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RESEARCH ARTICLE

Intergenerational trends in body size among Moscow's young adults: socio-demographic influences of the 20th century

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Abstract

This study aimed to investigate the influence of socio-demographic and epidemiological factors on the secular changes in body size indicators (height, weight, and BMI) among young adults aged 17–22 years in Moscow from the early 20th century to the present. Published average anthropometric data from screening surveys conducted from 1880/1925–26 to 2020–21 were analysed (4,823 males and 5,952 females), along with demographic data from the Federal State Statistics Service of the Russian Federation. Findings revealed consistent anthropometric trends and strong associations between secular changes in body size of Moscow youth and socio-demographic indicators such as population size, life expectancy, and infant mortality rates. An increase in height and weight was noted against the backdrop of urbanisation, increased life expectancy, and reduced infant mortality. These results indicate that the urbanisation process and the transformation of the epidemiological landscape in 20th-century Russia – marked by enhancements in public health, modernisation of the healthcare system, and medical advancements – have had a significant impact on changes in body size across generations. Notably, from the mid-20th century onwards, with the exception of the final decade, conditions favourable to growth and development were established, culminating in a significant increase in definitive anthropometric parameters across successive generations. The findings underscore the imperative for policymakers to bolster investments in urban development, healthcare, and education. Such strategic investments are essential for sustaining and amplifying the positive physical development trends witnessed.

Keywords: secular trend; height; weight; urbanisation; population health; living standards; infant mortality

Introduction

In recent decades, the accumulation of extensive anthropometric data has facilitated detailed studies of both spatial (geographical and cross-populational) and temporal (secular and intergenerational) variations in body size across global populations. Most countries have experienced significant increases in body size over the last 100–150 years (Danubio and Sanna, 2008; NCD-RisC, 2016, 2017). Although the trend towards larger body sizes is consistent, variations in timing, intensity, and extent exist across different populations (Kryst *et al.*, 2012; Bodzsar *et al.*, 2016; Malina *et al.*, 2018; Kirchengast *et al.*, 2022; Ikeda and Nishi, 2023; Liczbińska *et al.*, 2023). For example, research on Russian populations shows significant differences in the patterns and rates of body size changes across various regions and time periods (Godina, 2011; Kozlov and Vershubsky, 2015; Lebedeva

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et al., 2020; Negasheva *et al.*, 2023). These regional studies underscore the complexity and diversity of secular changes in anthropometric parameters over time.

Theoretical background

Spatiotemporal analysis of anthropometric characteristics, particularly height, is crucial for assessing population well-being from a historical perspective. Height serves as a cumulative indicator, reflecting both genetic factors and external environmental influences, including ecological, socio-economic, epidemiological, nutritional, and psycho-emotional factors (Cole, 2003; Silventoinen, 2003; Perkins *et al.*, 2016; Bogin, 2021; Hermanussen *et al.*, 2022; Conery and Grant, 2023). It is suggested that the significant secular changes in human body sizes observed over the past 100–150 years are predominantly due to shifts in external environmental conditions rather than major genetic reorganisation (Cole, 2003; Bozzoli *et al.*, 2009; Steckel, 2009, 2012; Baten and Blum, 2014; Hatton, 2014; Perkins *et al.*, 2016; Bogin, 2021). These changes include political and economic developments, agricultural and technological progress, urbanisation, enhancements in urban infrastructure and housing, improvements in sanitation and hygiene, modernisation of healthcare systems, and demographic shifts such as family size and structure.

The growth process and its outcomes, particularly in terms of body size, are influenced by epidemiological and sanitary-hygienic contexts, along with psychological factors, during key developmental stages. Research has shown that these factors significantly contribute to determining the definitive values of body size indicators (Bozzoli *et al.*, 2009; Komlos and Lauderdale, 2007; Perkins *et al.*, 2016). Advances in medicine and healthcare reforms, especially in Europe and the USA, have markedly improved public health, as evidenced by increased life expectancy and reduced mortality rates from infectious diseases, including a decline in infant mortality. These developments have coincided with marked changes in body sizes (Crimmins and Finch, 2005; Steckel, 2012; Hatton, 2014).

Metrics such as life expectancy and mortality rates are often used to assess the impact of the epidemiological environment on intergenerational changes in body size. The postneonatal infant mortality rate is a particularly sensitive indicator (Bozzoli *et al.*, 2009; Hatton, 2014). Studies have demonstrated a close interconnection between secular trends in body size and infant mortality, often showing mirrored patterns (Schmidt *et al.*, 1995; Crimmins and Finch, 2005; Bozzoli *et al.*, 2009; Quintana-Domeque *et al.*, 2011; Spijker *et al.*, 2012; Akachi and Canning, 2015; Borrescio-Higa *et al.*, 2019). An inverse relationship between infant mortality and final height has been documented across various demographic groups, based on anthropometric data for 31 demographic groups born between 1950 and 1980 in England, the USA, and 10 European countries (Bozzoli *et al.*, 2009).

Urbanisation's impact on body size trends is multifaceted and somewhat ambiguous (Steckel, 2012). In the 19th and 20th centuries, urbanisation suppressed the temporal dynamics of somatic features like height due to increased population density, disease proliferation, and poor sanitary conditions (Steckel, 2012; Hatton, 2014; Carson, 2020). However, in the last century, urbanisation has positively influenced the secular dynamics of anthropometric parameters through improvements in sanitary, hygienic, and living conditions, leading to more significant intergenerational changes in urban populations compared to rural ones (Luo *et al.*, 2009; Godina, 2011; Paciorek *et al.*, 2013; Kozlov and Vershubsky, 2015).

However, although urbanisation and economic growth have improved access to nutrition and healthcare, they have also led to lifestyle changes. These include decreased physical activity and an increase in the consumption of high-calorie, processed foods, which contribute to higher BMI values. The intergenerational dynamics of body mass and BMI among males and females across all age groups are characterised by a secular increase, with a gradual intensification during the second half of the 20th century (Danubio & Sanna, 2008; NCD-RisC, 2017). Furthermore, in many

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countries, the prevalence of individuals with overweight and obesity has risen throughout the past century (NCD-RisC, 2017).

Among the factors contributing to population adiposity and the spread of overweight and obesity, one of the dominant causes is the development of specific conditions in urbanised environments, driven by socio-economic transformations such as increased economic prosperity in developed countries. These conditions encourage an increase in body fat mass, particularly through reduced levels of physical activity (due to changes in types of work and leisure activities, trends towards a sedentary lifestyle, and hypodynamia) and significant changes in population nutrition (such as shifts in the production, distribution, and consumption of food products, and the transition to a Western-style diet characterised by higher levels of animal proteins, high-calorie, and processed foods) (Atkinson *et al.*, 2016; Hruby & Frank, 2015). However, recent studies indicate changes in the temporal somatic trend of BMI in the 21st century among the younger generation, with a reduction in the prevalence of overweight and obesity (Kryst *et al.*, 2022).

A reduction in BMI among children, adolescents, and young people in Russia and some Eastern European countries at the turn of the 20th and 21st centuries is usually attributed to the deterioration of socio-economic living conditions following the collapse of the USSR (Negasheva *et al.*, 2023). The observed decrease in BMI in some countries during the 21st century is most often linked to changes in lifestyle, particularly dietary, and exercise habits (Kryst *et al.*, 2022).

Historical background

The process of urbanisation in Russia during the 20th century was intense, intersecting with significant socio-political and economic upheavals. Initially, urban populations surged by 55% from 1897 to 1913, but World War I, the Revolutions, and the Civil War caused severe declines due to famine, epidemics, and migration away from cities (Nefedova and Treivish, 2003; Makhrova *et al.*, 2013). From 1914 to 1926, populations in Moscow and St Petersburg nearly halved.

The period from 1926 to 1939 marked a resurgence in urbanisation, driven by Soviet policies of forced industrialisation and collectivisation, which significantly increased the urban population (Nefedova and Treivish, 2003; Makhrova *et al.*, 2013; Wiśniewski, 2017). Post-World War II, urbanisation regained momentum, particularly from the 1950s to the mid-1980s, with the rate of urban growth stabilising from the 1960s through the 1980s (Nefedova and Treivish, 2003).

The 1990s saw a decline in urban population growth due to economic and social crises, but the 2000s experienced a revival, particularly in major cities (Nefedova and Treivish, 2003; Makhrova *et al.*, 2013). Despite crises at the century's start and in the 1990s, Moscow's population consistently grew, reinforcing its dominance as a centre of urbanisation into the current era (Denisenko and Stepanova, 2013; Makhrova *et al.*, 2013; Kolosov and Nefedova, 2014; Wiśniewski, 2017).

Concurrently, changes in the epidemiological environment significantly impacted health metrics. The 20th century's mortality rates and life expectancy showed overall positive trends, largely due to healthcare advancements (Reshetnikov *et al.*, 2019a, 2019b). However, several health crises occurred throughout the century (Minagawa, 2018; Reshetnikov *et al.*, 2019b). Fertility patterns also shifted, reflecting smaller family sizes and changing societal preferences (Billingsley and Duntava, 2017; Vishnevsky *et al.*, 2017).

In Moscow, notable increases in height and weight were observed from the late 19th to the early 20th century. Despite periods of gains followed by declines or stagnation, this trend of variability in body sizes underscores the need to consider the broader historical context to understand these fluctuations. While there are relatively few studies empirically assessing the relationship between these secular body size trends and socio-economic factors in Russian populations, previous

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research has begun to explore this, particularly focusing on Moscow's youth (Negasheva *et al.*, 2020; Negasheva *et al.*, 2023).

During the first two decades of the 21st century, Russia maintained a relatively stable political climate, experienced economic growth, and implemented national projects in the social sector, such as healthcare and education. These developments led to an improved standard of living and favourable changes in the population's biological status.

By 2021, Russia's socio-economic landscape included growth in the energy, technology, and services sectors, sustaining employment despite global fluctuations and the COVID-19 pandemic. Improvements in healthcare access and quality enhanced public health, while government initiatives in urban infrastructure, education, and public health contributed to higher living standards.

The aim of this study is to assess the impact of urbanisation, changes in the epidemiological environment, and demographic processes (such as shifts in birth rates) on intergenerational somatic trends among young adults aged 17–22 years in Moscow. Spanning a significant historical scope of 100–150 years, this research provides a comprehensive analysis of these long-term trends and their socio-demographic correlates. It is hypothesised that changes in body sizes among Moscow's youth and across Russia are closely linked to socio-demographic factors, including urbanisation, healthcare improvements, and economic shifts. Periods of urban and economic growth are expected to correlate with increases in body size, while eras marked by socio-economic challenges may exhibit stagnation or declines in these trends.

Data and methods

The meta-analysis was based on retrospective anthropometric and demographic data from literary sources and open statistical databases.

Anthropometric data

The time series of anthropometric indicators were constructed using published average values from screening surveys of Moscow's youth across the 20th and early 21st centuries. Datasets were comparable in terms of age, nationality, and residency, focusing on 17–20-year-old Russian males and females born and residing in Moscow. Birth cohorts ranged from 1860 to 1870 for males and 1907–1908 for females, extending to 2003–2004. Height data are available since the 1880s for males and from 1926 for females, extending to the present, and body weight data from the early 20th century for both sexes. The secular trend in the body mass index (BMI) has been traceable from the early 1970s onwards. The analysed anthropometric parameters encompassed body height (measured with a Martin anthropometer (GPM, Switzerland), accurate to 1 mm) and body weight (measured using a medical scale (Massa-K VEM-150 A3, Russia), accurate to 0.05 kg). BMI was calculated from individual data as the ratio of body weight (kg) to the square of body height (m): individual BMI = kg/m2. In total, anthropometric data from over 10,775 individuals (4,823 young males and 5,952 young females) were analysed, with methodologies and measurement techniques following Martin and Saller (1957). The average values of the anthropometric parameters used in this study are publicly accessible in the sources cited in Table 1, which also provides details on the years of examination and sample sizes.

Socio-demographic data

The study's demographic data were sourced from the Federal State Statistics Service (Rosstat, 2023) databases, with additional sources cited separately (Table 2). All the data used are publicly available. Nine demographic indicators were utilised, organised into three categories (Table 2).

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Table 1. Anthropometric indicator values for young males and females in Moscow across various years of examination

				Sample sizes		Height (cm)		Weight (kg)		**BMI (kg/m^2)**		
	Year of examination	Year of birth	Age	*Males*	*Females*	*Males*	*Females*	*Males*	*Females*	*Males*	*Females*	Data source
1	1880s	1860–1870s	17	N/D	N/D	162,7	N/D	N/D	N/D	N/D	N/D	Vlastovskii (1976)
2	1925–1926	1908–1909	17	483	862	163,2	156,0	50,3	52,8	N/D	N/D	Minkevich and Gorinevskaya, (1928)
3	1928–1930	1911–1913	17	299	342	165,0	155,9	54,6	52,3	N/D	N/D	Brodovskaya (1934)
4	1934–1935	1917–1918	17	101	100	164,2	155,8	52,7	54,1	N/D	N/D	Aron (1940)
5	1936–1937	1919–1920	17	N/D	N/D	168,8	N/D	N/D	N/D	N/D	N/D	Vlastovskii (1976)
6	1958–1959	1941–1942	17	171	262	170,2	158,4	59,8	53,6	N/D	N/D	Goldfeld *et al.* (1962)
7	1964–1965	1947–1948	17	104	209	172,9	161,4	61,9	N/D	N/D	N/D	Leontev and Shevchenko (1966)
8	1969	1952	17	185	184	173,2	160,8	64,4	58,1	N/D	N/D	Vlastovskii (1976)
9	1968–1972	1951–1955	17	71	77	172,6	160,7	62,8	56,8	21,8	22,0	Solov'eva *et al.* (1976)
10	1982	1965	17	113	85	175,8	164,0	68,1	57,5	22,0	21,4	Miklashevskaya *et al.* (1988)
11	1991	1974	17	121	125	174,9	163,4	66,7	57,6	21,8	21,6	Yampolskaya (2000)
12	1996–1999	1979–1982	17	100	102	175,9	N/D	65,9	N/D	20,5	N/D	Godina *et al.* (2003)
13	2000–2002	1983–1985	17–18	626	692	178,0	166,1	67,8	56,6	21,4	20,5	Negasheva *et al.* (2020)
14	2003–2005	1986–1988	17–18	798	945	177,4	165,9	67,5	56,6	21,5	20,5	
15	2006–2009	1989–1992	17–18	540	661	177,4	165,5	69,6	57,7	22,1	21,1	
16	2010–2012	1993–1995	17–18	456	449	177,8	165,8	70,0	57,7	22,1	20,9	
17	2013–2015	1996–1998	17–18	375	440	178,9	166,1	72,7	59,1	22,7	21,5	
18	2016–2019	1999–2002	17–18	211	241	179,1	166,5	70,4	59,2	21,9	21,3	
19	2020–2021	2003–2004	18–22	69	176	178,4	165,3	70,9	58,7	22,6	21,6	Sineva *et al.* (2022)

Note. N/D – no data.

Table 2. Information on the socio-demographic indicators used and data sources

Socio-demographic variables		Time interval	Data source
Urbanisation metrics	Russia's urban population size	1887–2021	Rosstat (2023)
	Proportion of the permanent urban population in Russia (as a percentage of the total population of the country)	1887–2021	Rosstat (2023)
	Population size of Moscow	1882–2021	Denisenko and Stepanova (2013); Rosstat (2023)
Population growth indicators	Birth rate (Russia, urban)	1950–2021	Rosstat (2023)
	Birth rate (Moscow)	1970–2021	
	Total fertility rate (Russia, urban)	1961–2021	
	Total fertility rate (Moscow)	1990–2021	
	Rate of natural increase (Moscow)	1970–2021	
Epidemiological indicators	Life expectancy at birth (Russia, urban, total population)	1897–2021	Rosstat (2023)
	Life expectancy at birth (Moscow, total population)	1970–2021	
	Life expectancy at birth (Russia, urban, males and females)	1897–2021	
	Life expectancy at birth (Moscow, males and females)	1990–2021	
	Total mortality rate (Russia, urban)	1950–2021	
	Total mortality rate (Moscow)	1970–2021	
	Infant mortality rate (Russia, urban)	1950–2021	
	Infant mortality rate (Moscow)	1990–2021	
	Consolidated budget expenditures of the Russian Federation on healthcare and social protection	1990–2021	Healthcare in Russia. Statistical Yearbook (2023)
	Healthcare expenditures of Moscow's consolidated budget	1995–2021	Moscow Statistical Yearbook. The Economy of Moscow in 1992–2021 (2023); United Databank of IAS MID (2023)

The first category included urbanisation metrics (Russia's urban population size, proportion of the permanent urban population in Russia, and population size of Moscow). The second category covered population growth indicators (birth rate and fertility rate). The third category combined epidemiological indicators (life expectancy at birth, total mortality rate, infant mortality rate, and healthcare expenditures).

Primarily, socio-demographic parameters for Moscow's population were used. For some indicators, due to the short duration of time series (from the 1990s to present), analogous data for Russia's urban population were utilised (Table S1). It was presumed that these time series might reflect a similar or closely related temporal trend of the socio-demographic indicator for Moscow's population.

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Statistical analysis

To investigate the direction and strength of the relationships between the time series of anthropometric features and demographic indicators, Spearman's rank correlation coefficients were calculated. For a more in-depth analysis of the identified associations and to assess the relative impact of demographic factors on the temporal variation of somatic traits, multiple linear regression models were created using the least squares method. The selection of predictors for the regression equation was performed through a stepwise inclusion method, selecting only those parameters contributing significantly to the overall correlation. The total variation in the outcome variable, explained by the collective effect of all predictors included in the model, was assessed using the coefficient of multiple determination (R^2).

Statistical processing was conducted using the STATISTICA 10 software package and Microsoft Excel from the Microsoft 365 suite, with the latter also being utilised for data visualisation.

Results

Correlations between anthropometric measures and socio-demographic indicators

The outcomes of the correlation analysis revealed the presence of stable relationships of moderate to high strength between the time series of anthropometric values (such as height and weight, BMI) and various demographic indicators.

For the data series spanning a substantial historical range (from the end of the 19th – beginning of the 20th century to the 2020s), the Spearman correlation coefficients were statistically significant, with absolute values exceeding 0.47, and displayed a positive correlation. The strongest correlational links were identified between long-term body size changes and urbanisation indicators, notably the population size of Moscow (Fig. 1), and the expected lifespan of the population (Fig. 2), for which data have been available since the 1880s.

The correlation coefficients between the time series of anthropometric characteristics and demographic indicators, spanning from the second half of the 20th century to the present, are presented in Table 3. The graphical representations of their combined temporal dynamics are displayed in Figs. 3–4 and in Supplementary materials (Figures S1–3).

Positive correlations have been observed between the time series of somatic characteristics and population growth indicators, such as birth rates and natural population growth rates, with correlation coefficients ranging from 0.50 to 0.77 (Table 3, Fig. 3). Slight sex differences were observed in the absolute values of the correlation coefficients. In most of the socio-demographic indicators studied, higher correlation coefficients were found among the young males. Furthermore, there were positive associations detected for two demographic variables related to population health and healthcare. An increase in life expectancy in the population of Moscow and higher healthcare expenditures were associated with an increase in the average values of body size indicators (Table 3). Conversely, negative correlation links were identified between somatic feature series and mortality rates, particularly infant mortality, with correlation coefficients ranging from −0.47 to −0.72 (Table 3, Figs. 3–4).

Evaluation of the relative impact of different socio-demographic factors on the secular trend

In the subsequent stage of the study, multiple regression analysis was performed to evaluate the relative contribution of various demographic factors to the temporal variability of anthropometric indicators. Regression models were developed for the total body sizes (height and weight) using the most comprehensive sets of demographic data available for two periods: from the 1960s to 1970s to the present and from 1990 to 2021. The predictors from each demographic category were selected based on existing literature and the results of the correlation analysis.

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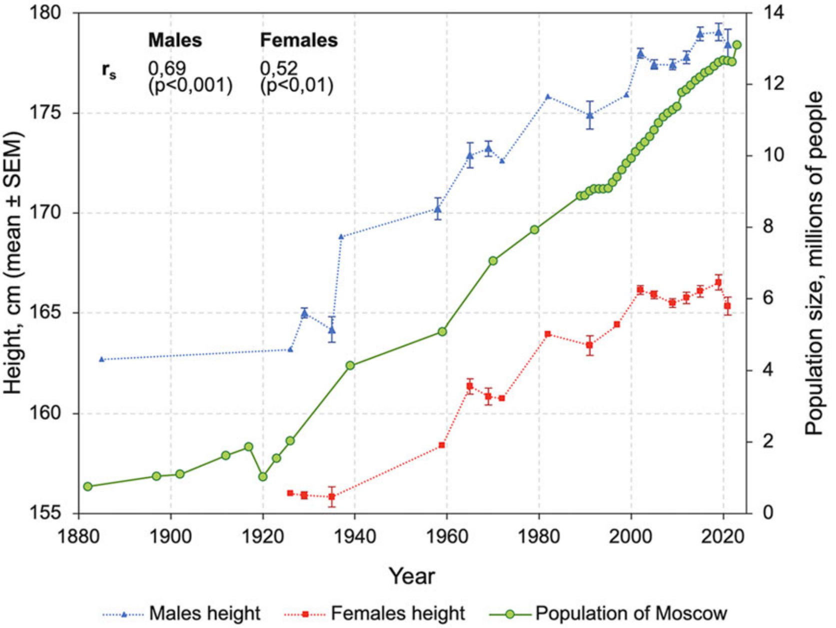

Figure 1. Secular trend in height among young males and females in Moscow, and changes in Moscow's population size from the late 19th to the early 21st century.

Note: Abbreviations: SEM, standard error of the mean; r_s, Spearman's rank correlation coefficient.

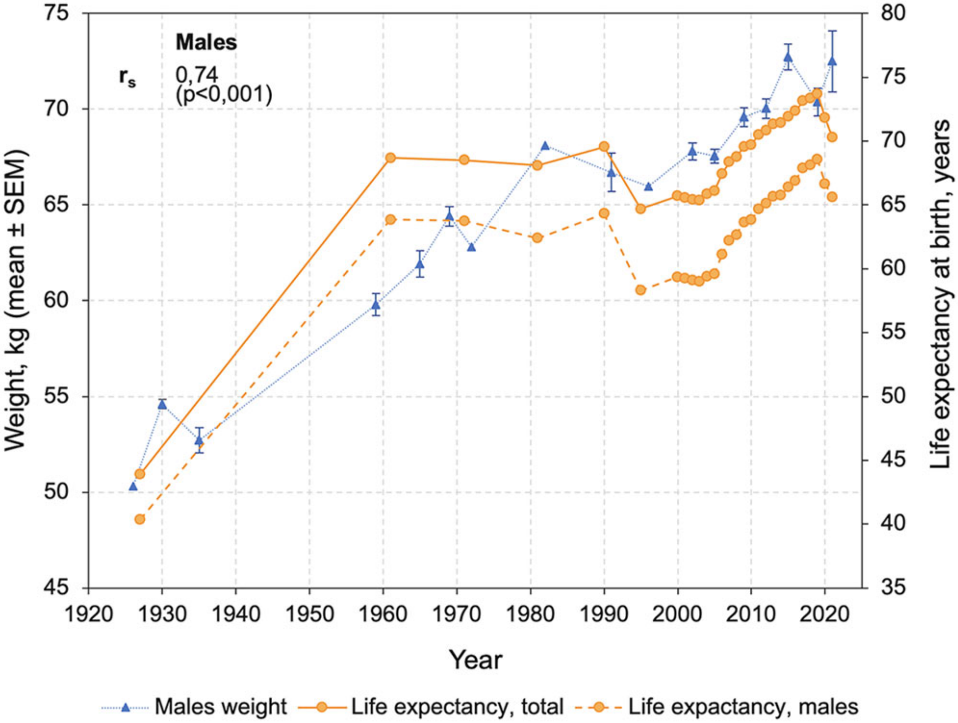

Figure 2. Secular trend in weight among young males in Moscow, and changes in life expectancy at birth in Russia's urban population from the early 20th to the early 21st century.

Note: Abbreviations: SEM, standard error of the mean; r_s, Spearman's rank correlation coefficient.

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Table 3. Spearman's correlation coefficients between anthropometric and demographic variables for Moscow population during the time interval from the second half of the 20th century to the present

		Anthropometric variables					
		Height		Weight		BMI	
		Males	Females	Males	Females	Males	Females
Demographic variables	Fertility rate, 1990–2021	**0.50**	0.29	**0.70**	**0.76**	**0.56**	**0.64**
	Birth rate, 1970–2021	**0.51**	0.30	**0.75**	**0.73**	**0.63**	**0.57**
	Rate of natural increase, 1970–2021	**0.51**	0.38	**0.77**	**0.74**	**0.64**	**0.55**
	Death rate, 1970–2021	−0.41	−0.37	**−0.66**	**−0.63**	**−0.53**	**−0.52**
	Infant mortality rate, 1990–2021	**−0.49**	−0.29	**−0.72**	**−0.63**	**−0.63**	**−0.47**
	Life expectancy at birth, 1970–2021	**0.58**	**0.45**	**0.79**	**0.75**	**0.65**	**0.54**
	Health expenditure, 1990–2021	0.38	−0.08	**0.63**	**0.71**	**0.63**	**0.69**

Note. Statistically significant correlation coefficients are highlighted in bold; the minimum significance level is assumed to be 0.05
Abbreviation: BMI, body mass index.

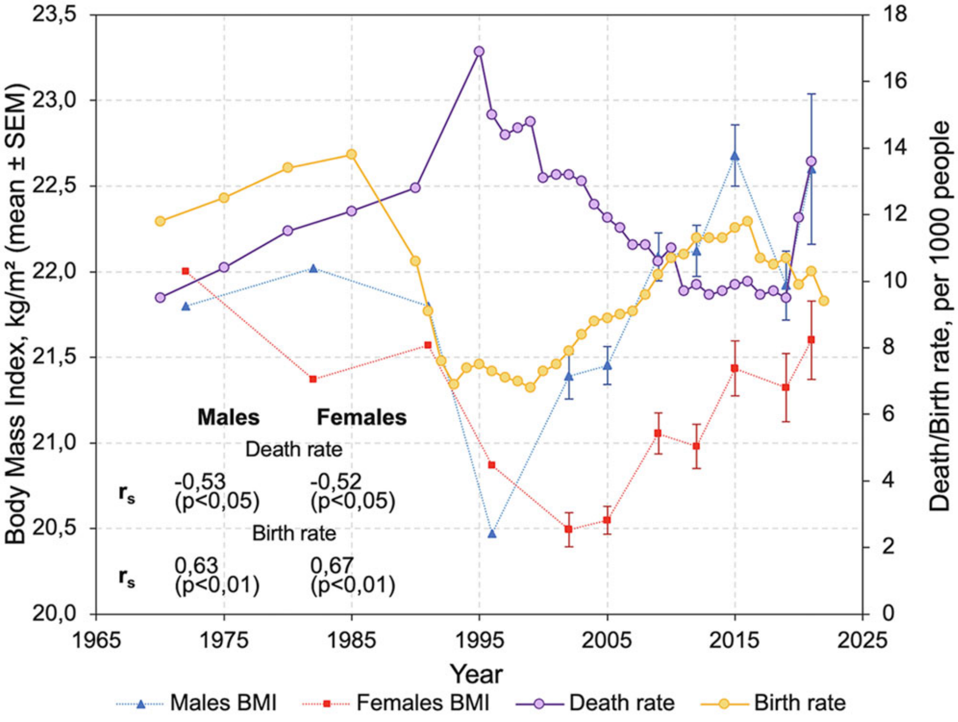

Figure 3. Secular trend in BMI among young males and females in Moscow, and changes in the birth rate and mortality rate in Moscow's population from the 1960s to 2021.
Note. Abbreviation: SEM, standard error of mean; r_s, Spearman's rank correlation coefficient.

The complete multiple regression models, incorporating all available predictors from the second half of the 20th century, reveal a statistically significant positive impact of Moscow's population size ($\beta = 1.899$, $p < 0.05$) and infant mortality rate ($\beta = 1.685$, $p < 0.05$) on the temporal variability in height among young males. The stepwise variable inclusion procedure

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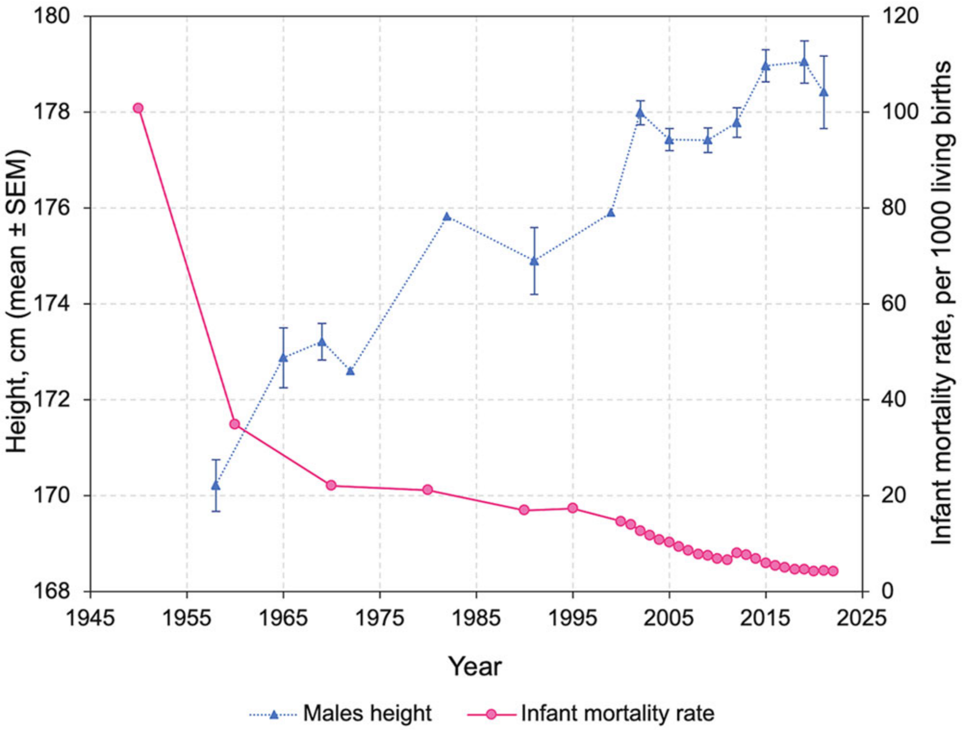

Figure 4. Secular trend in height among young males in Moscow, and changes in the infant mortality rate in Russia's urban population from the 1950s to 2021.
Note. SEM, standard error of mean; r_s, Spearman's rank correlation coefficient.

enhances the statistical parameters of the regression models and identifies Moscow's population size and the infant mortality rate as significant predictors for the height of young males.

The results of the regression analysis show that demographic factors explain approximately 50–60% of the temporal variation in body weight for both young males and females. Models that consider all the demographic factors examined are statistically significant for both sexes ($p < 0.01$), but none of the individual factors exhibit a statistically significant impact. However, after conducting a stepwise variable inclusion procedure, it becomes evident that life expectancy is a significant predictor for males ($\beta = 0.733$, $p < 0.001$), and the population size of Moscow is a significant predictor for females ($\beta = 0.592$, $p < 0.01$.)

In the regression analysis using data available from the early 21st century to the present, the demographic predictors focused on variables representing Moscow's population. The results presented in Table 4 are, in general, similar to those obtained in the previous series of analyses for a broader time interval.

In the case of height, for both young males and females, the population size of Moscow's permanent residents emerges as a significant predictor (Table 4). When it comes to the temporal variation in body weight, the multiple regression models, with variables included in a stepwise manner, reaffirmed the significant positive influence of Moscow's population size and life expectancy.

Specifically, in the group of young males, the population size of Moscow was found to have a significant impact ($\beta = 0.806$, $p < 0.001$), while in the group of young females, life expectancy was a significant predictor ($\beta = 0.741$, $p < 0.001$).

The correlation analysis across all somatic feature groups indicated the highest number of statistically significant links with factors such as Moscow's population size, life expectancy, and

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Table 4. The results of multiple regression analyses of height to estimate the impact of demographic factors on temporal changes in anthropometric variables among young males and females in Moscow from the 1990s to 2021

	Height				Weight			
	Males		Females		Males		Females	
Variables	All variables	Forward stepwise	All variables	Forward stepwise	All variables	Forward stepwise	All variables	Forward stepwise
Moscow population size	**$\beta = 1.98$**	**$\beta = 0.71$**	$\beta = 1.59$	**$\beta = 1.10$**	$\beta = 0.76$	**$\beta = 0.81$**	$\beta = 0.83$	
	$p < 0.05$	**$p < 0.001$**	$p = 0.08$	**$p < 0.01$**	$p = 0.27$	**$p < 0.001$**	$p = 0.28$	
Birth rate	$\beta = -0.45$		$\beta = -0.53$	$\beta = -0.59$	$\beta = 0.27$		$\beta = 0.02$	
	$p = 0.26$		$p = 0.22$	$p = 0.08$	$p = 0.46$		$p = 0.96$	
Infant mortality rate	$\beta = 0.77$		$\beta = 0.31$		$\beta = 0.16$		$\beta = 0.63$	
	$p = 0.10$		$p = 0.58$		$p = 0.72$		$p = 0.19$	
Life expectancy	$\beta = -0.18$		$\beta = -0.27$		$\beta = -0.03$		$\beta = 0.47$	**$\beta = 0.74$**
	$p = 0.78$		$p = 0.70$		$p = 0.96$		$p = 0.44$	**$p < 0.001$**
Regression statistics								
R	0.782	0.714	0.677	0.669	0.821	0.806	0.768	0.741
R^2	0.611	0.510	0.458	0.447	0.674	0.649	0.590	0.549
Adj. R^2	0.524	0.487	0.338	0.392	0.602	0.632	0.499	0.527
F	7.062	21.891	3.808	8.008	9.303	38.821	6.488	25.554
p	<0.01	<0.001	<0.05	<0.01	<0.001	<0.001	<0.01	<0.001

Note. β – regression coefficients of independent variables; R – multiple regression coefficient; R^2 – coefficient of determination; Adj. R^2 – adjusted coefficient of determination; F – F-test; p – significance level; statistically significant regression coefficients are highlighted in bold ($p < 0.05$).

infant mortality rate. The multiple regression analysis also suggests that urbanisation (indicated by the population size of Moscow) contributes most significantly and reliably to the intergenerational variation of somatic features.

Discussion

The combined analysis of anthropometric and demographic retrospective data has identified significant associations between the secular changes in the body sizes of Moscow's youth and the time dynamics of statistical indicators that characterise urbanisation, living standards of the population, and the epidemiological environment in Russia. To the best of current knowledge, this study is the first to examine the relationships between long-term time series of anthropometric and socio-demographic factors, assessing the impact of key social processes occurring in Russia in the 20th century on the secular trend of principal body size indicators.

Urbanisation in Russia and its impact on the secular trend

The intergenerational increase in height and weight among Moscow's youth has coincided with the rapid growth of Moscow's population, a result of the intense urbanisation process in Russia during the 20th century (see Fig. 1). The population growth in the capital is both a marker and a driver of Moscow's socio-economic development. Regional centres like Moscow far exceed other localities in economic activity and financial resources. Characterised by higher income levels, a sophisticated social structure, and greater access to high-quality education and healthcare, these centres provide more favourable living conditions. This environment attracts migratory inflows, further fuelling population growth (Nefedova and Glezer, 2023). Enhanced economic prosperity in urban areas leads to better living standards, including improved nutrition and healthcare access. Thus, a specific set of conditions in highly urbanised environments promotes faster growth and development in children and adolescents, intensifying the secular trend in body size indicators.

Changes in Russia's epidemiological environment and their impact on the secular trend

Throughout the 20th century, Russia's epidemiological environment underwent significant changes driven by economic and social factors. These shifts, part of the epidemiological transition, reflect changes in health and disease patterns due to socio-economic, political, cultural, medical, and technological transformations (Omran, 1998; Vishnevsky, 2021). This transition is intertwined with factors affecting secular trends in body size, embedded in the historical and societal context. Political and economic crises and periods of stagnation can impede these trends, reflecting the country's overall condition (Vishnevsky, 2021).

Initial modest increases in the height of young males in Moscow at the turn of the 19th and 20th centuries were disrupted by the tumultuous events of the early 20th century, including World War I, the Civil War, political upheavals, a collapse in the healthcare system, and outbreaks of infectious diseases. These events severely worsened the epidemiological situation, leading to high mortality rates, reduced birth rates, and shorter mean heights in the cohorts born during this period (Reshetnikov *et al.*, 2019b).

In response, the Bolshevik government established a unified national healthcare system focused on universal, free medical services, with special emphasis on preventive care, social hygiene, and maternal and child health (Baranov *et al.*, 2016; Reshetnikov *et al.*, 2019b). This system benefited large cities such as Moscow and Leningrad, leading to significant health improvements in the 1920s, evidenced by decreased morbidity and mortality rates, increased life expectancy, and intergenerational growth in height (Baranov *et al.*, 2016; Reshetnikov *et al.*, 2019b).

The 1930s, marked by rapid industrialisation and collectivisation, the devastating 1932 famine, and wartime hardships, interrupted these positive trends, causing a decline in population health

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and increased disease rates (Reshetnikov *et al.*, 2019a). Data on youth body size during this period are inconclusive, with some reports of modest increases and others noting decreases in height and weight (Brainerd, 2010; Vlastovsky, 1966).

In the post-war period, followed by the relatively stable phases of the USSR's history, there was a marked improvement in the epidemiological situation. The era known as the 'Thaw', characterised by increased political openness, saw a rise in government healthcare spending (Reshetnikov *et al.*, 2019a). From the mid-1950s to the late 1980s, public health indicators improved significantly, as evidenced by an increase in life expectancy (Shkolnikov *et al.*, 2001) and a reduction in infant mortality rates to below 100 per 1,000 live births. This decline in infant mortality marked the beginning of the epidemiological transition in Russia (Vishnevsky, 2021). Correspondingly, this period also witnessed significant secular increases in the height and weight of young people in Moscow.

The mid-1980s brought political and economic transformations, leading to the Soviet Union's dissolution. This era of socio-political crisis and economic decline destabilised the social sphere, slowing the epidemiological transition and causing a public health crisis (Stuckler *et al.*, 2009; Shkolnikov *et al.*, 2013; Minagawa, 2018; Reshetnikov *et al.*, 2019b). During Perestroika, declines in health were evident, with stagnation in height trends and decreases in body weight and BMI metrics (see Fig. 3). Life expectancy dropped dramatically in the mid-1990s, while mortality rates surged, influenced by declining living standards, psychological stress, and unhealthy behaviours (Balabanova *et al.*, 2004; Shkolnikov *et al.*, 2013; Minagawa, 2018).

In contrast, the early 21st century has seen improved socio-political and economic conditions in Russia. Investments in healthcare and education have led to better living standards, a consistent rise in life expectancy, and a decrease in mortality rates, along with increases in average weight and BMI among the youth (Shkolnikov *et al.*, 2013; Minagawa, 2018).

Changes in birth rate in Russia and their impact on secular trends

The concurrent increase in body sizes of Moscow's youth and the decrease in birth rates may be linked. A reduction in the number of children per family allows for better resource allocation and care for each child, potentially contributing to improved physical development (Silventoinen, 2003; Hatton, 2014). This study did not find divergent trends in birth rates over time; instead, it identified significant positive correlations and parallel trends between changes in birth rates and body sizes (see Table 3 and Fig. 3). The fluctuations in birth rates reflect the socio-political and economic dynamics of the 20th century in Russia, impacting living standards and health outcomes (Sobotka, 2011; Kreyenfeld *et al.*, 2012; Billingsley and Duntava, 2017). These fluctuations, marked by periods of increase and decline, were influenced by socio-economic transformations, social upheavals, and pro-natalist policies. Although these fluctuations often represent transient social changes, they also overshadow broader birth rate trends (Vishnevsky *et al.*, 2017). Therefore, changes in birth rates can be seen as indicators of the general improvement or deterioration in the population's well-being. The associations identified in this study are biologically significant, suggesting that the temporal trends in somatic indicators, such as body size, are influenced by similar environmental conditions.

The results overall indicate that somatic secular trends follow similar directions for both sexes, with comparable associations between body size time series and socio-economic characteristics. However, slight sex differences were observed in the strength of correlations, particularly between the time series of anthropometric traits and socio-demographic indicators related to changes in the epidemiological environment. One possible explanation is that males may be more sensitive to environmental factors, both negative and positive, and therefore exhibit greater reactivity, responding more quickly and strongly to these influences (Stinson, 1985).

It is important to note that demographic factors such as birth rate, mortality rate, and life expectancy are closely linked to broader socio-economic and environmental conditions. Thus, the

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secular trends in body size indicators among Moscow's youth are the result of multifaceted socio-demographic transformations. These interconnected factors highlight the role of socio-economic development in shaping demographic trends and physical growth. Socio-economic improvements that reduce mortality rates and increase life expectancy also enhance children's physical development by providing better living conditions, sanitation, and nutrition.

The findings of this study demonstrate that the temporal variability of the socio-demographic factors studied has a comparable influence on the secular variation of anthropometric indicators, such as height and weight (Table 4). It is well established that different somatic traits exhibit varying degrees of heritability (Conery and Grant, 2023; Robinson *et al.*, 2017), meaning that the influence of endogenous (genetic) versus exogenous (environmental) factors on phenotypic variation differs across traits. Therefore, one might expect that traits more strongly determined by genetics would be less influenced by environmental changes, resulting in weaker correlations. However, the results of this study revealed that, over the examined period, environmental factors – rather than genetics – were the primary drivers and regulators of variation in anthropometric traits, regardless of the heritability of their variability.

Conclusion

This study demonstrates a significant relationship between demographic changes and the development of body size among Moscow's youth, highlighting the profound influence of urbanisation, socio-economic advancements, and healthcare improvements. The progression of urban development and improved living standards has nurtured healthier, better-nourished generations. Throughout the 20th century – particularly in the latter half, except for the 1990s – socio-demographic shifts led to notable increases in key body size metrics across generations, reflecting the impact of societal transformations on physical development. Additionally, the trend towards smaller family sizes likely enhanced child welfare, contributing to the observed secular growth in height and weight.

The research also underscores the pivotal role of the epidemiological transition in the 20th century, characterised by public health advancements that extended life expectancy and reduced infant mortality despite economic and political challenges. The links between mortality rates, life expectancy, and body size emphasise how the epidemiological environment shapes public health outcomes.

These findings advocate for integrating historical epidemiological insights into contemporary public health policymaking to better understand and improve the well-being of future generations.

Limitations

This study sheds light on the anthropometric development of Moscow's youth over the past century but has notable limitations. Its focus on Moscow, due to its distinct socio-economic and healthcare environment, may not allow for generalisation to the entire Russian Federation, which exhibits significant regional diversity. The reliance on historical data introduces potential variations in data quality and consistency. Moreover, internal migration to Moscow poses a risk of bias, as migrants' health and socio-economic statuses may differ from those of the native population. Additionally, the rapid socio-economic and healthcare changes in recent years might not be fully captured, suggesting a need for continued investigation into these trends. Recognising these limitations paves the way for future research, encouraging broader geographic coverage and the adoption of longitudinal designs to further unravel these complex dynamics.

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Author contribution. MN and AK conceived the idea, designed the study, collected, and analysed the data. MN supervised the study. AK performed the statistical analysis and wrote the original draft of the manuscript. MN and AM revised and edited the manuscript. The final version of the manuscript has been reviewed and approved by all authors.

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References

Akachi Y and Canning D (2015) Inferring the economic standard of living and health from cohort height: Evidence from modern populations in developing countries. *Economics and Human Biology* **19**, 114–128. doi: 10.1016/j.ehb.2015.08.005.

Atkinson K, Lowe S and Moore S (2016) Human development, occupational structure and physical inactivity among 47 low- and middle-income countries. *Preventive Medicine Reports* **3**, 40–45. doi: 10.1016/j.pmedr.2015.11.009.

Aron DI (1940) Materialy dlya ustanovleniya proporcij tela detej i podrostkov v vozraste ot 8 do 18 let [Materials for determining body proportions in children and adolescents aged from 8 to 18 years]. *Uchyonye zapiski MGU* **34**, 103–125. (In Russ.)

Balabanova D, McKee M, Pomerleau J, Rose R and Haerpfer C (2004) Health service utilization in the former Soviet Union: Evidence from eight countries. *Health Services Research* **39**(6), 1927–1950. doi: 10.1111/j.1475-6773.2004.00326.x.

Baranov A, Namazova-Baranova L, Albitskiy V, Ustinova N, Terletskaya R and Komarova O (2016) The Russian child health care system. *The Journal of Pediatrics* **177**, S148–S155. doi: 10.1016/j.jpeds.2016.04.052.

Baten J and Blum M (2014) Why are you tall while others are short? Agricultural production and other proximate determinants of global heights. *European Review of Economic History* **18**(2), 144–165. doi: 10.1093/ereh/heu003.

Billingsley S and Duntava A (2017) Putting the pieces together: 40 years of fertility trends across 19 post-socialist countries. *Post-Soviet Affairs* **33**(5), 389–410. doi: 10.1080/1060586X.2017.1293393.

Bodzsar EB, Zsakai A and Mascie-Taylor N (2016) Secular growth and maturation changes in Hungary in relation to socioeconomic and demographic changes. *Journal of Biosocial Science* **48**(2), 158–173.

Bogin B (2021) Social-Economic-Political-Emotional (SEPE) factors regulate human growth. *Human Biology and Public Health* **1**, 1–20. doi: 10.52905/hbph.v1.10.

Borrescio-Higa F, Bozzoli CG and Droller F (2019) Early life environment and adult height: The case of Chile. *Economics and Human Biology* **33**, 134–143. doi: 10.1016/j.ehb.2018.11.003.

Bozzoli C, Deaton A and Quintana-Domeque C (2009) Adult height and childhood disease. *Demography* **46**(4), 647–669. doi: 10.1353/dem.0.0079.

Brainerd E (2010) Reassessing the standard of living in the Soviet Union: An analysis using archival and anthropometric data. *The Journal of Economic History* **70**(1), 83–117.

Brodovskaya VS (1934) *Osnovnye priznaki fizicheskogo razvitiya v ix vozrastnoj dinamike* [The main signs of physical development in their age dynamics]. Moscow: Gosmedizdat. (In Russ.)

Carson SA (2020) Net nutrition, insolation, mortality, and the antebellum paradox. *Journal of Bioeconomics* **22**(2), 77–98. doi: 10.1007/s10818-020-09293-6.

Cole TJ (2003) The secular trend in human physical growth: A biological view. *Economics and Human Biology* **1**(2), 161–168. doi: 10.1016/S1570-677X(02)00033-3.

Conery M and Grant SFA (2023) Human height: A model common complex trait. *Annals of Human Biology* **50**(1), 258–266. doi: 10.1080/03014460.2023.2215546.

Crimmins EM and Finch CE (2005) Infection, inflammation, height, and longevity. *PNAS USA* **103**(2), 498–503. doi: 10.1073/pnas.0501470103.

Danubio ME and Sanna E (2008) Secular changes in human biological variables in Western countries: An updated review and synthesis. *Journal of Anthropological Sciences* **86**, 91–112.

Denisenko MB and Stepanova AV (2013) Dinamika chislennosti naseleniya Moskvy za 140 let [Population dynamics of Moscow over 140 years]. *Moscow University Economics Bulletin* (3), 88–97. (In Russ.)

Godina EZ (2011) Secular trends in some Russian populations. *Anthropologischer Anzeiger* **68**(4), 367–377. doi: 10.1127/0003-5548/2011/0156.

Godina EZ, Khomyakova IA, Zadorozhnaya LV, Purundzhan AL, Gilyarova OA, Zubareva VV, Stepanova AV and Fomina EI (2003). Moskovskie deti: osnovnye tendencii rosta i razvitiya na rubezhe stoletij. Chast I [Moscow children: Main trends of growth and development at the turn of the century. Part I]. *Voprosi Antropologii* **91**, 42–60. (In Russ.)

https://doi.org/10.1017/S0021932024000385 Published online by Cambridge University Press

Goldfeld AY, Merkova AM and Cejtlin AG (1962). *Materialy po fizicheskomu razvitiyu detej i podrostkov nekotoryx gorodov i selskix mestnostej SSSR* [Materials on the physical development of children and adolescents in some cities and rural areas of the USSR]. Moscow: Medgiz. (In Russ.)

Hatton TJ (2014) How have Europeans grown so tall? *Oxford Economic Papers* **66**(2), 349–372. doi: 10.1093/oep/gpt030.

Healthcare in Russia (2023) Statistical Yearbook. Accessed July 18, 2023. https://rosstat.gov.ru/folder/210/document/13218.

Hermanussen M, Erofeev S and Scheffler C (2022) The socio-endocrine regulation of human growth. *Acta Paediatrica* **111**(11), 2077–2081. doi: 10.1111/apa.16504.

Hruby A and Frank BH (2015) The epidemiology of obesity: A big picture. *Pharmacoeconomics* **33**(7), 673–689. doi: 10.1007/s40273-014-0243-x.

Ikeda N and Nishi N (2023) Spatiotemporal variations in mean height of 17-year-old students born in 1957–2002 across 47 Japanese prefectures: Evidence from School Health Surveys. *Economics and Human Biology* **51**, e101283. doi: 10.1016/j.ehb.2023.101283.

Kirchengast S, Juan A, Waldhoer T and Yang L (2022) An increase in the developmental tempo affects the secular trend in height in male Austrian conscripts birth cohorts 1951–2002. *American Journal of Human Biology* **35**(4), e23848. doi: 10.1002/ajhb.23848.

Kolosov VA and Nefedova TG (2014) Cities, rural areas and urbanization: Russia and the World. *Regional Research of Russia* **4**(2), 68–75. doi: 10.1134/S2079970514020099.

Komlos J and Lauderdale BE (2007) Underperformance in affluence: The remarkable relative decline in US heights in the second half of the 20th century. *Social Science Quarterly* **88**(2), 283–305. doi: 10.1111/j.1540-6237.2007.00458.x.

Kozlov AI and Vershubsky G (2015) Secular trends in average height and age at menarche of ethnic Russians and Komi-Permyaks of the Permsky Krai, Russia. *Anthropologischer Anzeiger* **72**(1), 27–42. doi: 10.1127/anthranz/2014/0427.

Kreyenfeld M, Andersson G and Pailhé A (2012) Economic uncertainty and family dynamics in Europe: Introduction. *Demographic Research* **27**, 835–852.

Kryst Ł, Kowal M, Woronkowicz A, Sobiecki JAN and Cichocka BA (2012) Secular changes in height, body weight, body mass index and pubertal development in male children and adolescents in Krakow, Poland. *Journal of biosocial science* **44**(4), 495–507. doi: 10.1017/S0021932011000721.

Kryst Ł, Żegleń M, Woronkowicz A and Kowal M (2022). Body height, weight, and body mass index–magnitude and pace of secular changes in children and adolescents from Kraków (Poland) between 1983 and 2020. *American Journal of Human Biology* **34**(9), e23779. doi: 10.1002/ajhb.23779.

Lebedeva L, Kucherova Y and Godina E (2020) Secular changes in male body height in the European Part of Russia during the 20th century. *Collegium Antropologicum* **44**(2), 63–72. doi: 10.5671/ca.44.2.1.

Leontev VY and Shevchenko LI (1966*) Fizicheskoe razvitie detej doshkolnogo i shkolnogo vozrasta g. Moskvy po dannym obsledovaniya 1964 goda* [Physical development of preschool and school-age children in Moscow according to a 1964 survey]. Ministry of Health of the RSFSR. Institute of Pediatrics and Pediatric Surgery, Moscow. (In Russ.)

Liczbińska G, Gautam RK, Bharati P and Malina RM (2023) Body size and weight status of adult Indian males born in the 1890s–1950s: Age and secular change in the context of demographic, economic, and political transformation. *American Journal of Human Biology* **35**(10), e23939. doi: 10.1002/ajhb.23939.

Luo Y, Yang F, Lei SF, Wang XL, Papasian CJ and Deng HW (2009) Differences of height and body mass index of youths in urban vs rural areas in Hunan province of China. *Annals of Human Biology* **36**(6), 750–755. doi: 10.3109/03014460903120925.

Makhrova AG, Nefedova TG and Treivish AI (2013) Moscow agglomeration and “New Moscow”: The capital city-region case of Russia’s urbanization. *Regional Research of Russia* **3**, 131–141. doi: 10.1134/S2079970513020081.

Malina RM, Little BB and Pena Reyes ME (2018) Secular trends are associated with the demographic and epidemiologic transitions in an indigenous community in Oaxaca, Southern Mexico. *American Journal of Physical Anthropology* **165**(1), 47–64. doi: 10.1002/ajpa.23326.

Martin R and Saller K (1957) *Lehrbuch der Anthropologie*. Stuttgart: Gustav Fischer Verlag.

Miklashevskaya NN, Solov‘yova VS and Godina EZ (1988) *Rostovye processy u detej i podrostkov* [Growth processes in children and adolescents]. Moscow: Moscow University Press. (In Russ.)

Minagawa YS (2018) Changing life expectancy and health expectancy among Russian adults: Results from the past 20 years. *Population Research and Policy* **37**(5), 851–869. doi: 10.1007/s11113-018-9478-0.

Minkevich MA and Gorinevskaya VV (1928) *Shtandarty antropometricheskix izmerenij i fiziologicheskix velichin dlya razlichnyx grupp naseleniya* [Standards of anthropometric measurements and physiological values for various population groups] Moscow: Publication of the Moscow Health Department. (In Russ.)

Moscow Statistical Yearbook (2023) The Economy of Moscow in 1992–2021. Accessed July 18, 2023. https://77.rosstat.gov.ru/folder/65047.

NCD Risk Factor Collaboration (NCD-RisC) (2016) A century of trends in adult human height. *Elife* **5**, e13410. doi: 10.7554/eLife.13410.

https://doi.org/10.1017/S0021932024000385 Published online by Cambridge University Press

NCD Risk Factor Collaboration (NCD-RisC) (2017) Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: A pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. *Lancet* **390**(10113), 2627–2642. doi: 10.1016/S0140-6736(17)32129-3.

Negasheva MA, Zimina SN, Khafizova AA, Sirazetdinov RE and Sineva IM (2020) Secular changes in the morphotype of the modern human (based on anthropometric data from a retrospective survey of Moscow youth). *Moscow University Biological Sciences Bulletin* **75**(1), 13–19. doi: 10.3103/S0096392520010071.

Negasheva MA, Khafizova AA and Movsesian AA (2023) Secular trends in height, weight, and body mass index in the context of economic and political transformations in Russia from 1885 to 2021. *American Journal of Human Biology* **36**(2), e23992. doi: 10.1002/ajhb.23992.

Nefedova TG and Glezer OB (2023) Transformation of Russia's sociogeographical space. *Regional Research of Russia* **13**(1), 142–168. doi: 10.1134/S2079970522700538.

Nefedova T and Treivish A (2003) Differential urbanisation in Russia. *Tijdschrift voor economische en sociale geografie* **94**(1), 75–88. doi: 10.1111/1467-9663.00238.

Omran AR (1998) The epidemiologic transition theory revisited thirty years later. *World Health Statistics Quarterly* **53**(2, 3, 4), 99–119.

Paciorek CJ, Stevens GA, Finucane MM and Ezzati M (2013) Children's height and weight in rural and urban populations in low-income and middle-income countries: A systematic analysis of population-representative data. *Lancet Global Health* **1**(5), 300–309. doi: 10.1016/S2214-109X(13)70109-8.

Perkins JM, Subramanian SV, Davey Smith G and Özaltin E (2016) Adult height, nutrition, and population health. *Nutrition Reviews* **74**(3), 149–165. doi: 10.1093/nutrit/nuv105.

Quintana-Domeque C, Bozzoli C and Bosch M (2011) Infant mortality and adult stature in Spain. *Social Science and Medicine* **72**(11), 1893–1903. doi: 10.1016/j.socscimed.2011.03.042.

Reshetnikov V, Arsentyev E, Boljevic S, Timofeyev Y and Jakovljević M (2019a) Analysis of the financing of Russian health care over the past 100 years. *International Journal of Environmental Research and Public Health* **16**(10), 1848. doi: 10.3390/ijerph16101848.

Reshetnikov VA, Ekkert NV, Capasso L, Arsentyev EV, Mikerova MS and Yakushina II (2019b) The history of public healthcare in Russia. *Medicina Historica* **3**(1), 16–24.

Rosstat (2023) The Official website of the Federal State Statistics Service for the Russian Federation. Accessed July 15, 2023. https://rosstat.gov.ru/statistic.

Robinson MR, English G, Moser G, Lloyd-Jones LR, Triplett MA, *et al.* (2017) Genotype-covariate interaction effects and the heritability of adult body mass index. *Nature Genetics* **49**(8), 1174–1181. doi: 10.1038/ng.3912.

Schmidt IM, Jørgensen MH and Michaelsen KF (1995) Height of conscripts in Europe: Is postneonatal mortality a predictor? *Annals of Human Biology* **22**(1), 57–67. doi: 10.1080/03014469500003702.

Shkolnikov V, McKee M and Leon DA (2001) Changes in life expectancy in Russia in the mid-1990s. *Lancet* **357**(9260), 917–921. doi: 10.1016/S0140-6736(00)04212-4.

Shkolnikov VM, Andreev EM, McKee M and Leon DA (2013) Components and possible determinants of the decrease in Russian mortality in 2004–2010. *Demographic Research* **28**, 917–950. doi: 10.4054/DemRes.2013.28.32.

Silventoinen K (2003) Determinants of variation in adult body height. *Journal of Biosocial Science* **35**(2), 263–285. doi: 10.1017/S0021932003002633.

Sineva IM, Permiakova EY, Khafizova AA, Iudina AM, Zimina SN and Negasheva MA (2022) Izuchenie kompleksnogo vliyaniya biosocial'ny'x faktorov na pokazateli morfofiziologicheskoj adaptacii sovremennoj molodezhi v usloviyax gorodskogo stressa [Study of the complex influence of biosocial factors on the morphophysiological adaptation of modern youth in conditions of urban stress]. *Moscow University Anthropology Bulletin* **1**, 23–40. doi: 10.32521/2074-8132.2022.1.023-040. (In Russ.)

Sobotka T (2011) Fertility in Central and Eastern Europe after 1989: Collapse and gradual Recovery. *Historical Social Research* **36**(2), 246–296. doi: 10.2307/41151282.

Solov'eva VS, Godina EZ and Miklashevskaya NN (1976) Materialy prodolnyh issledovanij moskovskix shkolnikov [Materials of longitudinal studies of Moscow schoolchildren]. *Voprosi Antropologii* **54**, 100–118. (In Russ.)

Spijker JJA, Cámara AD and Blanes A (2012) The health transition and biological living standards: Adult height and mortality in 20th-century Spain. *Economics and Human Biology* **10**(3), 276–288. doi: 10.1016/j.ehb.2011.08.001.

Steckel RH (2009) Heights and human welfare: Recent developments and new directions. *Explorations in Economic History* **46**(1), 1–23. doi: 10.1016/j.eeh.2008.12.001.

Steckel RH (2012) Social and economic effects on growth. In Cameron N and Schell L (eds) *Human Growth and Development* (2nd ed.). Academic Press, pp. 225–244. doi: 10.1016/B978-0-12-383882-7.00009-X.

Stinson S (1985) Sex differences in environmental sensitivity during growth and development. *American Journal of Physical Anthropology* **28**(S6), 123–147. doi: 10.1002/ajpa.1330280507.

Stuckler D, King L and McKee M (2009) Mass privatisation and the post-communist mortality crisis: A cross-national analysis. *Lancet* **373**(9661), 399–407. doi: 10.1016/S0140-6736(09)60005-2.

https://doi.org/10.1017/S0021932024000385 Published online by Cambridge University Press

United Databank of the Information and Analytical System for Monitoring the Integrated Development (IAS MID) of the city of Moscow (2023) Accessed July 18, 2023. https://ehd.moscow/.

Vishnevsky A (2021) The epidemiologic transition and its interpretations. *Demographic Review* **7**(5), 4–41. doi: 10.17323/demreview.v7i5.13196.

Vishnevsky A, Denisov BP and Sakevich VI (2017) The contraceptive revolution in Russia. *Demographic Review* **4**(5), 86–108. doi: 10.17323/demreview.v4i5.8570.

Vlastovsky V (1966) The secular trend in the growth and development of children and young persons in the Soviet Union. *Human Biology* **38**(3), 219–230.

Vlastovskii VG (1976) *Aktseleratsiya rosta i razvitiya detei* [Acceleration of Growth and Development in children]. Moscow: Moscow University Press. (In Russ.)

Wiśniewski R (2017) Spatial differentiation of urban population change in Russia. *Bulletin of Geography-Socio-Economic Series* **38**, 143–162.

Yampolskaya YA (2000) *Fizicheskoe razvitie shkol'nikov krupnogo megapolisa v poslednie desyatiletiya: sostoyanie, tendencii, prognoz, metodika skrining-ocenki* [Physical development of schoolchildren of a large metropolis in recent decades: state, trends, forecast, screening assessment methodology]. [Doctoral dissertation, Moscow State University, Moscow]. The Russian State Library Database. (In Russ.)

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