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Patterns of Growth and Development in Urban and Rural Children of the Northern Part of European Russia*

Two thousand children and adolescents of both sexes aged 7–17 were studied in 2009–2010 in Arkhangelsk and several villages of the Arkhangelsk Region. Results were compared with data, collected by the same authors in the same area in 1988–1989, on 1500 children of the same age. The program included some 50 metric and descriptive characteristics, estimates of biological age, and somatotyping. We collected data on parental education and occupation, number of children per family, etc. Lengths of body segments and extremities, body mass index (BMI), and certain other indexes were calculated. Statistical analysis included standardization of data and one-way ANOVA. Urban children were shown to be slightly taller than their rural peers but did not differ from them in weight, chest circumference, or BMI. Modern children, both urban and rural, showed greater stature, weight, and chest circumference as compared to those measured in 1988. Significant changes in body proportions were found in modern children: they had a longer torso, narrower shoulders, and a larger pelvic breadth. Also, a significant increase in limb circumferences and subcutaneous fat was found. Modern urban and rural children were closer to each other in most physical characteristics than were their peers of the previous generation. The results can be interpreted in terms of the ongoing secular trend in population of the Arkhangelsk Region.

Keywords: *Physical anthropology, growth and development, rural and urban children, Arkhangelsk Region, secular changes.*

Introduction

The study of growth and development processes in urban versus rural populations has a prolonged history. In the 18th and 19th centuries, in the majority of European countries and in the USA, rural children were taller than their urban peers (Rona, 1984; Bogin, 1988). A.T. Steegman (1985) gives the average height values for English military recruits according to the archives of the 18th century: 168.6 and 157.5 cm for rural and urban young men, respectively.

In the 20th century, this tendency has been reversed: urban children exceed rural ones in terms of height and weight, development of fat component, and other metric characteristics (Meredith, 1982). This trend is typical of the majority of economically developed and especially of developing countries (Godina, Miklashevskaya, 1989). Presumably, these differences have been caused by the better socioeconomic and hygienic living conditions and the nutritional status of urban children and adolescents (Eveleth, Tanner, 1990: 191–207; Rona, 1991).

Little seems to have changed in the 21st century. On the basis of analysis of the health indicators of children in 47 developing countries, it has been found that children's health is better in cities than in rural areas (Van de Poel,

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O'Donnell, van Doorslaer, 2007). In 2013, a large-scale study was conducted in urban and rural populations of 141 countries with low and middle income levels. On the basis of a meta-analysis of data on height and weight, the authors concluded that actually in all countries urban children were taller and heavier than their rural peers. The scale of differences can vary. The greatest difference is recorded in Latin America (Peru, Honduras, Bolivia, Guatemala), some African countries, in Vietnam, and China (Paciorek et al., 2013). Urban children are distinguished by higher growth rates, which account, in part, for the recorded differences in body dimensions (Wronska-Weclaw, 1984; Petrovic et al., 1984; Miklashevskaya, Solovieva, Godina, 1988: 53–59).

Differences in body proportions have been established: rural children are more heavily-built and brachymorphic (Wronska-Weclaw, 1984; Chigea, Miu, Tudoscie, 1987). Being inferior to their urban peers in height and weight, they keep abreast with them in chest circumference, thus demonstrating a higher strength of body compared to city dwellers (Polyakov, 1985). Hypodynamia is considered to be among the factors with negative influence on the physical development of modern city people; however, in recent years, studies pointing also to reduction in physical loads on rural dwellers have been published (Permyakova, 2012: 20–22; Liu et al., 2012).

Apart from differences in body dimensions, urban and rural schoolchildren are characterized by different ages of sexual maturation. A distinct correlation is observed between the settlement size and the age at menarche, indicating the latter's decrease with an increasing number of residents (Godina, Miklashevskaya, 1990). Also, quicker changes in the age of sexual development are recorded for representatives of different generations in cities (Popławska et al., 2013).

Secular changes of body dimensions in urban and rural children and adolescents are a subject of special research. The previously mentioned review (Paciorek et al., 2013) points to substantial differences in the rates of these changes and their trend. During the period from 1985 to 2011, the difference between rural and urban children in height has considerably decreased in the southern and tropical areas of Latin America and in South Asia; however, it has not changed substantially in the majority of other regions. Body weight differences have decreased in the same areas of Latin America, however, but they have considerably increased in the majority of regions, owing to the fact that body weight gain in urban children was substantially higher.

Differences between the urban and rural children were observed in Russia as well. On the basis of growth studies that were conducted to establish standards for assessment of physical development and were limited to measurements of total body dimensions (Materialy…, 1986; Fizicheskoye razvitiye…, 1988), the trend of accelerated growth in urban children was reported for many regions of Russia. Analysis of the results of physical examination of St. Petersburg children and their peers from the Leningrad Region, conducted in the 1990s by a group of U.S. and Russian scientists, revealed substantial differences in morphological characteristics, total caloric content of food, and consumption of vitamins and mineral nutrients, which proved to be significantly higher among the city dwellers (Spurgeon et al., 1994; Steele et al., 1994). In recent years, a number of researchers in various regions of Russia have studied specific features of physical development in urban and rural children (Kabanov, 2005; Medvedev et al., 2011; Osmanov R.O., Omarieva, Osmanov O.R., 2013; Egorova et al., 2014; Filatova, 2014; Tsybulskaya et al., 2014), including the Arkhangelsk Region (Degteva et al., 2013; Fedotov, Degteva, Godina, 2012; Fedotov, 2014). However, as with many other studies related to hygiene in children and adolescents, the program of this research was limited to a minimal set of characteristics.

The purpose of this paper is to characterize the processes of growth and development in the children and adolescents of Arkhangelsk and Arkhangelsk Region at the present stage (on the basis of an extensive set of characteristics, including biological age indicators), and to correlate the obtained results with archival data collected at the end of the 1980s.

Materials and methods

The material of this paper was collected in 2009–2010 as part of the project devoted to the tercentenary jubilee of M.V. Lomonosov, the founder of Moscow University. A comprehensive anthropological examination of the child population was conducted in the villages of Kholmogory (where M.V. Lomonosov was born), Matigory, and Emetsk, and in the city of Arkhangelsk. More than 2000 children and adolescents, aged from 7 to 17, were examined. The material was collected by the cross-sectional method with observance of the rules of bioethics and signing of informed-consent forms for each subject (in case of younger schoolchildren, forms were signed by their parents). The examination included only children whose parents, either both (96 %) or one (4 %), were ethnic Russians.

The comparison was based on materials collected by the authors in the same districts and villages as in 1988–1989 (Miklashevskaya et al., 1992). It can be said that two generations of urban and rural children and adolescents of the Arkhangelsk Region were studied. In each village, examination was conducted of all schoolchildren, the number of which has been considerably reduced as compared to the 1980s, owing to the fall of the birth rate, and also migration processes, in Russia. The rural

population of the Arkhangelsk Region continually reduces (Tabakov, 2005): according to official statistics, in recent years, the total decline in population of the region proceeds at the rate of 10 thousand people annually (http://www.vdvsn.ru/novosti/region/tendentsiya_depopulyatsii/).

The material was divided into age groups according to the principle accepted in Russian anthropology: the average age of the children in a group is equated to an integral number of years. The anthropometric examination was performed following the standard procedure (Bunak, 1941: 58–86). The program included some 50 metric and descriptive characteristics; a questionnaire survey taking into account parental education and occupation, number of children per family, financial standing of family, type of nutrition, etc. (Zadorozhnaya, 1998: 13–16). The following calculations were performed: leg, arm, and torso lengths; the Quetelet index (body mass index (BMI)) from the formula $I = W/L^2$, where I is the index value, W is the body weight (kg), L is the height (m); absolute and relative amount of fat mass (kg, %) from the formulas provided by M. Slaughter with co-authors (Slaughter et al., 1988).

Data on the sexual development of adolescents have been collected. The following characteristics were taken into account: in girls, development of mammary glands (Ma), axillary (Ax) and pubic (P) hair, and age at menarche (Me); in boys, pubertal nipple swelling (S), axillary (Ax) and pubic (P) hair, age of voice change (VC), degree of protrusion of the Adam's apple (A), and growth of mustache (M), beard (B), and chest hair (C) (Solovieva, 1966: 51–56).

Statistical processing of the results was carried out using the standard statistical package *Statistica* (versions 6.0 & 8.0). The standardization procedure was applied to enable comparison of special features of intra-group differences irrespective of age and sex (Cole, 1997). The statistical significance of average values was evaluated by Student's *t*-test. Analysis of variance (one-way ANOVA) was conducted. Statistical significance was evaluated using Scheffé's test. The average age of appearance of secondary sexual characteristics was determined by the probit regression method.

Results and discussion

The dynamics of age-related changes in the average values of the main body dimensions in the girls and boys of Arkhangelsk and the Arkhangelsk Region are presented in Table 1*. During puberty, the girls of Arkhangelsk are ahead of their rural peers in height; however, the differences are only statistically significant at the ages of 11 and 12 (Table 1). At 17, this indicator reaches 161.97 cm in urban girls and 160.56 cm in girls from villages in the region. Both in the city and in rural areas, it is higher (reaching 163 cm) in the group of 16-year-olds than in the 17-year-olds. It is likely that the girls born in 1993 were affected by the economic crisis of the beginning of 1990s to a greater extent than members of subsequent age groups.

The boys of Arkhangelsk are actually ahead of their rural peers in height within the entire age interval. The differences are significant at the ages of 7, 11, and 15 (Table 1). At the age of 17, this indicator reaches 175.3 cm in urban young men and 173.4 cm in rural ones. The 17-year-old young men of Arkhangelsk are behind their Moscow peers in height (175.9 cm) (Godina, 2001: 143). The results of measurement of the height of the male population of the Arkhangelsky Uyezd conducted in 1870–1880s and, repeatedly, in 1925 (166.1 and 166.6 cm, respectively) were no different, on the whole, from the indicators for the Moskovsky Uyezd inhabitants (166.0 and 166.7 cm, respectively) (Bunak, 1932). A considerable secular gain of height in the Russians of Arkhangelsk of almost 10 cm over the 100-odd years is comparable in value to the mean European numbers (Malina, 2004).

The urban girls are ahead of their rural peers in body weight at younger ages; however, this trend is reversed at older ages (Table 1), which is in agreement with the earlier obtained data on more leptosomic body structure in urban girls (Godina, 2009). A statistically significant difference in favor of urban boys is only observed at the age of 11, while there are actually no significant differences in other age groups, though the trend towards greater body weight persists in city dwellers (Table 1).

The trend that we have already detected for body weight can also be noted for chest circumference: some excess of values in urban girls at younger ages and, in contrast, their reduction at older ones. Statistically significant differences are recorded for the age of 15, when the difference favoring rural girls reaches 3.5 cm ($p<0.01$). The urban boys are ahead of their rural peers in chest circumference at the age of 11 ($p<0.01$). No statistically significant differences have been revealed in other age groups. Having regard to the fact that city dwellers are taller, this points to a greater brachymorphia of the rural population, confirming conclusions made by other authors (Wronska-Weclaw, 1984; Chigea, Miu, Tudoscie, 1987).

The trends that we have already mentioned when analyzing the age-dependent dynamics of body weight are characteristic of BMI. This indicator is lower in urban girls at the age of 14–17, though statistically significant differences have been only recorded for the age of 15. The differences in boys reach statistically significant values in favor of city dwellers at the age of 11 (Table 1).

*For more detailed information about dimensional indicators see (Godina et al., 2011).

Table 1. **Main statistical parameters of morphological characteristics of children from the city of Arkhangelsk (CA) and the Arkhangelsk Region (AR)**

Age, years	*N*		Height, cm				Body weight, kg				BMI			
	CA, 2009/1988	AR, 2010/1989	CA		AR		CA		AR		CA		AR	
			2009	1988	2010	1989	2009	1988	2010	1989	2009	1988	2010	1989
							Girls							
7	75/55	30/69	123.2 ± 6	121.6 ± 5	121.1 ± 7	120.4 ± 6	**25.4 ± 6**	23.5 ± 3	**22.6 ± 3**	23.2 ± 3	**16.6 ± 3**	15.9 ± 2	**15.4 ± 1**	15.9 ± 1
8	96/50	38/62	126.7 ± 6	126.1 ± 5	127.5 ± 6	124.9 ± 5	26.5 ± 6	24.9 ± 4	26.8 ± 5	24.7 ± 4	16.4 ± 3	15.6 ± 2	16.4 ± 2	15.8 ± 2
9	69/58	34/69	133.6 ± 6	**131.2 ± 6**	132.2 ± 6	**128.6 ± 5**	30.5 ± 6	**28.7 ± 4**	29.7 ± 6	**26.7 ± 5**	17.0 ± 3	16.6 ± 2	16.9 ± 3	16.1 ± 2
10	56/73	24/72	139.7 ± 8	**138.5 ± 6**	137.2 ± 8	**135.3 ± 7**	35.2 ± 10	31.8 ± 6	31.1 ± 7	31.0 ± 7	17.8 ± 4	16.5 ± 2	16.4 ± 2	16.8 ± 3
11	62/91	39/40	**148.0 ± 8**	**143.2 ± 7**	**142.9 ± 9**	**139.1 ± 8**	**40.7 ± 10**	35.8 ± 7	**35.7 ± 9**	33.8 ± 8	18.5 ± 3	17.3 ± 2	17.3 ± 3	17.2 ± 3
12	71/84	37/73	**151. 9 ± 8**	**151.2 ± 7**	**148.4 ± 8**	**146.1 ± 8**	43.5 ± 10	41.9 ± 8	40.6 ± 11	40.1 ± 9	18.7 ± 3	18.2 ± 2	18.2 ± 3	18.6 ± 3
13	62/80	39/55	157.4 ± 7	**156.1 ± 7**	154.9 ± 8	**152.1 ± 7**	48.4 ± 10	46.7 ± 8	48.3 ± 12	46.2 ± 12	19.4 ± 3	19.1 ± 3	19.9 ± 4	19.8 ± 4
14	84/78	32/55	160.7 ± 6	**159.0 ± 7**	158.6 ± 6	**156.0 ± 7**	52.0 ± 9	**52.5 ± 9**	50.1 ± 7	**49.1 ± 9**	20.1 ± 3	20.7 ± 4	19.9 ± 2	20.1 ± 3
15	66/75	43/53	161.0 ± 6	**162.2 ± 5**	161.6 ± 7	**159.7 ± 6**	**51.1 ± 8**	53.7 ± 8	**56.1 ± 9**	53.4 ± 9	**19.7 ± 3**	20.4 ± 3	**21.5 ± 3**	20.9 ± 3
16	87/79	41/56	163.1 ± 7	161.8 ± 6	163.2 ± 6	161.4 ± 7	55.7 ± 8	56.3 ± 9	57.8 ± 10	56.4 ± 7	20.9 ± 3	21.5 ± 3	21.7 ± 4	21.7 ± 3
17	62/0	44/43	162.0 ± 6	–	160.6 ± 7	161.2 ± 6	55.1 ± 8	–	55.7 ± 10	57.5 ± 8	21.0 ± 3	–	21.6 ± 3	22.1 ± 3
							Boys							
7	68/50	24/54	**123.8 ± 5**	**123.8 ± 5**	**121.0 ± 6**	**118.9 ± 5**	25.8 ± 5	**24.6 ± 3**	24.4 ± 4	**22.8 ± 3**	16.8 ± 2	16.0 ± 1	16.5 ± 2	16.1 ± 1
8	73/56	40/74	128.8 ± 6	126.6 ± 5	126.4 ± 6	124.8 ± 6	28.4 ± 6	26.0 ± 3	26.6 ± 6	25.7 ± 4	17.0 ± 3	16.2 ± 1	16.5 ± 2	16.4 ± 1
9	69/67	28/55	132.9 ± 6	**133.2 ± 6**	133.1 ± 7	**129.9 ± 6**	30.7 ± 5	**29.9 ± 5**	29.8 ± 6	**27.9 ± 3**	17.3 ± 2	16.8 ± 2	16.7 ± 3	16.5 ± 1
10	67/71	26/70	139.5 ± 6	137.2 ± 6	138.2 ± 7	135.4 ± 6	33.5 ± 7	31.9 ± 5	33.6 ± 7	31.6 ± 5	17.2 ± 3	16.9 ± 2	17.4 ± 2	17.1 ± 2
11	53/72	33/58	**145.9 ± 7**	**141.7 ± 6**	**141.5 ± 8**	**139.3 ± 6**	**40.3 ± 10**	34.5 ± 5	**34.4 ± 6**	33.6 ± 5	**18.8 ± 4**	17.2 ± 2	**17.1 ± 2**	17.3 ± 2
12	58/78	42/67	151.0 ± 8	146.5 ± 7	149.8 ± 8	144.0 ± 8	41.7 ± 9	37.3 ± 6	41.2 ± 8	37.3 ± 7	18.2 ± 3	17.3 ± 2	18.2 ± 3	17.9 ± 2
13	57/62	48/59	157.3 ± 9	152.8 ± 8	156.9 ± 8	151.1 ± 9	47.1 ± 10	43.3 ± 8	48.4 ± 10	42.3 ± 7	18.9 ± 3	18.4 ± 2	19.6 ± 3	18.4 ± 2
14	56/65	33/58	163.7 ± 9	158.7 ± 9	160.1 ± 9	155.9 ± 7	55.2 ± 12	48.6 ± 8	51.7 ± 11	46.6 ± 8	20.5 ± 4	19.2 ± 2	20.0 ± 3	19.0 ± 2
15	81/58	43/56	**171.0 ± 7**	**170.6 ± 8**	**167.8 ± 8**	**164.2 ± 8**	60.5 ± 12	58.5 ± 10	57.1 ± 12	55.0 ± 10	20.6 ± 3	20.0 ± 2	20.2 ± 3	20.3 ± 3
16	71/73	57/51	174.0 ± 8	**172.3 ± 8**	171.8 ± 7	**168.8 ± 9**	62.0 ± 10	60.7 ± 8	61.9 ± 9	58.9 ± 11	20.3 ± 3	20.4 ± 2	20.9 ± 3	20.5 ± 2
17	53/44	44/30	175.3 ± 6	174.9 ± 6	173.4 ± 7	172.3 ± 7	65.3 ± 9	65.4 ± 9	63.4 ± 10	65.9 ± 9	21.2 ± 2	21.4 ± 2	21.0 ± 3	22.2 ± 3

Note: Characteristics, for which differences between the dwellers of Arkhangelsk and the Arkhangelsk Region (in the corresponding year of examination) reach the highest significance value ($p < 0.01$), are given in bold type.

The ANOVA results for combined age groups demonstrate highly significant differences in a number of characteristics. Substantial differences in relation between the lengths of torso and leg have been found ($p<0.000$ in boys, $p<0.05$ in girls). With similar values of torso length in urban and rural children, city dwellers have longer legs, which is well demonstrated by the results of ANOVA (Fig. 1). According to current opinion, differences in this indicator point primarily to the influence exercised by environmental conditions on growth processes at the prepubertal stage of ontogenesis. Relative shortening of legs and lengthening of trunk can be indicators of unfavorable growth conditions (Bogin, Varela-Silva, 2010).

A typical tendency towards a greater subcutaneous fat layer in modern city dwellers is observed (Fig. 2). It is more pronounced in boys: the scale of differences is greater, four skin-fat folds on the trunk and extremity are affected ($p<0.05$ to 0.01). The thickness of fat folds on the back and on the external surface of upper arm is a little larger in urban girls.

When comparing the dynamometric characteristics of urban and rural schoolchildren, it would be logical to assume that the latter show higher values owing to their engagement in seasonal agricultural works, active way of life, etc. (Gundegmaa, 2009: 17–19). In our case, the study has yielded some interesting results (Fig. 3). No differences have been actually revealed between the urban and rural boys (except for 16-year-olds, among which the rural boys have significantly higher indicators). In girls, they demonstrate the same already stated pattern: city dwellers are stronger before the onset of sexual maturity, while inhabitants of rural areas become stronger in postpuberty. The revealed differences constitute a trend. The obtained results can testify that life-style changes related to reduction in physical activity now affect not only the urban population, but the rural inhabitants as well. This is confirmed by the data provided by other authors (Permyakova, 2012: 20–22; Liu et al., 2012).

Urban girls are far ahead of rural ones with respect to the age of appearance of secondary sexual characteristics (Table 2). This difference is approximately 5 months in terms of the key indicator, the age at menarche. This age in the girls of Arkhangelsk falls at 12 years 9 months, which is considerably earlier than with

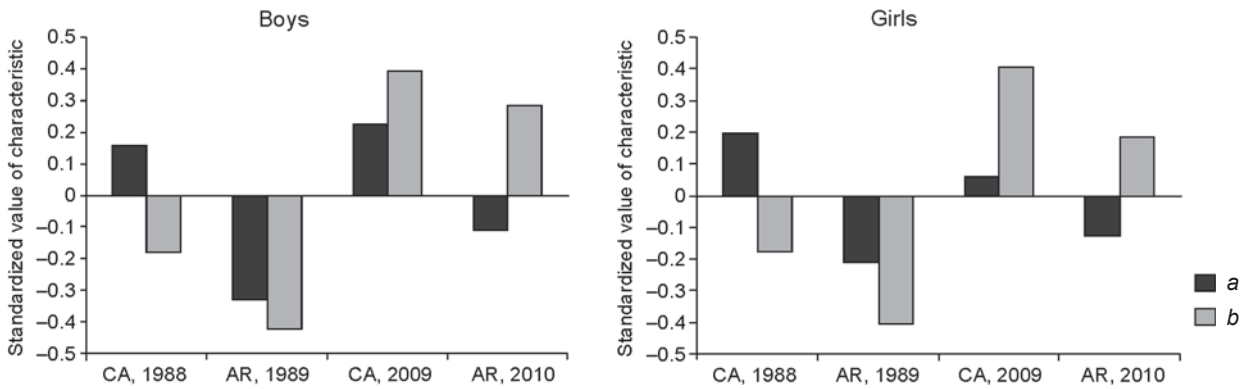

Fig. 1. The results of ANOVA of leg (*a*) and torso (*b*) lengths in children of urban (CA) and rural (AR) groups.

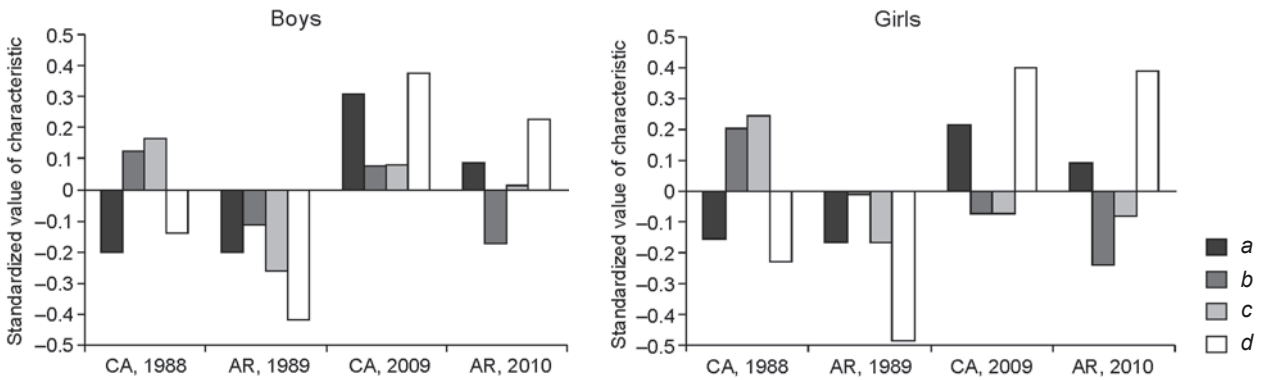

Fig. 2. The results of ANOVA of the skin-fat fold values in children of urban (CA) and rural (AR) groups.
a – on the back; *b* – on the outer surface of upper arm; *c* – on the internal surface of upper arm; *d* – on the abdomen.

Moscow girls, in whom this indicator was 13.0 years at the turn of the century (Godina, 2001: 133). Judging by these figures, active processes of a secular trend in modern women of the North can be described. The young men of the Arkhangelsk Region keep abreast of their urban peers in most indicators, and ahead of them in such characteristics as development of pubescence and pubertal nipple swelling (by 3 and 12 months, respectively). In general, these data confirm information in the literature about the type of differences in the ages of sexual maturation between urban and rural children (Godina, Miklashevskaya, 1990; Popławska et al., 2013).

The second important task of this research is to study secular shifts that have occurred in the last two decades. In the 21st century, two most probable scenarios have been identified: changes in body weight and subcutaneous fat along with stabilization of height, or changes in body shape towards more leptosomic type (Godina, 2009). What individual scenario of secular trend is characteristic of children and adolescents in the northern region of Russia?

One-way ANOVA analysis has revealed that modern Arkhangelsk girls are different in height from their peers who lived at the end of 1980s, slightly but significantly ($p<0.01$). Statistically significant differences by age groups are recorded for 8- and 9-year-old girls (which is, possibly, related to the earlier age of sexual development in modern urban girls). The boys, during the entire period of adolescence, demonstrate statistically significant differences in favor of the modern Arkhangelsk dwellers. By the age of 17, the indicators actually level off: modern young men reach a height of 175.27 cm, while their peers from the previous generation had a height of 174.88 cm (see Table 1). This confirms the conclusion drawn earlier by us (Miklashevskaya, Solovieva, Godina, 1988: 47–48; Godina, 2001: 142–157) and by a number of other researchers (Yampolskaya, 2000: 62–63; Roede, van Wieringen, 1985; Susanne, Bodzsár, 1998) that the processes of longitudinal growth in modern young people have stabilized in most countries of the world.

The average values of chest circumference in boys and girls of Arkhangelsk are indicative of secular shifts towards an increase (statistically significant differences are recorded for the majority of studied age groups). According to the results of analysis of variance

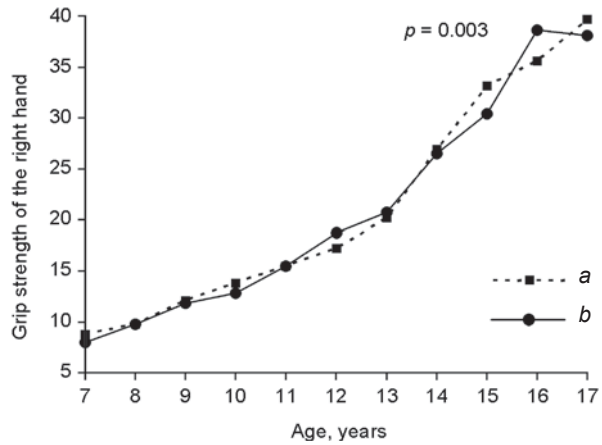

Fig. 3. Age-related changes in the grip strength of the right hand in urban (*a*) and rural (*b*) boys examined in 2009–2010.

Table 2. **Average age of appearance of secondary sexual characteristics in adolescents of Arkhangelsk and the Arkhangelsk Region (years)**

Characteristic	Arkhangelsk, 1988	Arkhangelsk Region, 1989	Arkhangelsk, 2009	Arkhangelsk Region, 2010
		Girls		
Mammary glands (Ma)	10.23 ± 1.96	10.36 ± 1.68	9.75 ± 1.66	10.25 ± 1.92
Pubic (P) hair	11.72 ± 1.68	11.78 ± 1.25	10.75 ± 1.66	11.25 ± 1.33
Axillary (Ax) hair	12.13 ± 1.96	11.92 ± 1.25	11.00 ± 1.83	12.75 ± 2.25
Menarche (Me)	12.82 ± 1.68	13.62 ± 1.68	12.75 ± 1.66	13.25 ± 1.66
		Boys		
Pubertal nipple swelling (S)	13.54 ± 1.25	14.23 ± 1.96	12.75 ± 1.25	11.75 ± 2.25
Pubic (P) hair	13.27 ± 1.68	13.23 ± 1.96	12.50 ± 1.50	12.25 ± 1.92
Axillary (Ax) hair	14.22 ± 1.68	14.50 ± 1.16	12.50 ± 2.16	12.75 ± 1.66
Protrusion of the Adam's apple (A)	13.27 ± 1.68	14.00 ± 1.96	13.50 ± 1.25	13.75 ± 1.92
Voice change (VC)	13.40 ± 1.66	14.00 ± 1.33	13.66 ± 1.66	13.23 ± 1.66
Growth of mustache (M)	15.12 ± 1.39	15.23 ± 1.33	14.25 ± 1.92	14.00 ± 1.83
Growth of beard (B)	16.21 ± 1.11	16.23 ± 1.66	15.25 ± 1.92	14.25 ± 1.92

(Fig. 4), the differences reach the highest significance value (p<0.000). Similar shifts are somewhat less pronounced in rural children of the region (p<0.05). Thus, it is hardly possible to talk about changes of body shape towards leptosomization in this case, as was earlier shown by us for Moscow and other cities of Russia (Godina, 2009). However, certain changes in body shape still take place: these include a decrease of shoulder breadth and increase of pelvic breadth in urban children (Fig. 5). The absolute difference between individual ages is small; however the ANOVA results for combined age groups demonstrate highly significant differences (p<0.001). The changes are most pronounced in rural children.

Modern young dwellers of Arkhangelsk show rather substantial changes of body length segments against the background of slight changes in height per se. In contrast to the data on increasing leg length and decreasing trunk or torso length presented in classical studies on secular shifts in the body proportions (Tanner et al., 1982; Cole, 2003), the leg length in the Arkhangelsk population has significantly reduced in girls (p<0.05) and has remained unchanged in boys, while the torso length has increased in persons of both sexes (p<0.001). In rural areas of this region, the corresponding tendency is more pronounced in boys. These changes can be interpreted in terms of the deterioration of living conditions in Arkhangelsk during the last 20 years. Similar data on a larger contribution of trunk length in secular changes of growth are observed in some other countries as well (Leung et al., 1996).

Children of the Arkhangelsk Region show changes in limb circumferences, mainly an increase (Fig. 4), and similar changes (significant in boys) in total and relative amount of fat (Fig. 6). A greater increase of fat-mass is observed in urban children (p<0.01); however, rural children also undergo substantial changes in this regard (p<0.05). The tendency towards an increasing amount of fat in modern adult and child population is global. There is some evidence that it is more pronounced in rural children. Thus, according to materials of the 1999–2006 National Health and Nutrition Examination Survey, the present-day living conditions in the rural areas of the USA facilitate a greater development of fat deposition (Liu et al., 2012). The authors came to a conclusion about insufficient physical activity in rural children, which is in

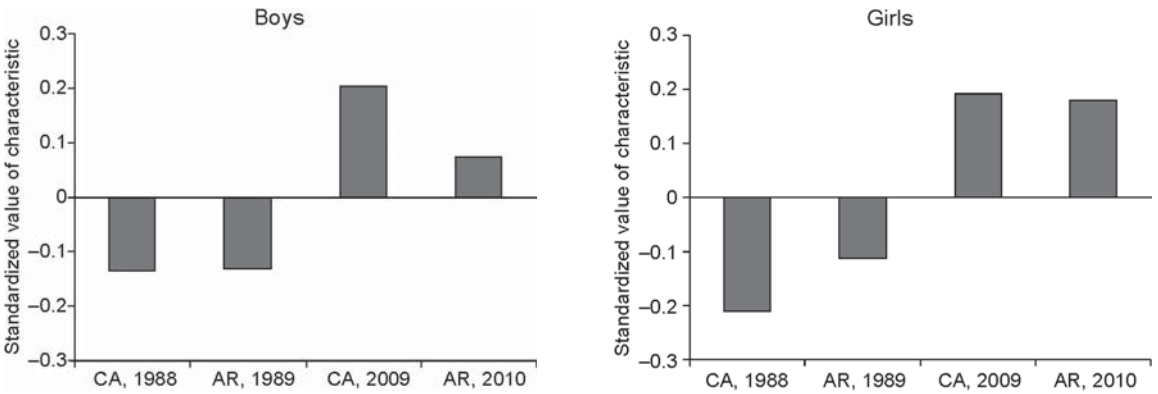

Fig. 4. The results of ANOVA of the chest circumference in children of urban (CA) and rural (AR) groups.

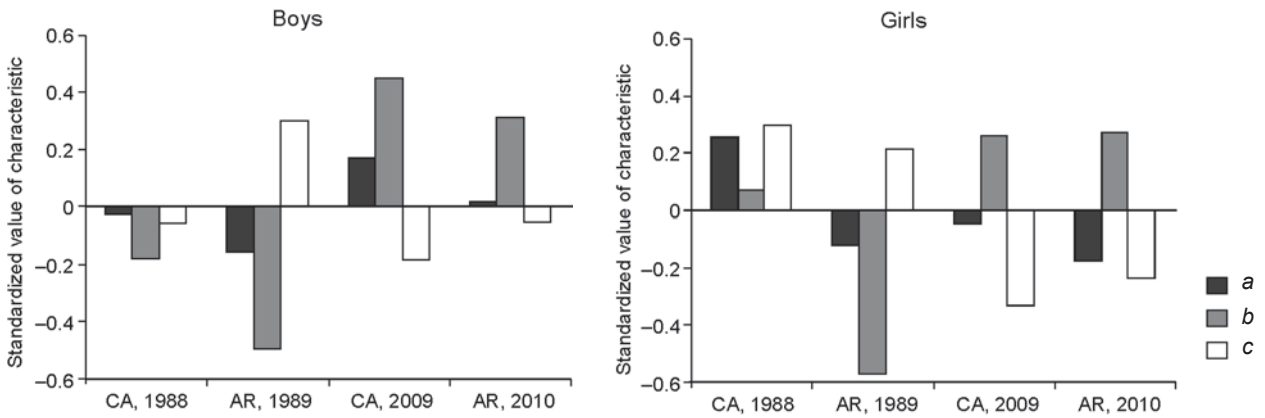

Fig. 5. The results of ANOVA of the shoulder breadth (*a*) and pelvic breadth (*b*), and relation between the shoulder breadth and height (*c*) in children of urban (CA) and rural (AR) groups.

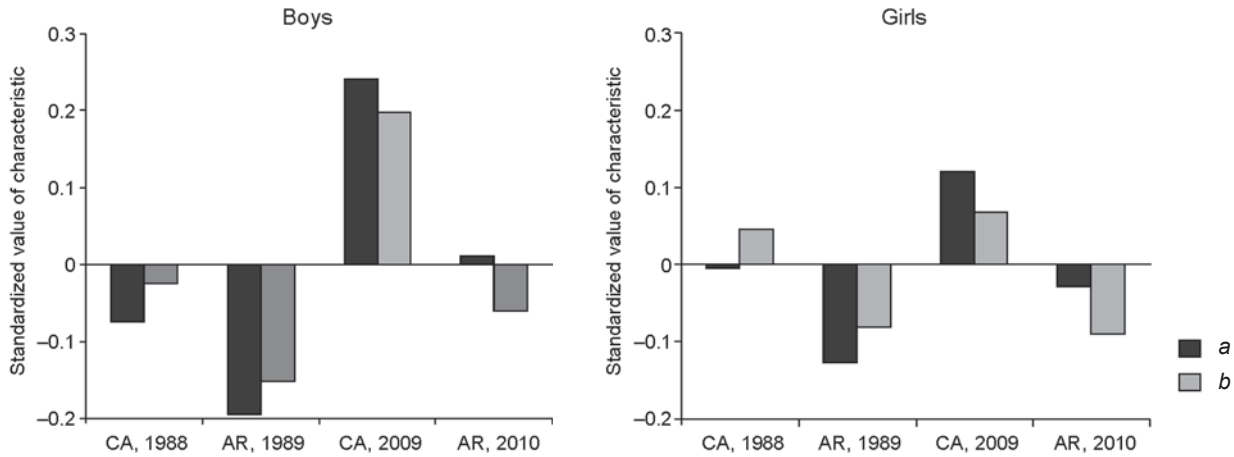

Fig. 6. The results of ANOVA of the total (*a*) and relative (*b*) amount of fat mass in children of urban (CA) and rural (AR) groups.

agreement with our data on equal indicators of muscle strength in urban and rural children and adolescents, and with the results of questionnaire survey of rural dwellers that show smaller physical loads as compared to city dwellers (Permyakova, 2012: 20–22).

Substantial changes have taken place in the character of subcutaneous fat-layer distribution. It has statistically significantly increased on the torso and decreased on extremities (Fig. 2) in urban and rural children and adolescents of the Arkhangelsk Region over 20 years. The fat fold on the abdomen has especially increased (p<0.000). Its thickness in some age groups has become larger by 4–5 mm, which is a quite substantial value. According to data obtained by a number of researchers, an increase in abdominal fat deposition is a predictor of a wide range of illnesses (cardiovascular diseases, diabetes, etc.) both in adult life and in childhood (Demerath et al., 2011). The mentioned tendencies may be indicative of unfavorable predictions regarding the health both of urban and of rural children living in the Arkhangelsk Region.

Substantial changes in the ages of sexual maturation towards its acceleration have taken place in urban and rural adolescents. Compared to archival data (Miklashevskaya et al., 1992), the average age of appearance of secondary sexual characteristics have considerably reduced both in boys and in girls (see Table 2). We already mentioned the inconspicuous but statistically valid increase of pelvic breadth in modern girls of Arkhangelsk. According to data from a number of authors (Ellison, 1982; Worthman, 1993), the age at menarche is best predicted exactly by this indicator. The average value of 24 cm determines the menstrual age in girls both in modern and in traditional populations. The "critical" value of pelvic breadth (to a greater extent than the "critical" weight (Frish, Revelle, 1971)) is one of the necessary conditions for successful establishment of the reproductive function. In 2010, the

Table 3. **Differences in socioeconomic and demographic characteristics of families of children examined in Arkhangelsk and the Arkhangelsk Region**

Groups compared (place, year of examination)	Average number of children per family		Average score of parental education		Average score of parental occupation	
	Boys	Girls	Boys	Girls	Boys	Girls
Arkhangelsk, 1988 and Arkhangelsk Region, 1989	–0.47*	–0.53	0.48 **	0.51	0.56	0.59
Arkhangelsk and Arkhangelsk Region, 2010	–0.26***	–0.36***	0.07	0.16***	0.26***	0.45
Arkhangelsk, 1988 and 2010	–0.04	0.16***	0.34***	0.11**	0.33**	0.18***
Arkhangelsk Region, 1989 and 2010	0.17***	0.33***	–0.07	–0.24***	0.03	0.04

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

figures for the most important marker of adolescence, the age at menarche, were 12 years 9 months for the girls of Arkhangelsk and 13 years 3 months for rural girls, versus 12 years 10 months and 13 years 7 months in 1988, respectively. The shift towards acceleration is also observed in other characteristics in girls and young men, while the degree of urban-rural differences is reduced. Approximately equal rates of changes can be stated for rural and urban children and adolescents of the Arkhangelsk Region, though some other studies mention that biological age indicators in rural dwellers change more slowly (Popławska et al., 2013).

The degree of urban-rural differences has been substantially reduced for a number of indicators that characterize total body dimensions as well. To elucidate the nature of these changes, we have compared socioeconomic and demographic characteristics obtained on the basis of questionnaire surveys in two series of examinations. A significant reduction in the educational and professional level of adult population of Arkhangelsk is observed. At the same time, the average number of children, especially in rural families, is reduced, which means a larger income per family member (Zadorozhnaya, 1998: 13–16). A combination of the observed tendencies (Table 3) leads to equalization of socioeconomic conditions in the urban and rural areas, which can probably account for the increased resemblance between the two studied groups of child population.

Changes in socioeconomic and demographic characteristics may be caused by migration processes that have proceeded with maximum intensity in the Russian North during recent years (http://www.vdvsn.ru/novosti/region/tendentsiya_depopulyatsii/). In 2002, 83.9 % of migrants in Arkhangelsk (or 79.6 % according to the 2010 census statistics) shifted their permanent place of residence within the Arkhangelsk Region (Konstantinov, 2015), i.e. moved from smaller towns and villages. According to our data, the parents of 42.3 % of the children examined in Arkhangelsk in 2010 moved to the city from the countryside.

Conclusions

1. A comparison between modern rural and urban young men has shown that the dwellers of Arkhangelsk are slightly taller than their rural peers, but do not differ from them in chest circumference, body weight, or BMI. A tendency towards smaller chest circumference, body weight, and BMI has been found in urban girls at older ages, as compared to their peers from rural areas. City dwellers are ahead of rural inhabitants with regard to ages of sexual maturation.

2. It has been established that modern urban and rural schoolchildren have greater stature, body weight, and body mass index as compared to those measured in 1988, this being especially pronounced in boys during adolescence. Changes in body proportions towards longer torso are typical of modern children. Significant differences in limb circumference and subcutaneous fat have been found. Children and adolescents examined in 2010 are distinguished by greater chest and upper arm circumferences. They have thicker skin-fat folds. Changes in fat deposition topography towards a greater development of the fat layer, especially in the abdominal area, are typical of boys and girls. No substantial changes in height have been found in 17-year-old young men and girls, which suggests stabilization of the longitudinal growth processes in modern young people.

3. In a number of indicators, physical characteristics of urban and rural dwellers become closer. This can be attributed to equalization of socioeconomic and demographic characteristics of rural and urban environment caused by explosive social processes in the Russian North during the last two decades.

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