

MORPHOLOGY, PHYSIOLOGY AND PATHOPHYSIOLOGY

AGE-RELATED AND REGIONAL PECULIARITIES OF SOMATOMETRIC CHARACTERISTICS OF YOUNG MEN AND MEN OF THE 2nd MATURE AGE LIVING IN THE CONDITIONS OF THE NORTH-EAST AND NORTH-WEST OF THE RUSSIAN FEDERATION

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RESUME

Introduction. Anthropometric characteristics are necessary to obtain objective data on human physical development that allow us to assess the age, gender and geographical features of the human body structure while geographical differences in the shape of the human body (body size, body proportions, shape and size of limbs, as well as the relative proportions between these components) are often interpreted as the result of adaptation to the climate.

Objective. Assessment of the age dynamics of somatometric characteristics of males living in various climatogeographic regions – North-East, North-West of Russia.

Materials and methods. The main anthropometric characteristics, their calculated indices, and body composition were evaluated in 333 males living in various northern regions of the Russian Federation: Magadan Region (Northeast of Russia) – 199 young men and 110 men, Murmansk Region (Northwest of Russia) – 72 young men and 32 men.

Results: In the course of the work, a distinct regional feature has been established in the formation of the morphotype of the inhabitants of the North-East of Russia in the adolescent and mature periods of ontogenesis, manifested by large body lengths and body disproportionality due to the greater contribution of leg length to body length compared to the inhabitants of the North-West of Russia. The age-related dynamics of changes in the analyzed parameters in residents of the North-East and North-West of Russia had similar trends, manifested in an increase in hypersthenization of body build, conditioned by excessive body weight.

Conclusion. The results obtained emphasize the importance of conducting continuous monitoring studies of key indicators of physical development as valuable markers for identifying geographical variations in morphological types under the influence of socio-economic and environmental factors in the northern and Arctic regions.

Keywords: anthropometric characteristics; climatogeographic zones; somatotype; boys; men; Russia; north; Arctic

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ВОЗРАСТНЫЕ И РЕГИОНАЛЬНЫЕ ОСОБЕННОСТИ СОМАТОМЕТРИЧЕСКИХ ХАРАКТЕРИСТИК ЮНОШЕЙ И МУЖЧИН 2-ГО ЗРЕЛОГО ВОЗРАСТА, ПРОЖИВАЮЩИХ В УСЛОВИЯХ СЕВЕРО-ВОСТОКА И СЕВЕРО-ЗАПАДА РОССИЙСКОЙ ФЕДЕРАЦИИ

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РЕЗЮМЕ

Обоснование. Антропометрические характеристики необходимы для получения объективных данных о физическом развитии человека, которые позволяют оценить возрастные, половые и географические особенности строения человеческого тела, при этом географические различия в форме тела (размер тела, пропорции тела, форма и размер конечностей, а также относительные пропорции между этими компонентами) часто интерпретируются как результат адаптации к климату.

Цель исследования. Оценка возрастной динамики и региональных особенностей соматометрических характеристик лиц мужского пола, проживающих в различных климатогеографических регионах – Северо-Восток и Северо-Запад России.

Методы. Проведена оценка основных антропометрических характеристик, их расчетных индексов, а также показателей компонентного состава тела у 333 лиц мужского пола, проживающих в различных северных регионах Российской Федерации: Магаданская область (Северо-Восток России) – 119 юношей и 110 мужчин, Мурманская область (Северо-Запада России) – 72 юноши и 32 мужчины.

Результаты. В ходе работы выявлена отчетливая региональная особенность в формировании морфотипа жителей Северо-Востока России юношеского и зрелого периодов онтогенеза, проявляющаяся большими величинами длины тела и диспропорциональностью телосложения за счет большего вклада длины ног в длину тела относительно жителей Северо-Запада России. Возрастная динамика изменения анализируемых параметров у жителей Северо-Востока и Северо-Запада России имела схожие тенденции, проявляющиеся в усилении гиперстенизации телосложения, обусловленной избыточной массой тела.

Заключение. Полученные результаты подчеркивают важность проведения постоянных мониторинговых исследований ключевых показателей физического развития как ценных маркеров для выявления географических вариаций морфологических типов под влиянием социально-экономических и экологических факторов в северных и арктических регионах.

Ключевые слова: антропометрические характеристики, климатогеографические зоны, конституция телосложения, юноши, мужчины, Россия, Север, Арктика

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INTRODUCTION

Anthropometric data on body structure is necessary to obtain an objective understanding of human physical development [1]. These data are used as a comprehensive assessment of morphofunctional characteristics, and they fully reflect physical performance and overall health status [2]. Due to this, physical development indicators are now seen as a “mirror of ongoing processes in society” [3]. It is worth noting that the intensity of growth processes is influenced by both internal factors (hormones and local tissue-specific factors that regulate growth) and external factors, including climatic conditions of the environment [4]. In early ontogenesis, anthropometric parameters can help characterize growth rates and phenotypic features that are determined by both genotype and external factors. In older age groups, it is possible to assess the risk of developing a range of pathological conditions [5], including overweight and obesity, which are a significant public health concern with global implications. These conditions are reaching epidemic proportions [6].

Basic anthropometric measurements such as height, body weight and body build differ significantly among populations in different climatic and geographic regions [7]. Secular morphological changes are adaptive responses to dynamic environmental, climatic and socio-economic conditions [8]. The economic development of a region can significantly influence the dynamics of anthropometric parameters, particularly linear body measurements [9].

In modern scientific research, there is a growing interest in the role of climatic and geographic factors and their impact on human morphological and functional characteristics [7, 10]. Particular attention has been paid to northern regions with their harsh climate, which affects functional systems first and subsequently the phenotype of the population [11]. This study assessed the anthropometric characteristics of residents in two northern regions of the Russian Federation: the North-East and the North-West. These regions have different climatic and geographic conditions. The North-West (Murmansk Region) has a relatively mild climate, shaped by warm air masses. In contrast, the North-East of Russia (Magadan Region) is influenced by cold continental Arctic air masses [12, 13].

Therefore, **the purpose of this study** is to analyze the age-related dynamics of anthropometric characteristics, considering regional differences, in male individuals (young adults and those in the 2nd mature age group) residing in various climatic and geographic northern regions of the Russian Federation.

MATERIALS AND METHODS

As part of a field study aimed at assessing the functional reserves of residents in different

regions of the Russian Federation, an assessment was made of the somatometric status and body composition of male residents in the North-East (Magadan) and the North-West (Arctic zone – Murmansk). The total sample consisted of 333 men, including 119 young men (17–21 years) and 110 middle-aged men (35–60 years) from the North-Eastern region, as well as 72 young men and 32 middle-aged men from the North-Western region of Russia. The study was conducted during the autumn-winter period of 2024.

The study participants were Caucasian men and young adults of the 1st to 3rd generation, who permanently resided in various climatic and geographic areas. All the young men in the sample were students with comparable living conditions and physical activity levels, as they all participated in physical education classes as part of their academic curriculum. The group of older men also had similar living conditions, being office workers with a predominantly intellectual occupation and a moderate level of physical activity.

Characteristics of the climatic and geographical zones. Murmansk lies in the subarctic zone of the Atlantic region. The climate in this region is shaped by cyclonic activity throughout the year. Winters are relatively mild, with average January temperatures ranging from -12°C to -14°C. The mean annual temperature is between 0°C and -2°C. Magadan is located in the temperate zone of the Pacific region. During the cold season, the climate of this region is primarily shaped by cyclonic activity over the Sea of Okhotsk and Bering Sea. Winters in Magadan are cold, with an average January temperature of -28°C. Mean annual temperatures range from -4°C to -6°C [14].

Inclusion criteria: male sex; young or middle-aged men; native Caucasians from the study region; absence of chronic diseases in acute stage and absence of health complaints; signed informed consent.

Outcome registration methods. Somatometric parameters were measured as follows: body height (BH, cm) and sitting height (SH, cm) were recorded to the nearest 0.5 cm using a wall-mounted stadiometer; body weight (BW, kg) was measured to the nearest 0.1 kg using medical scales. Waist circumference (WC, cm) and chest circumference (CC, cm) were measured to the nearest 0.1 cm using a measuring tape. Body composition parameters, such as total body fat (%) and muscle mass (kg), were obtained using the bioelectrical impedance method with the ABC-02 “MEDASS” bioimpedance analyzer (Russia). Hand grip strength (both left and right hands, kg) was assessed using a hand dynamometer.

Based on the data obtained, the Pignet index (PI, arbitrary units) was calculated using the formula: $PI = BH - (CC + BW)$, that characterizes body strength. The body strength was then used to determine the body type: asthenic ($PI > 25$), normosthenic ($10 \leq PI \leq 25$), and hypersthenic ($PI < 10$). The body proportionality index (BPI, %) was calculated using the following formula: $BPI = ((BH - SH) / SH) \times 100$. Body mass index (BMI,

kg/m²) was calculated as $BMI = BW / BH^2$. Interpretation of BPI values: 87–92 % – proportional physical development; BPI < 87 % – relatively short leg length; BPI > 92 % – long leg length. BMI categories for adult participants were based on World Health Organization (WHO) guidelines [15].

Ethical approval. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki (2013). The study protocol was approved by the local ethics committee of the Scientific Research Center “Arktika”, Far Eastern Branch of the Russian Academy of Sciences (Protocol No. 002/021 dated November 26, 2021). All participants provided written informed consent prior to their involvement in the study.

Statistical analysis. Data processing was conducted using IBM SPSS Statistics 21.0 software. The normality of the data was tested using the Shapiro – Wilk test. The results of parametric tests are presented as means ± standard errors ($M \pm m$). The sample size was not predetermined. The statistical significance of the differences was determined using a Student’s *t*-test for independent samples, which assumes a parametric distribution.

RESULTS

Table 1 presents the results of a comparative analysis of the age-related dynamics of basic anthropometric characteristics and their corresponding indices in males residing in the north-east and north-west regions of the Russian Federation. The data obtained indicate that the young men from these two groups were similar in terms of age and somatometric parameters, such as body weight, BMI, and basic body composition features.

In the young men’s group, there were significant differences in body height and body build. Young men from the northeast had a normosthenic body type and more asthenic chest. Their physique was

disharmonious due to the greater contribution of leg length to their body height. In contrast, young men from the northwest of Russia had a hypersthenic and proportionate body build. The men groups did not differ significantly in age or the number of somatometric characteristics analyzed, except for the differences observed in young men’s groups.

With regard to age-related changes in basic somatometric parameters, similar trends were observed among residents of the North-East and North-West regions of Russia, including an increase in body weight, accompanied by an increase in body fat percentage, chest circumference, waist circumference and BMI. The mean values of these parameters in the second mature age group indicate overweight. At the same time, height (both standing and sitting), as well as the body proportionality index, did not change significantly with age, suggesting that a disproportionate physique is preserved in the male population in the second mature age in these regions. It is worth noting that the increase in body fat among northern residents, coupled with an increase in muscle mass, suggests a low risk of sarcopenia in this age group.

Classification of the analyzed groups based on the Pignet index revealed the following distribution among young men from Magadan: asthenic – 36 %, hypersthenic – 34 %, and normosthenics – 30 %. In men, hypersthenics dominated (90 %) with a low proportion of normosthenics (10 %) and no asthenic body types. The young male population in the North-West of Russia was characterized by a predominance of hypersthenics (41 %) with normosthenics and asthenics accounting for 38 % and 21 % respectively. In the second mature age group, as in the case of men from the North-East of Russia, there was a marked predominance of hypersthenics reaching 91 % with normosthenics accounting for only 9 %.

Based on classification by BMI category, as shown in Figure 1, residents in both regions had a similar proportion of individuals across different BMI categories,

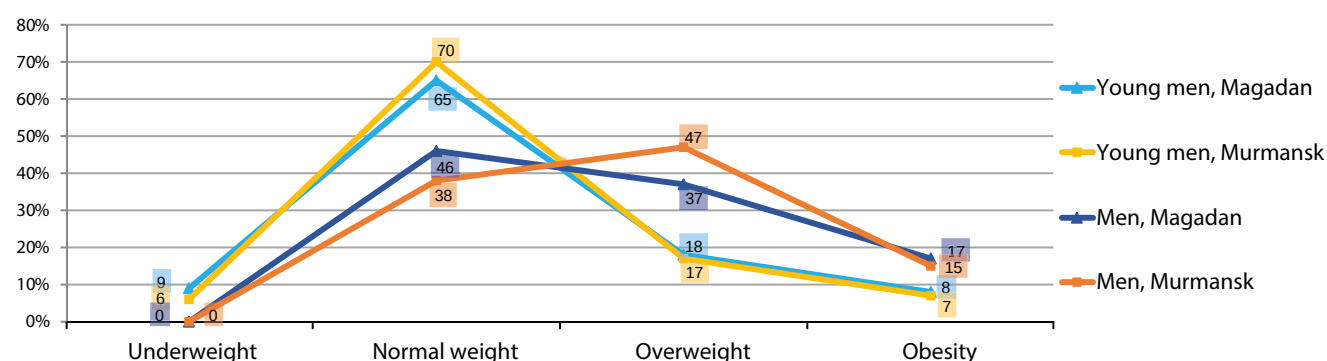


FIG. 1.
Distribution of the analyzed groups depending on the BMI category

TABLE 1

AGE-RELATED DYNAMICS OF CHANGES IN THE MAIN SOMATOMETRIC CHARACTERISTICS OF THE MALE POPULATION OF THE TWO NORTHERN REGIONS OF RESIDENCE

Parameter	North-East of Russia		<i>p</i>	North-West of Russia		<i>p</i>
	Young men	Men		Young men	Men	
Age, years	19.5±0.2	38.9±0.6	<0.001	19.3±0.2	38.6±1.9	<0.001
Body height, cm	180.3±0.5	180.4±0.6	0.914	178.7±0.7**	177.8±1.1*	0.492
Body weight, kg	74.8±1.3	86.2±1.3	<0.001	73.9±1.6	83.6±2.3	0.001
Sitting height, cm	93.0±0.3	92.8±0.3	0.638	94.2±0.4*	93.9±0.5*	0.711
Muscle mass, kg	36.2±0.3	37.5±0.3	0.002	36.4±0.3	37.7±0.5	0.050
Total body fat, %	13.2±0.9	18.9±0.5	<0.001	11.2±0.5	17.4±0.8	<0.001
Chest circumference, cm	92.6±0.8	105.7±0.8	<0.001	97.2±1.0**	106.7±1.5	<0.001
Left hand grip strength, kg	43.9±0.8	52.7±0.9	<0.001	41.9±1.0	49.6±1.1*	<0.001
Right hand grip strength, kg	46.8±1.1	52.8±0.9	<0.001	43.9±0.9**	51.3±1.2	<0.001
Pignet index, arb. units	16.5±2.2	-13.0±2.0	<0.001	9.6±2.3**	-16.3±3.5	<0.001
Body proportionality index, %	93.9±0.5	94.4±0.5	0.485	91.5±0.5**	90.2±0.6*	0.100
Body mass index, kg/m ²	23.0±0.4	26.5±0.4	<0.001	23.1±0.4	26.6±0.7	<0.001

Note. ** – statistically significant differences between young men groups, $p < 0.05$; * – statistically significant differences between men groups, $p < 0.05$.

with the “normal weight” category predominating in young adulthood.

As individuals age, a similar pattern of changes in BMI categories was observed in both regions. This pattern is characterized by no individuals with underweight, a decrease in the proportion of normal weight individuals, and an increase in the prevalence of overweight and obese individuals. The main difference between the two regions is that men from the North-Eastern region are more likely to have normal BMI, while their counterparts from the northwestern region predominantly have overweight.

DISCUSSION

Considering the regional differences in physical development, it should be noted that the average body height of residents of the North-East of Russia is significantly higher in both age groups compared to those from the North-West. It is noteworthy that

this increase in height occurred alongside lower sitting heights, which has led to a disproportionate physique due to the greater contribution of leg length. This is reflected in the high values of the body proportion index (BPI, %). Therefore, regardless of age, a distinct regional characteristic has been identified in the morphological development of people living in the North-Eastern part of Russia. This characteristic is manifested by a greater average body height and an imbalance in the physique, resulting from a larger contribution of leg length compared to people from the North-Western part of the country. It should be noted that lower limb length is the most important determinant of adult body size, as it shows the strongest association with childhood nutrition and family socio-economic status. In particular, most differences in height parameters between individuals from different socio-economic backgrounds are due to differences in lower leg length, rather than upper body length [16].

Studies over the past few decades have shown that body height is often used as an indicator of overall

health [17]. In various fields such as medicine, anthropology, history, and economics, body height is also used to analyze living conditions and the quality of life during periods of population formation [18]. The ratio of body height to leg length may also be seen as an indicator of adaptation to temperature-related factors. However, in today's world, due to socio-economic and political influences, there are changes in lifestyle, standards, and living conditions that directly affect physical developmental parameters [19]. These changes can lead to ecogeographical patterns of body proportions that extend beyond the influence of temperature-based selection [20]. This finding is also supported by our study, as the greatest differences from the "northern" morphotype (characterized by a larger, wider chest [21], and proportionally shorter distal limb segments, necessary to reduce heat loss through a decrease in the surface-to-volume ratio [22]), were observed among young men from the North-Eastern regions of Russia. The authors suggest that this phenomenon may be partly related to transformations in the socio-economic environment of the North-East region, where positive trends began to emerge in the Magadan region from the 2000s, contributing to the continued secular trend of increased leg length and increased asthenization [23].

Analyzing anthropometric data, it should be noted that they are influenced by both genetic and environmental factors. On the one hand, genetic factors determine anthropometric characteristics. On the other hand, anthropometric measures are affected by factors such as nutrition, physical activity, climate, socio-economic status, psychological and emotional state, urbanization and environmental pollution [24]. These factors influence living conditions, lifestyle, and population health, leading to changes in physical development parameters [19].

Turning to the analysis of age-related peculiarities of the studied characteristics, it should be noted similar trajectories of changes in anthropometric parameters, driven by an increase in BMI in the two northern male populations. This led to the elimination of significant differences in chest circumference and physical strength observed in early adulthood. It should be noted that since the beginning of the 21st century, many regions of our country and several other countries have seen a slowdown in the growth of definitive body height alongside the widespread epidemic of obesity [25]. This observation is confirmed by our study, which shows lower body heights and an increased prevalence of overweight individuals in the second mature age among men from the north-west of Russia.

Classification of samples according to the prevalence of body types revealed that among young men from the North-East of Russia, asthenic body types were predominant, with equal proportions of hypersthenics and normosthenics. In contrast, among residents of the North-West of Russia, hypersthenic types dominated, with the least frequency of asthenics.

Therefore, the prevalence of overweight in the Murmansk group may be associated with a preponderance of hypersthenic individuals in the younger Murmansk population, which suggests that this body type at a young age may be a risk factor for the development of overweight and obesity in adulthood.

It is worth noting that the age-related changes in body fat composition in the two groups of northern residents are in line with global trends, with total body fat increasing with age [26]. However, the average values of this parameter in each group did not exceed the upper acceptable threshold of 19 % for young adults and 21 % for adults in the second mature age group [15, 27]. Analysis of the results also revealed an increase in muscle mass from young adults to the older group in both populations of northern residents, reflecting a positive trend in physical fitness, as muscle mass has a protective role against chronic non-communicable diseases [28].

Assessment of hand grip strength is an indicator of overall physical strength, and variations in these parameters may be influenced by changes in muscle mass and lifestyle factors [29]. In the group of young men, a pronounced asymmetry in dynamometric parameters was observed, with the right hand demonstrating greater strength compared to the left hand, which may be attributed to the dominance of the stronger hand [30]. Additionally, a significant increase in hand strength parameters with age has been noted among residents of both northern regions, likely due to an increase in overall muscle mass, indicating a reduced risk of sarcopenia-related issues in older northern populations.

CONCLUSION

The study revealed age-related peculiarities in somatometric characteristics among residents of two northern regions of Russia (the North-East and the North-West), which manifested in similar trends in changes in the analyzed parameters. These include a significant increase in body weight, BMI, chest circumference, and body fat content, which is comparable with global trends. Among the positive aspects of physical development observed in different northern regions in parallel, it should be noted the age-associated increase in muscle mass accompanied by an increase in mean hand grip strength.

It has been established that, regardless of age group, there is a distinct regional feature in the formation of the morphotype of residents in the north-eastern regions of Russia, which is manifested by an increased body height and disproportionality, due to a larger contribution of leg length to the total height compared to residents in the northwest of Russia, who have a more proportionate, harmonious physique.

These findings emphasize the significance of ongoing monitoring of key physical development

parameters as valuable indicators for identifying geographical differences in morphological types influenced by socio-economic and environmental factors in northern and Arctic areas.

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Conflicts of interest

The authors declare no conflicts of interest.

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