990s [Borovkova et al., 2012; Fedotova, Gorbacheva, 2017].

Separately, it is worth noting a series of works devoted to the analysis of sexual dimorphism of newborns of the former USSR, and the subsequent comparison of the results obtained with data on modern children. As the main indicator, the Kullback distance is used – a value expressed in fractions of standard deviations. It is shown that the minimum variability of the indicator of sexual dimorphism among the body sizes of newborns belongs to body weight – the main object of stabilizing selection. The body height, the head and chest circumferences are characterized by higher rates of sexual dimorphism, which, in general, are not rigidly associated with either ethnic or environmental factors in a broad sense [Gorbacheva, Fedotova, 2015]. It is also shown that the ethnic factor makes a significant contribution to the formation of the intergroup diversity of growth processes and sexual dimorphism patterns in infancy. Different ethnic groups in the same anthropoecological niche have both an unequal level of sexual dimorphism of each of the body sizes, and some ethno-specific features of the age dynamics of sexual dimorphism [Gorbacheva, Fedotova, 2022a]. To a certain extent, the variability of sexual dimorphism of the main body sizes also depends on the level of urbanization of the region of residence. The results of the analysis of 120 samples of newborns of each sex of the republics of the former USSR indicate that at the start of postnatal ontogenesis, the value of sexual dimorphism varies slightly and for most body sizes is almost unchanged at the level of 0.3 sigma, regardless of the degree of urbanization of the place of residence or ethnicity of the groups. However, living conditions in million-plus cities are favorable for improving the physical status of male infants [Fedotova, Gorbacheva, 2021].

A similar work carried out for 12-month-old children, taking into account the influence of exogenous factors of various nature on sexual dimorphism, allows us to conclude that 4 factors can be identified, collectively describing 79% of the variability of the parameters of the ecological niche of the place of residence. The dominant characteristic of the urban ecological niche is the variable population. The fact of the dominant role of the population in the formation of the somatic status of one-year-olds is confirmed by a change in the direction of the relationship of sexual dimorphism with such factors as the level of wastewater pollution, the amount of emissions into the atmosphere when excluding megacities from the sample. Correlations of sexual dimorphism of the body size of one-year-olds with the most informative environmental factors based on the results of factor analysis turned out to be unreliable, however, an assessment of their sign for a number of pairs of signs showed that height-weight indicators are more eco-sensitive in girls, girth sizes in boys. As the authors point out in their analysis, for the adult populations, the literature shows gender-differentiated phenotypic plasticity of a significant level, in particular, disproportionately high plasticity of fat deposition in the female sex and disproportionately high plasticity of lean mass in the male [Wells, 2012]. The picture for samples of definitive age and for infants in this study is not

identical, however, the fact of different ecosensitivity by gender is confirmed at the start of postnatal ontogenesis [Gorbacheva, Fedotova, 2022b].

The form of the dynamics of the level of sexual dimorphism of somatic parameters is an informative indicator of the heterogeneity of the infant period of ontogenesis. The quantitative level of sexual differences also indicates heterogeneity and a well-known substantial alternative of indicators of skeletal development and fat deposition. The sign of these differences indicates gender differentiation of growth strategies in infancy – more intensive skeletal development in boys and more intensive accumulation of fat deposition in girls [Gorbacheva, Fedotova, 2021]. As for the secular variability of sexual dimorphism, in this case, the analysis of the data of Moscow 12-month-old children from the 1930s to the 2010s showed the existence of timeless and suprapopulation growth mechanisms, in particular, an increase in sexual dimorphism of all body sizes without exception in the first trimester. At the same time, the intergroup differentiation of body size dimorphism is minimal at the start of postnatal ontogenesis. The nonlinearity of the dynamics of its level for the studied body sizes during the first year of life is confirmed. The most significant quantitative indicator of secular processes, obtained on the materials of several series of data from infants in Moscow, is sexual dimorphism in body height [Gorbacheva, Fedotova, 2022c].

Conclusion

Studies of the considered period of ontogenesis from the point of view of both their organization and implementation represent one of the most urgent problems not only of auxology, but also of anthropology as well. Despite the difficulties that arise, Russian anthropologists are continuously working in this area, and the results obtained allow us to conclude about their relevance, the possibility and even the need to establish interdepartmental and interdisciplinary contacts in this area.

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ОСНОВНЫЕ НАПРАВЛЕНИЯ АУКСОЛОГИЧЕСКИХ ИССЛЕДОВАНИЙ ДЕТЕЙ ОТ РОЖДЕНИЯ ДО 3 ЛЕТ В МОСКОВСКОЙ ШКОЛЕ АНТРОПОЛОГИИ (ПО МАТЕРИАЛАМ СТАТЕЙ В «ВЕСТНИКЕ МОСКОВСКОГО УНИВЕРСИТЕТА. СЕРИЯ XXIII. АНТРОПОЛОГИЯ» ЗА ПОСЛЕДНИЕ 14 ЛЕТ)

Введение. *Настоящее исследование носит комплексный характер и посвящено оценке основных направлений развития ауксологии в отечественной антропологии. В значительной степени данная работа является продолжением обзора деятельности лаборатории ауксологии НИИ и Музея антропологии МГУ [Godina, 2010]. В то же время, более детально рассматриваются и описываются основные направления работы не только непосредственно лаборатории ауксологии, но и других рабочих групп НИИ и Музея антропологии МГУ имени М.В.Ломоносова, кафедры антропологии Биологического факультета МГУ имени М.В.Ломоносова, а также иных академических учреждений.*

Материалы и методы. *Конкретно в данной части работы в качестве источника информации использованы статьи, посвященные комплексной оценке процессов роста и развития детей от рождения до 3 лет, которые были опубликованы в «Вестнике Московского университета. Серия XXIII. Антропология» с 2009 по 2022 г.*

Результаты и обсуждение. *Исследования, проведенные в данной области, затрагивают большое количество аспектов физического развития в грудном возрасте и раннем детстве – так, на представительных выборках анализируются факторы, влияющие на данные процессы (эволюционные, климато-географические, этнические и генетические факторы, конституциональные особенности матерей, обстоятельства внутриутробного роста). Отдельного внимания заслуживают работы по оценке в сравнительном и секулярном аспектах ростовых процессов и показателей полового диморфизма детей до 3 лет стран бывшего СССР.*

Заключение. *Несмотря на сложности в работе с достаточно специфичным контингентом, факт наличия данных работ вкупе с полученными результатами позволяет сделать заключение о том, что данный этап онтогенеза в работах отечественных антропологов представлен в значительной степени, что дает возможность использовать эти данные как в области междисциплинарных, так и межведомственных исследований.*

Ключевые слова: биологическая антропология; популяции человека; ауксология; грудной период онтогенеза; ранее детство; рост и развитие; морфология человека

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