Fedotova T.K., Gorbacheva A.K.

Lomonosov Moscow State University, Anuchin Research Institute and Museum of Anthropology, Mokhovaya st., 11, Moscow, 125009, Russia

TO THE PROBLEM OF SIGNIFICANCE OF THE PARAMETER «PEAK HEIGHT VELOCITY» IN PUBERTY AS THE BIOMARKER OF CHRONOBIOLOGICAL STATUS OF THE POPULATION IN GROWTH STUDIES

Introduction. *The significance of peak height velocity (PHV) in screening studies of children and adolescents as the biomarker of the chronobiological status of the population is in the focus of the study.*

Material and methods. *The analysis embraces a significant specter of samples (N=37, literary data), including different ethnoterritorial groups of Russia and former USSR, examined through the vast historical period of second half of XX century – beginning of the XXI century. The analysis of interpopulation variability of the parameter of peak height velocity of growth changes of the average level of height through the adolescence is under discussion – its absolute value (MPHV, cm) and chronological age (APHV, years); intragroup sexual differences of these characteristics are under consideration as well.*

Results. *Dynamic curves of height increase for urban samples from USSR territory, both native populations and Russian, have dome-shaped form, monotonous height increase/gain velocities up to the peak, slump further on. Traditional Mongolian groups and rural Abkhazian show the dynamic curve with descending wavy form. Histograms of intergroup distribution of the parameter APHV both for boys and girls differ from normal Gaussian distribution and gravitate towards double-peak form. Population values of APHV for boys are two and a half years later as compared to girls; MPHV is a more solid parameter, sex differences here are 0.41 cm with boys' advantage. Factor analysis revealed definite autonomy of the process of pubertal spurt for male and female adolescents: the first factor describes growth activity of boys, the second — of girls (35% and 30% of the total variability of parameters correspondingly).*

Conclusion. *The results allowed to conclude, that the variability of the parameter points to the significant social/anthropogenic base of chronobiological status of the population and independent growth strategies of male and female sexes, which suggests to interpret PHV as the valid and perspective biomarker in population growth studies.*

Keywords: anthropological variability; environmental influences; growth activity peak; chronobiological status of the population; independent growth strategies of male and female sexes

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Introduction

One of the basic methodological principles while research of intergroup morphological variability of growing children is: the valid methodical algorithm in the course of mass growth studies is grouping data according to the chronological age and comparing of somatic status of one-year age groups. This algorithm is not the only possible one and has the character of convention. In fact, the category «chronological age» in mass studies reflects the property of some average statistical variant of standard (norm), which is important, but not universal and not exhaustive enough; normal (optimal) vital activity and health may be maintained through a rather wide diapason of variability of morphofunctional parameters [Khrisanfova, 1999]. The more exhaustive characteristics of morphofunctional

status is the category «biological age», which means the level of morphofunctional development of the individual organism and may correspond to the age standard, as well as deviate from it to one side or the other [Vlastovskiy, 1976; Khrisanfova, 1999; Deryabin, 2004].

Analogically «biological age», or chronobiological status, is the informative characteristic of the whole group, reflecting the differential population rhythm of the integral ontogenesis from birth to venerable age, intergroup manifestations of acceleration, etc. [Pavlovskiy, 1987; Batsevich et al., 2020; Batsevich, 2022].

The most universal criterion of biological age among others (somatic development, sexual development, tooth age), most reliable through the integral ontogenesis, is skeletal age, applicated in our national anthropology not only as indicator of ontogenesis rhythm, but as the standard of adaptation of the population to the environment as well [Batsevich et al., 2020; Batsevich, 2022]. It is worth mentioning that collecting data in the regime of detailed complex anthropological expeditions finely assimilate roentgen-anthropological method to estimate skeletal age [Batsevich, 2022]. While for swift screening studies of children, which aim usually at renewing of standards of physical development of local groups and are limited by three main indices of physical development (height, weight, chest girth), the more appropriate biological age criterion is, maybe, especially somatic simple biomarker of ontogenesis rhythm – peak height velocity (PHV), describing the moment (age) of the maximal velocity of growth changes of the average level of height in puberty (in other words: the characteristics of the age of the intensive pubertal process in each separate data set), estimated on base of empirical series of yearly changes of average height levels with the following smoothing according to the least square method [Deryabin, Fedotova, 2002]. We'd like to emphasize that morphological criterions of biological age, for instance skeletal and sexual development, or skeletal and somatic development (to a lesser degree) are connected closely enough [Khrisanfova, 1999; Cole et al., 2008, 2014; Batsevich, 2022], and are interchangeable through some ontogenesis periods [Khrisanfova, 1999]. Skeletal development shows marked associations with somatic development, despite the fact that the latter reflects changes in size, while the former is essentially a maturity index and reflects changes in biochemical composition of tissues, which allows the conclusion that these different domains develop along similar biological mechanisms, which are steered mainly by genetic factors [Gasser et al., 2013; Molinari et al., 2013]. For instance, age at peak velocity correlates highly with sexual parameters in puberty (correlation 0.8–0.92 for girls, though significantly lower for boys 0.62–0.68). Still the picture with the intensity of peak velocity is less so and reversed, with higher correlations for boys than girls [Cole et al., 2014].

The concept of the tempo of growth, a measure of passing time in individuals relating to their pubertal status as quantified by their developmental age, in other words – the PHV phenomenon, its intensity and timing (Maximum Peak Height Velocity, MPHV, and Age at Peak Height Velocity, APHV), was suggested and explored deeply by the outstanding British creator of auxology James M. Tanner (1920–2010). His anthropological bestseller «Growth at adolescence» [Tanner, 1962], as well as later studies [Tanner et al., 1966, 1976; Tanner, Cameron, 1980; Tanner, 1981, 1988; Tanner, Davies, 1985], deal with many aspects – physiological, endocrinological, motor, and mental changes – of growth at adolescence and other ages. Since the 1960s PHV used to be discussed in world literature in association with many factors: skeletal and pubertal (sexual characteristics) maturity [Iuliano-Burns et al., 2001; Gasser et al., 2013;; Molinari et al., 2013; Cole et al., 2014]; secular trends [Ali et al., 2001; Aksglaede et al., 2008; Gomula et al., 2021]; altitudes of the residence place of population [Santos et al., 2019; Correa-Rodríguez et al., 2022]; other local peculiarities of ethnic groups [Dabas et al., 2018; Kleanthous et al., 2022]; intergroup variability of constitution and obesity [Aksglaede et al., 2009; Yokoya, Higuchi, 2014; Narchi et al., 2021].

The goal of the present study is the estimation of the informative value of the index of the PHV of the population as a biomarker of its chronobiological status; the analysis of interpopulation variability of the index PHV of growth changes of the average level of height in puberty – its absolute level, cm, (Maximum Peak Height Velocity, MPHV) and its chronological age, years, (Age at Peak Height Velocity, APHV); and the estimation of intergroup sex differences of these parameters.

Material and methods

The study embraces the specter of samples of schoolchildren (7–17 years), including different ethnic and territorial groups of Russia and former USSR, examined through the vast historical period of the second half of the XX – beginning of the XXI century; both literary data [Materiali…, 1962, 1965, 1977, 1986, 1988, 1998; Miklashevskaya et al, 1988; Godina et al., 2019; Fedotova, Gorbacheva, 2019; Batsevich et al., 2020] and archive data of the authors. The list of samples in this pilot study is relatively modest, but reflects ethnic, territorial and temporal diversity of growth processes:

- Abkhazians of long-liver regions, 1979;
- Abkhazians, 2005;
- Estonian of Tallinn, 1966/69;
- Kazakhs of Kzyl-Orda (Kazakh Republic), 1968;
- Kirghizs and Russians of Frunze, 1972/72;
- Kirghizs of highlands, 1968/69;
- Kumyks of Buinaksk (Daghestan Republic), 1968/69;
- Latvians of Riga, 1969;
- Lituanians of Vilnius, 1965/67;
- Moldavians and Russians of Kishinev, 1969;

Mongolians, 2019;

- Russian of Astrakhan, 1965/66;
- Russian of Kemerovo, 1969/70;
- Russian of Novosibirsk, 1970;
- Russian of Rostov-na-Donu, 1965/66;
- Russian of Ryazan, 1970/71;
- Russian of Sichi, 1968;
- Russians of Dzezkazgan (Kazakh Republic), 1969/70;
- Russians of Gorkiy, 1959/60
- Russians of Gorkiy, 1980
- Russians of Moscow, 1934;
- Russians of Moscow, 1958/59;
- Russians of Moscow, 1969/70;
- Russians of Moscow, 1974/79;
- Russians of Moscow, 1993;
- Russians of Moscow, 2005/06
- Russians of Nizhegorodskiy region, 2010/2012;
- Russians of Nizhniy Novgorod, 1991/92;
- Tatar and Russian of Kazan, 1977;
- Turkmen and Russian of Ashkhabad, 1966/67;
- Tuvans and Russian of Tuva cities, 1967/68;
- Uzbeks and Russians of Tashkent, 1964/65;

The samples contain minimal necessary number of statistics of height for each sex/age group: quantity of the group, average meanings of height, standard deviations.

The following list of characteristics was evaluated for each sample: Age at Peak Height Velocity (APHV), describing the moment (age in years) of the maximal speed of growth changes of the average level of height during puberty, estimated on base of empirical series of yearly changes of average height levels with the following smoothing according to the least square method – separately for boys and girls; delta between APHV values for boys and girls; Maximum Peak Height Velocity (MPHV) – maximal absolute quantitative level of growth changes during this moment, separately for boys and girls, as well and delta between MPHV values for boys and girls. The total sum of indices was used to calculate statistic parameters and draw up intergroup distributions, and carry out factor analysis.

Results

Figures 1–3 illustrate the curves of height velocity changes of the average level of height in puberty for the groups, contrastive by ethnicity and ontogenesis rhythm: Russians and Turkmens of Ashkhabad, examined in 1967; rural Abkhazians 1979 (settlements Chlow, Tkhina, Otap); urban Mongolians 2013/15.

The dynamics of increase of height velocity gains of Turkman children from Ashkhabad (quantity of population 253 thousand in 1967), fig. 1, has a «classic» dome-shaped form, monotonous acceleration of growth velocity up to the peak, slump further on. The MPHV is 0.6 cm higher for boys as compared to girls, delta between the peaks for sexes is almost 4 years (11.4 and 15.2 years). Russian boys have MPHV 0.55 cm higher than Russian girls, still APHV doesn't differ much by sex and is lower for Russian boys as compared to Turkmen boys. MPHV in fact slightly differs between aborigine and Russian samples, both for boys and girls. The similar or very close picture of dynamic curves is fixed for urban samples of USSR: Kirghiz and Russian groups from Frunze 1973 (population quantity 430 thousands); Tatars and Russians of Kazan 1964 (population 742 thousands); Russians and Uzbeks from Tashkent 1965 (population about 1 million); Latvians from Riga 1969 (population 730 thousands); Lithuanian from Vilnius 1966 (popula-

tion 300 thousands); Estonians of Tallinn (population 400 thousands).

For urban Mongolian group, fig. 2, dynamic curve has descendant wavy character for both boys and girls with APHV at 9 years (7.5 cm for girls and about 6 cm for boys) and some smaller peaks at 12 years (about 7 cm for girls and 5 cm for boys), 15 years for boys (4.4 cm) and 16 years for girls (modest 1.5 cm).

Rural Abkhazian girls, fig. 3, have two peaks of height increase — higher at 11 years and less at 14 years (6.5 and 5.5 cm correspondingly). Rural Abkhazian boys have the peak of height increase about 15 years (7.3 cm) and the prolongation of the curve is under the question, because the data massive stops just at 15 years.

For the Abkhazian sample, examined in 1981 (settlements Duripsh and Lichny), the evident APHV for girls takes place about 11 years (7 cm); for boys two peaks are fixed — smaller one almost at 10 years (6 cm) and pubertal peak at 16 years (7.6 cm). The prolongation of the curve for boys is under the question, as well as for the Abkhazian boys 1979, because the data massive interrupts at 16 years.

The specificity of dynamic curves of Abkhazian and Mongolian children obviously doesn't allow to determine correctly the moment of APHV, first of all for boys. So, in the following parts of the present study — construction of histograms of intergroup distribution of APHV, calculation of statistical parameters, factor analysis — these groups were not used.

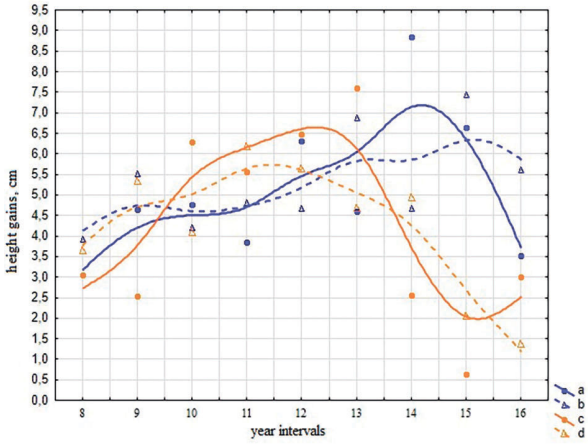

Figure 1. The dynamics of increase of height velocity gains of Russian (a, c) and Turkmen (b, d) adolescents of Ashkhabad (1967); a and b – boys, c and d – girls. Axis Y – height gains (cm); axis X – year intervals of age (8 – interval between ages 8 and 7 years, 9 – between 9 and 8 years, etc.)

Figure 4 illustrates histograms of intergroup distribution of APHV for boys and girls. For both sexes the distribution somehow differs from the normal Gaussian one and gravitates toward the double-peak form. The distribution for girls may be described as a double-peak with maximal frequency of cases at 11.65 years and one more lower peak at 10.8 years. The first peak embraces urban samples first of all (Moscow 1950th-60th-80th, Latvian from Riga 1960th, Russian from Tashkent 1960th, Kirghiz from Frunze 1970th). The distribution for boys has maximal frequency of cases at 14.1 years and one more peak at 13.7 years, represented by Moscow samples of 1960th-70th-80th and Nizhniy Novgorod 1990th – 2010th. So in Moscow samples, accelerated rhythm of growth belongs to both boys and girls, in other cities either boys or girls.

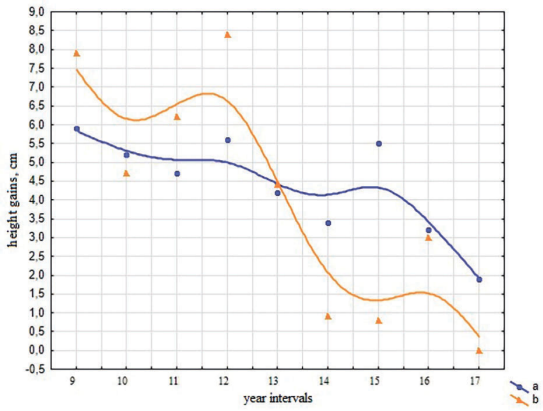

Figure 2. The dynamics of increase of height velocity gains of urban Mongol adolescents (2013–15); a – boys, b – girls. Axis Y – height gains (cm); axis X – year intervals of age (9 – interval between ages 9 and 8 years, 10 – between 10 and 9 years, etc.)

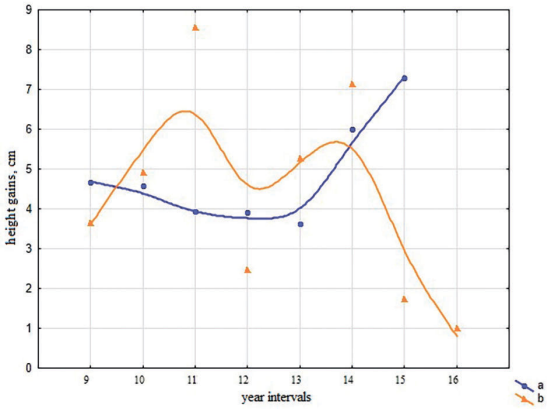

Figure 3. The dynamics of increase of height velocity gains of rural Abkhaz adolescents (1979); a – boys, b – girls. Axis Y – height gains (cm); axis X – year intervals of age (9 – interval between ages 9 and 8 years, 10 – between 10 and 9 years, etc.)

The double-peak form of the distribution points, that besides big number of factors, common for all samples, there is at least one separating factor — growth rhythm, accelerated or decelerated.

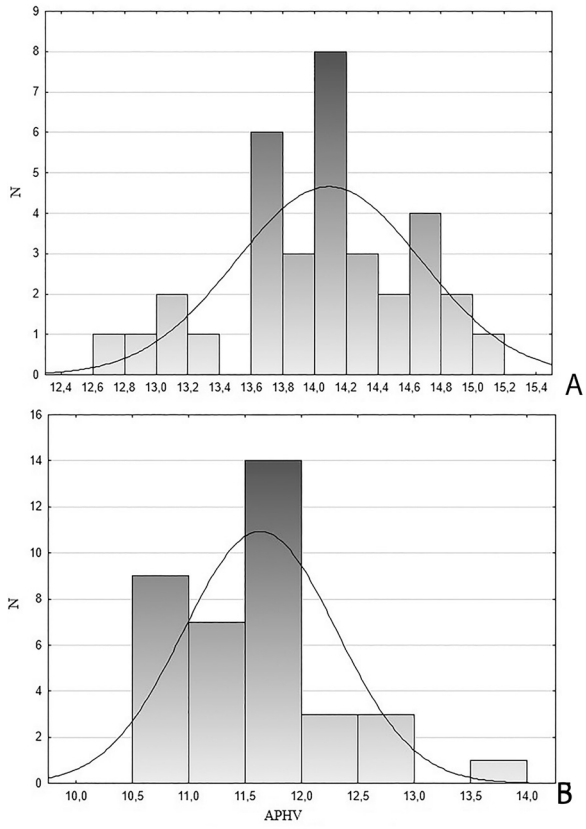

Figure 4. Intergroup distribution of APHV in boys (a) and girls (b)

Figures 5–9 illustrate the temporal and spatial variability of dynamics of absolute average values of height and its yearly gains for boys and girls of several more contrastive samples. For Moscow samples APHV in boys decreases through almost 50-year historical period (1934–1981) from 14.9 to 13.2 years, the same for girls – from 11.9 to 10.4 years; which corresponds to the results of recent studies that puberty starts in younger years than previously [Aksglaede et al., 2008, 2009; Dabas et al., 2018]. Three ethnoterritorial groups of late 1960's – Estonians of Lutheran Tallinn (about half a million-population quantity), Kirghizs of highlands (settlements Kizil-Dzhar, Sagindik, Osh region; about 5 thousand of inhabitants in total, 2300–2800 m over sea level), Kumyks of Islam Buinaksk, Daghestan Republic (about 40 thousand population quantity) – show more compact distribution of boys' APHV (14.3–14.6–15.0 years) as compared to girls' APHV (11.7–13.6–11.0). It seems, that in our data set the most striking contrast is fixed for intragroup sex differences of APHV – delta is 2.6 years for Estonians of the capital city, which is a quite ordinary sex delta, as we know from literature [Cole, 2020; Tanner, 1962]. Delta is only 1 year for Kirghiz highlanders, though the study of Peruvians, living at higher altitudes, as compared to sea level residence, fixed significant sex differences in growth spurt parameters [Santos et al., 2019]. The greatest delta is 4 years for urban Kumyks. So it's rather evident that APHV depends on a vast complex of factors (ethnic, ecological, secular, cultural/religious, biological sex, etc.). In fact, the timing of individual PHV can fluctuate from as early as 10 years of age in girls to as late as 17 years in boys [Tanner, 1962; Cole, 2020].

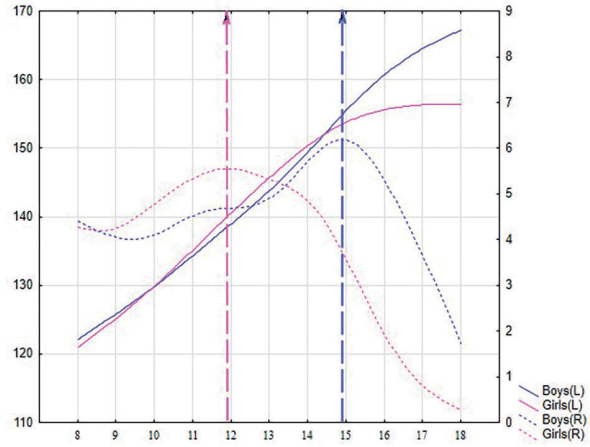

Figure 5. Age dynamics of absolute average values of height (left (L) axis Y) and its yearly gains (right (R) axis Y) for boys and girls of Moscow (1934) aged 8–18 years (axis X)

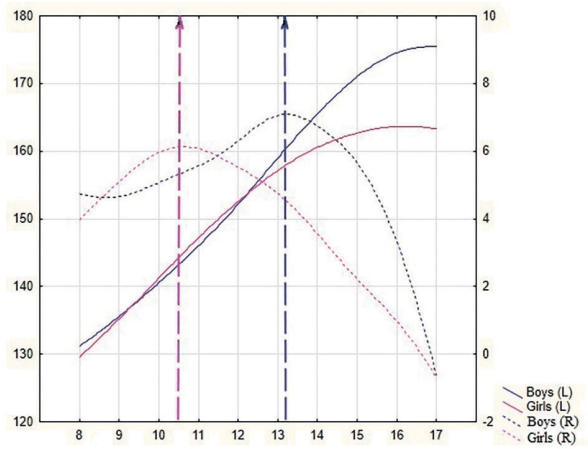

Figure 6. Age dynamics of absolute average values of height (left (L) axis Y) and its yearly gains (right (R) axis Y) for boys and girls of Moscow (1981) aged 8–18 years (axis X)

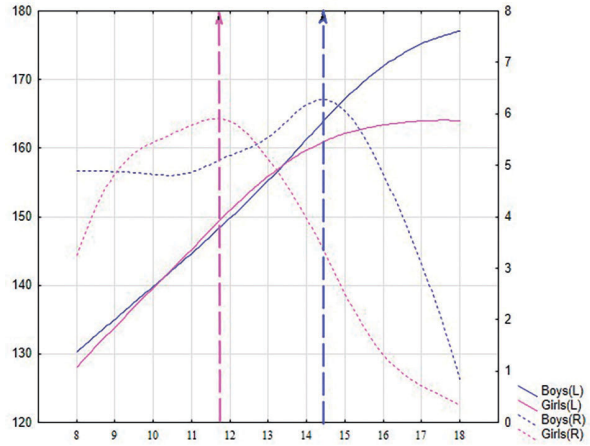

Figure 7. Age dynamics of absolute average values of height (left (L) axis Y) and its yearly gains (right (R) axis Y) for Estonian boys and girls of Tallinn (1960th) aged 8–18 years (axis X)

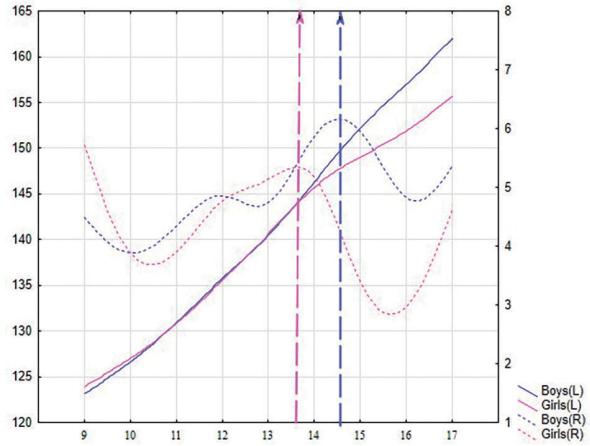

Figure 8. Age dynamics of absolute average values of height (left (L) axis Y) and its yearly gains (right (R) axis Y) for Kirghizs boys and girls of highlands (1960th) aged 8–18 years (axis X)

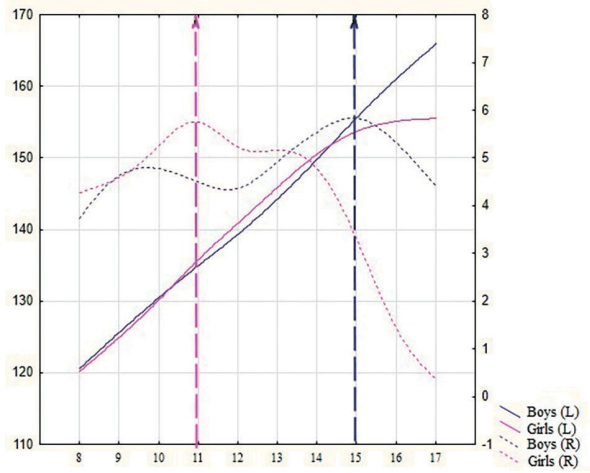

Figure 9. Age dynamics of absolute average values of height (left (L) axis Y) and its yearly gains (right (R) axis Y) for Kumyks boys and girls of Buinaksk (1960th) aged 8–18 years (axis X)

Table 1 illustrates statistical characteristics of intergroup variability of APHV and MPHV for boys and girls. Population APHV for boys is about two and a half years later than for girls, 14.08 and 11.62 years correspondingly; maximal sex differences belong to Kumyks of Buinaksk (Daghestan) – about 4 years. APHV is slightly more variable for girls as compared to boys (standard deviation is 0.67 and 0.58). While MPHV is more solid parameter, sexual differences here are 0.46 cm in average with advantage for boys, maximal differences belong to Abkhazians of Sukhumi 2005 – 1.95 cm; in some samples girls show more intensive MPHV (Moscow, 1956, Astrakhan 1960th, Russians from Kazan 1964).

Table 1. Statistical parameters of characteristics of growth changes of the average level of height during puberty, calculated on researched samples

	N	M	min	max	StD
APHV_Boys	34	14.08	12.70	15.15	0.58
APHV_Girls	37	11.62	10.65	13.63	0.67
Delta/APHV	33	2.54	0.07	4.03	0.83
MPHV_Boys	34	6.58	5.70	7.85	0.51
MPHV_Girls	37	6.12	5.35	7.23	0.38
Delta/MPHV	33	0.41	-0.40	1.95	0.50

Table 2 introduces factor structure of six analyzed parameters of growth spurt. The first factor describes about 35% of total variability of parameters, significant loadings with the level about 0.8 are fixed for APHV and MPHV of boys; the bigger is APHV, the less is MPHV. The second factor describes 30% of total variability of parameters and has high significant loading about 0.8 on APHV of girls; the loading on MPHV is also big and negative, though doesn't reach significant level.

Table 2. Factor structure of intergroup variability of characteristics of growth changes of the average level of height during puberty

Parameters	Factor 1	Factor 2
APHV_Boys	0.80*	0.08
APHV_Girls	0.09	0.85*
Delta/APHV	0.52	-0.66
MPHV_Boys	-0.85*	0.08
MPHV_Girls	-0.51	-0.59
DeltaPr	-0.44	0.54
Total var.	2.11	1.81
Share of total var.	0.35	0.30

Discussion

It is worth reminding that the use of biological skeletal age as the grouping factor in intergroup comparisons significantly reduces intergroup variability of a number of morphological traits (height and leg length, acromial and pelvic diameters, square of body surface, weight and BMI) as compared to the grouping according to the chronological age. Although the situation with other morphological characteristics is different: the level of the average skinfold regardless of the method of grouping (chronological vs biological age) do not differ much through the analyzed age period for boys of all samples, but boys have lower values of this parameter as compared to girls. At the same time grouping according to skeletal age for girls allows to fix intergroup differences of the level of skinfolds, mostly evident after 14 years of age [Batsevich et al, 2020]. Simultaneously using biological (skeletal) age as grouping factor allows to reveal some specific adaptive peculiarities or morphological characteristics, which appeared in the populations under the influence of climatic/geographical factors (for instance, flat chest of some middle-Asian groups) and are not associated with the «attack» of anthropogenic environment on traditional cultures [Batsevich, 2022]. This observation finely corresponds to the results of a number of growth studies, discussing the significance of chest girth as the marker of physiology of respiratory and cardiovascular systems, evolutionary connected with climatic conditions [review: Fedotova, Gorbacheva, 2020].

It is evident, that PHV, as well as skeletal age, also differentiates populations according to the rhythm and intensity of growth processes — at which age one or another population passes the peak of growth activity and the intensity of the peak.

At least PHV differentiates rural samples with non-typical picture of dynamics of height increase and urban population; and divide the pool of urban samples into populations with accelerated and decelerated growth rhythm. Probably the grouping of samples according to the APHV will decrease significantly intergroup somatic variability, as well as grouping according to skeletal age, which ought to be verificated later on.

Interpopulation specificity of growth curves is obviously associated with the level of anthropogenic pressure of residence place – the character of curves is similar for urban samples from big cities (quantity of population about 1 million) of USSR epoch of economic reorientation, regardless of ethnic identification of groups, but differs for traditional rural Abkhazia and patriarchal Mongolia. Mongolia to the present has the least density of population in the world – less than 2 persons/square km; the quantity of population of the cities is about 2-3 thousand, seldom more. Both long-liver Caucasus groups and Khalkhass populations of Mongolia, examined before social/economic changes in these regions, belonged to well adapted populations with slow/delayed ontogenesis through the completely vital cycle, anthropometric characteristics without signs of acceleration, temporal stability of morphofunctional indices [Batsevich, 2022]. The similarity of growth dynamics of urban populations, on one hand, reflects the fact of universality of urban environment. On the other hand, corresponds finely to literary data, that variations of growth processes and biological age (sexual maturation in particular) of different ethno territorial groups are associated exclusively with social (anthropogenic) or genetic factors [Miklashevskaya et al., 1988]. Thus, menarche occurs after the peak of growth (pubertal) spurt [Godina, 2003]. The vast material from Russia and former USSR shows, that rhythms of age changes of roentgen graphical indices of the wrist (skeletal age) have high ecological variability exclusively in connection with socioeconomic factors of environment and their dynamics [Batsevich, 2022].

However, interpopulation differences may result not only of ecological, but methodical aspect as well. The authors deal with the literary cross-sectional data; hence, monotonous curves of dynamics, as it takes place in longitudinal studies, are out of the question. Even more, some samples have very modest quantity of age/sex groups, in particular rural Abkhazian 1979. Both Abkhazian and Mongolian samples are, among other circumstances, combined, not local groups. These methodic peculiarities and comparative heterogeneity of samples may contribute to the dynamic curves of height, which demands additional verification of the results of the present pilot study. To compare, the local sample of Sukhumi 2005 has practically classic form of the dynamics of the increase of height.

Specific dynamic curves are fixed for Moscow children, examined in 1928 (Fig. 10). This sample is

combined, and embraces both children born in 1910th, which were 9–17 years old at the moment of the study, and children born in 1920th, which were 8 and less years at the moment of the study. Moscow of 1920th was the city under New Economic Policy, with abundant food supply; besides schools started the program of complimentary dinners for pupils with strict control of daily calorie necessity and balance of proteins, fats and carbohydrates. These circumstances became a favorable accelerating background, which initiated high yearly increase of height of children aged 7-8 years, exceeding yearly increase of children born in 1910th, even of pubertal age. At the same time dynamic curves for Moscow children examined later (1959, 1969, 1978 years) have absolutely classic parabolic form and peaks of height increase do not differ much for different years of study, having no accurate temporal associations. Thus, figure 11 shows temporal sequence of standardized peaks of height increase through several decades from 1920th till 1990th. The zero level belongs to the age of 1928th sample; the following ages are expressed in parts of standard deviations of the parameter. All the following ages of peak are less as compared to the sample of 1928 year; the levels of standard differences are negative. So as compared to the sample of 1928, all the later samples have accelerated growth rhythm. The lowest (earliest) age of the peak is fixed for the sample of 1956 year (10,8 years). This is in fact the first Moscow generation, born and grown in peaceful safe historical time; and the sample of 1981 (10.65 years) – the generation of babies of manifest Moscow accelerated children of 1969-70; which may be interpreted as the confirmation of inter-generation synchrony of the rhythm of growth process. The similar picture is fixed for boys.

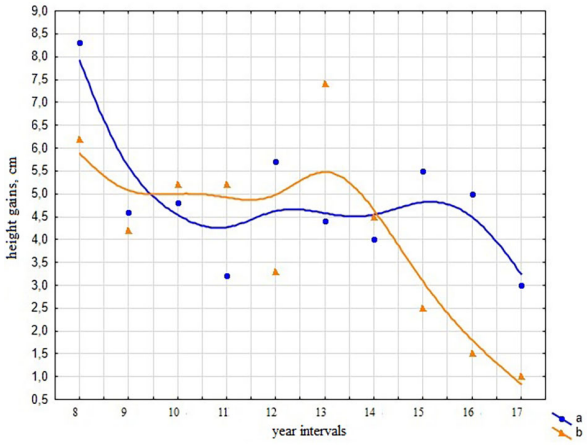

Figure 10. The dynamics of increase of height velocity gains of boys (a) and girls (b) of Moscow (1928), aged 8–17 years. Axis Y – height gains (cm); axis X – year intervals of age (8 – interval between ages 8 and 7 years, 9 – between 9 and 8 years, etc.)

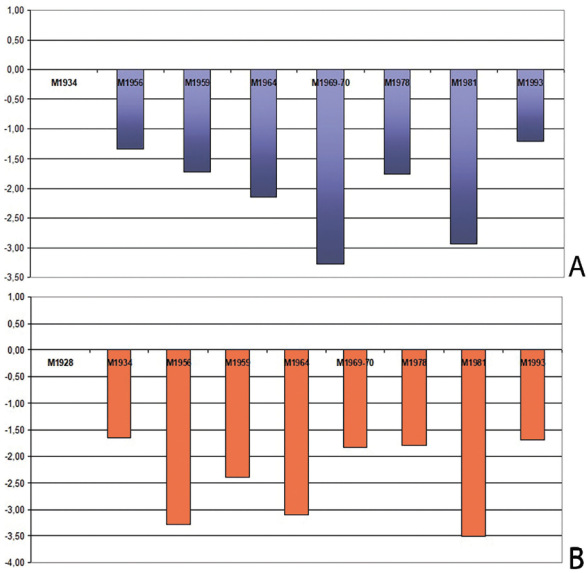

Figure 11. Standardized differences (axis Y) of age value of height growth peak between boys (a) and girls (b) of Moscow 1928 sample and Moscow groups since 1930th to 1990th years

Non-typical dynamics pictures are most probably connected with the peculiarities of the sample, have definite ecological reasons, but their reconstruction several decades later is a problem. Such specific samples, which do not correspond to classic scheme of biological algorithms of growth dynamics demand recurring examination and definition of growth processes of populations they belong to.

Factor analysis showed definite autonomy of pubertal growth spurt of adolescent boys and girls; the first factor describes growth activity of boys, the second of girls. This reminds the problem of different by sex biosocial strategies and different ecosencitivity and phenotypic plasticity of the sexes [Geodakyan, 1965, 1991; Stulp et al., 2012; Morrow, 2015; Zimina, 2019].

Conclusion

The results of study allow concluding that APHV is evidently informative and non-accidental characteristic of biological age. The character of variability of this parameter points to significant social/anthropogenic

conditionality of chronobiological status of the population and independence of growth strategies by sex. These two facts finely correspond to the fundamental biological conceptions of the meaning and intergroup variations of parameters of biological age and sexual somatic dimorphism. Quite probable that the inclusion of wider ethno territorial and temporal specter of samples, and sufficient quantity of all analyzing groups, will allow to standardize the gradations of the parameter APHV for utilization in intergroup comparisons of growth processes of child groups.

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Information about Authors

Fedotova Tatiana K., PhD., D.Sc.; ORCID ID: 0000-0001-7750-7924; tatiana.fedotova@mail.ru

Gorbacheva Anna K., PhD.; ORCID ID: 0000-0001-5201-7128; angoria@yandex.ru

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Федотова Т.К., Горбачева А.К.

МГУ имени М.В. Ломоносова, НИИ и Музей антропологии, ул. Моховая, д. 11, Москва, 125009, Россия

ОБ ИНФОРМАТИВНОСТИ ПАРАМЕТРА «ПИК РОСТОВОЙ АКТИВНОСТИ» В ПУБЕРТАТЕ КАК БИОМАРКЕРА ХРОНОБИОЛОГИЧЕСКОГО СТАТУСА ПОПУЛЯЦИИ В РОСТОВЫХ ИССЛЕДОВАНИЯХ

Введение. *Рассматривается информативность характеристики пика ростовой активности в скрининговых обследованиях детского населения как биомаркера хронобиологического статуса популяции.*

Материал и методы. *К анализу привлечен значительный спектр выборок (N=37, литературные материалы), включающий разные этно-территориальные группы РФ и бывшего СССР, обследованные на широком историческом срезе второй половины XX — начала XX1 века. Проводится анализ межпопуляционной изменчивости показателя наибольшей скорости ростовых изменений среднего уровня длины тела в подростковом периоде - его абсолютной величины (см) и хронологического возраста, на который он приходится; анализируются внутригрупповые половые различия этих показателей.*

Результаты. *Линии динамики приростов длины тела для урбанизированных выборок с территории СССР, равно коренного и русского населения, имеют куполообразную форму, достаточно монотонное ускорение темпов прироста вплоть до пика, далее спад. Для традиционных монгольских групп и сельских абхазов кривая динамики имеет нисходящий волнообразный характер. Гистограммы межгруппового распределения показателей возраст пика приростов ДТ у девочек и у мальчиков отличаются от нормального Гауссового распределения и тяготеют к двувершинной форме. Популяционный возраст максимального ускорения приростов ДТ у мальчиков отстает от этого показателя у девочек примерно на два с половиной года. Максимальный уровень прироста - более компактный показатель, половые различия здесь составляют в среднем 0,41 см в пользу мальчиков. Факторный анализ показал известную автономность процесса пубертатного ускорения роста у подростков мужского и женского пола — первый фактор описывает ростовую активность мальчиков, второй фактор — девочек (35% и 30% общей изменчивости показателей соответственно).*

Заключение. *Установлено, что характер изменчивости показателя указывает на значительную социальную/антропогенную обусловленность хронобиологического статуса популяции и независимость ростовых стратегий мужского и женского полов, что позволяет считать его достаточно надежным перспективным биомаркером в популяционных ростовых исследованиях.*

Ключевые слова: антропологическая изменчивость; средовые воздействия; пик ростовой активности; хронобиологический статус популяции; независимость ростовых стратегий женского и мужского полов

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Информация об авторах

Федотова Татьяна Константиновна, д.б.н.; ORCID ID: 0000-0001-7750-7924; tatiana.fedotova@mail.ru

Горбачева Анна Константиновна, к.б.н.; ORCID ID: 0000-0001-5201-7128; angoria@yandex.ru

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