ACTA MEDICA LITUANICA. 2008. Vol. 15. No. 4. P. 222–228

Secular changes in height, weight and chest circumference of 4–7 year old children from Minsk in the 20th century

Tatyana Hurbo

Department of Anthropology and Ecology,
Institute of History,
National Academy of Sciences,
Republic of Belarus

Background. The growth and development of children is dependent on hereditary and environmental factors. Thus, secular trends in growth processes of children can be important indicators of changes in the country's public health and economic conditions. The purpose of our work was to analyze the dynamics of parameters of body weight, height and chest circumference in children aged 4–7 years from Minsk over the last 80 years.

Materials and methods. The present study is based on cross-sectional data of 802 children (409 boys and 393 girls) aged between 4 and 7 years from Minsk, Belarus, measured in 2001–2002. The height, weight, chest circumference were measured according to standard anthropometrical methods, BMI was calculated. The materials obtained in 2001–2002 were compared with measurements from previous studies (1923, 1950, 1972–1973, 1990–1991).

Results. Substantial growth for values of body sizes from 1923 to 2001–2002 in boys and girls in all the investigated age groups has been found. The most significant shifts in parameters of physical development in children fall to the time period between 1920 and 1970 while the period from 1980 to 2000 is characterized by smaller intensity of changes.

Conclusions. Positive secular trends occurred in 4–7 year old children from Minsk, Belarus, between 1923 and 2002, which may reflect the secular changes in socio-economic status.

Key words: anthropometry, children, secular changes

INTRODUCTION

The investigation of physical development of children and teenagers is one of the necessary elements in monitoring the population's state of health and well-being. Statural growth is dependent on hereditary and environmental factors. Thus, secular trends in growth processes of children can be important indicators of changes in the country's public health and economic conditions.

The improvement of socioeconomic conditions that took place during the 20th century resulted in a positive secular trend of body sizes in most of the world: the height, weight and other parameters of the human body have considerably increased (1–11).

At the same time there are new tendencies in the growth and development of children and adolescents in the last decades. So, there is research concerning attenuation of acceleration processes in certain cities and settlements, gracilization of constitution in children (12–14). In the developed countries adiposity becomes a universal global problem and world-wide epidemic (15–16). The factors that contribute to the health problems facing today's children include their sedentary lifestyle, irregular intake of meals (especially skipping breakfast), and the increasing daily ratio of fat to total energy intake (17–19).

The purpose of our work was to analyze the dynamics of parameters of body weight, height and chest circumference in children aged 4–7 years from Minsk over the last 80 years.

MATERIALS AND METHODS

The present study is based on cross-sectional data of 802 healthy children (409 boys and 393 girls) aged between 4 and 7 years from Minsk, Belarus, measured in 2001–2002.

All the measurements were performed before the lunch time at Minsk kindergartens. All the children had a light breakfast and did not exercise before being tested. The children were investigated according to a wide anthropometric program (32 indices were investigated). In the present study, height, weight, chest circumference and body mass index were included for analysis. The standard anthropometrical methods (20) and standard anthropometrical instruments were used. Height was measured by Martin metal anthropometer (± 0.1 cm), body mass was defined by medical electronic scales (± 0.1 kg) and chest circumference was measured by centimetric tape (± 0.1 cm). All the children were in underwear clothing and without shoes. The body mass index (BMI, kg/m^2) was calculated.

Correspondence to: Tatyana Hurbo, Akademicheskaya 1, BY-220072, Minsk, Belarus. E-mail: hurbo@mail.ru

The data obtained in 2001–2002 were compared with measurements from the previous studies (1923, 1950, 1972–1973, 1990–1991). Studies of the physical development in 4–7 year old children from Minsk begin in mid-1920s when statistical year-book of the BSSR published anthropometrical parameters in children of preschool and school age, collected by Ejngorn (21). The materials of 1930s and 1940s were not kept, only the data on the basic parameters of physical development in children of 4–7 years for 1950 are available. Since the 50s of the 20th century and down to mid-60s the children living in Minsk was surveyed by Livshits (22–25). Greater work on gathering anthropometrical material on preschoolers was done by the scientists of the Scientific Research Institute of Protection of Motherhood and Childhood: Livshits, Deryugina, Verenich and Vrublevskaya (26–30). They collected representative materials on body height and weight, chest circumference of children, and standards for basic indices of physical development were worked out every decade.

The significant contribution to studies of peculiarities of growth and development of children and adolescents in Belarus was made by scientists of the Department of Anthropology and Ecology in the Arts, Ethnography and Folklore Institute (from 2008, at the Institute of History) of the National Academy of Sciences of Belarus. In 1990–1991 they, in particular, conducted anthropometry of preschoolers from Minsk (31), dynamics of age increases for the basic parameters of physical development was tracked. The last research of physical development of 4–7 year old children from Minsk was carried out by the author in 2001–2002.

The data analysis was performed using Statistica 6.0. Standard statistical methods were used to calculate mean (M) and standard deviation (S). An unpaired, two-tailed t-test was used to assess differences between groups. Significance was set at $p < 0.05$.

RESULTS

Table 1 provides the means, standard deviations and sample sizes for basic anthropometrical parameters of the children aged 4–7 from Minsk, Belarus (2001–2002). In the age group from 4 till 7 years, the intensity of increase in size of parameters in girls was a little bit greater than that in boys. So, the height of girls between 4 and 7 years has increased by 20.97 cm, weight by 6.98 kg, chest circumference by 4.72 cm; while in boys by 19.04 cm, 6.42 kg and 4.31 cm, accordingly. Maximal increase both in boys and in girls takes place in the age interval between 6 and 7 years on all the basic parameters of physical development. The height, weight and chest circumference, the body mass index in boys of 4–7 years is greater than in girls (for height of 4 years – $p < .05$; for chest circumference of 4.6 years – $p < 0.05$, of 5 years – $p < 0.001$), with the exception of height of 6 and 7 years, which is insignificant (0.02–0.27 cm) greater in girls. The body mass index decreases to the minimal value in boys of 5 years, in girls of 6 years, and then starts to increase gradually in both groups.

Fig. 1 shows the prevalence of children classified as overweight, obese, with normal weight and thinness grades 1, 2, 3. In Minsk (2001–2002) 84.6% boys and 78.1% girls have normal weight. Overweight is noted in 7.5% boys and 11.0% girls, adiposity – in 2.0% children of both sexes (32); thinness grades 1 occurred in 4.7% boys and 6.6% girls, grades 2 and 3 – in 1.2% and 2.3% accordingly (33).

Table 1. **Basic anthropometric parameters in 4–7 year old children from Minsk, Belarus (2001–2002)**

Age, years	Boys			Girls		
	N	M	S	N	M	S
Height (cm)						
4	81	104.19	5.27	78	102.53	4.68
5	113	110.54	4.49	99	109.64	4.60
6	113	115.87	4.63	102	115.89	5.38
7	102	123.23	5.50	114	123.50	5.35
Weight (kg)						
4	81	17.90	2.76	78	17.07	2.80
5	113	19.46	2.58	99	19.06	2.44
6	113	21.42	2.82	102	21.14	3.22
7	102	24.32	3.22	114	24.05	3.53
Chest circumference (cm)						
4	81	55.62	2.99	78	54.52	3.14
5	113	57.06	2.55	99	55.74	2.63
6	113	58.10	2.94	101	57.13	3.15
7	102	59.93	2.76	114	59.24	3.08
BMI (kg/m²)						
4	81	16.42	1.35	78	16.17	1.85
5	113	15.89	1.51	99	15.83	1.52
6	113	15.90	1.40	102	15.67	1.48
7	102	15.97	1.39	114	15.71	1.63

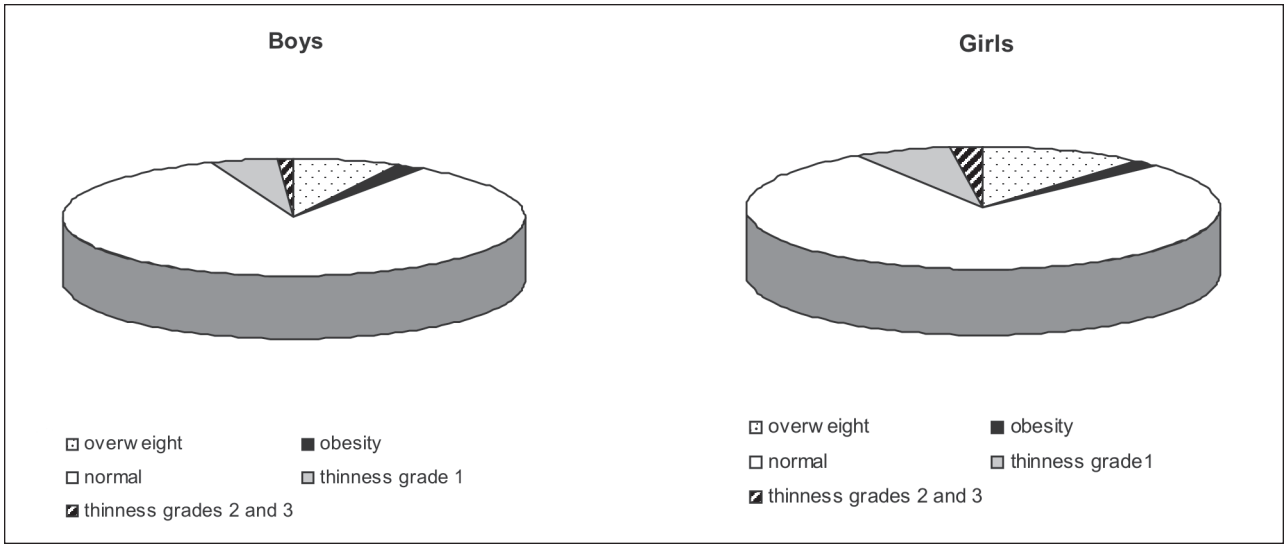


Fig. 1. Distribution of overweight, normal weight and thinness in children aged 4–7 years from Minsk, Belarus (2001–2002)

The dynamics of the basic parameters of physical development of 4–7 year old Minsk children from 1923 to 2001–2002 period was investigated.

Substantial growth for values of body sizes from 1923 to 2001–2002 in boys and girls in all age groups was found. So, the body height of modern boys of 5–7 years is greater by 12.7–15.1 cm, of girls – by 11.1–14.4 cm, while the body weight – by 2.6–3.5 kg and 1.7–2.9 kg, chest circumference – by 0.1–3.2 cm and 0.3–0.8 cm accordingly. In modern girls of 6 years, the chest circumference is less by 0.2 cm, than in girls surveyed in 1923.

The data of 1930s on physical development of Belarusian children are not available. During 1940s the territory of the Republic was the arena of military actions, invasion and post-war ruin, which made a significant impact on the physical development of children surveyed in the 1950s as well.

The time interval from 1923 to 1950 is characterized by gracilization of the children's constitution: while the body height increased noticeably, the weight and chest circumference changed slightly. So, the height of boys increased by 6.6–9.4 cm, that of girls – by 5.2–7.3 cm, weight – by 0.7–1.1 kg and by 0.4–0.6 kg accordingly (in 6 year old girls weight decreased by 0.2 kg). The chest circumference in girls of 5–7 years decreased by 0.5–1.6 cm, while in boys of 5 years increased by 1.4 cm, in 6-year-olds remained constant, and in 7 year-olds decreased by 0.5 cm. In view of the fact that in data of 1920s not all the statistical parameters (only the mean parameters and sample sizes are given in tables) are available, we cannot precisely calculate the level of significance of the distinctions received. It is also necessary to note a small number of the children surveyed in 1923: there are only individual data on children of 4 years old and small groups of children aged 5–7 whose number does not exceed 20 persons. Therefore, it is necessary to consider these restrictions and to be cautious in conclusions by consideration of all anthropometric parameters of children in 1923.

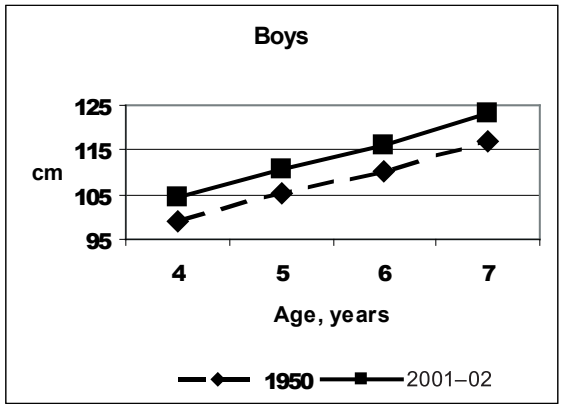
Comparison of the materials of 2001–2002 to data for 1950 has shown that from 1950 to 2001–2002 the height of boys of 4–7 years has increased by 5.1–6.1 cm, of girls by 4.4–7.1 cm, weight by 1.5–2.8 and 1.3–2.5 kg accordingly. The maximal distinctions on parameters are observed at the age of 7 years. Chest circumference has increased less significantly, only by 0.4–1.9 in boys and by 1.3–1.9 cm in girls (Fig. 2).

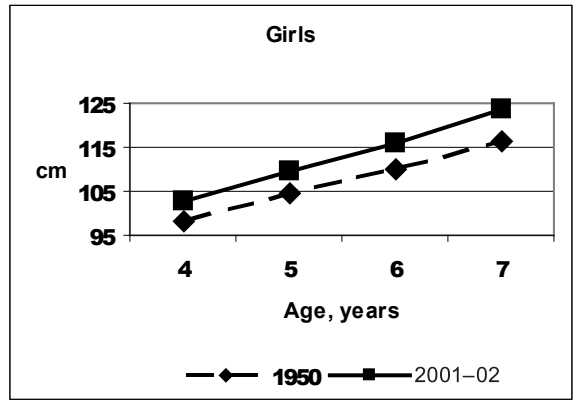
The time interval from 1950 to mid-1970s is characterized by gradual increase in all the basic anthropometrical indices. The comparison of the basic parameters of physical development of children investigated in 1950 and 1972–1973 reflects a significant ($p < 0.001$) increase for this period of height, weight and chest circumference irrespective of sex in all age groups. Only in 4-year-old girls the level of significance of distinction in parameters for chest circumference is a little bit less ($p < 0.05$), and in boys of the same age, the distinction does not reach the statistical level. Increase has occurred in the following parameters: boys' height by 5.1–6.2 cm, girls' – by 5.4–6.7 cm; boys' weight by 1.3–3.7 kg, girls' – by 1.5–2.9 kg; boys' chest circumference by 0.6–2.1 cm, girls' – by 0.7–2.0 cm. Minimal increase in all the three indices of physical development was observed in the 4 years group, the maximal one, in the 7 years group, except for the height of girls, the greatest increase of which take place in the group of 6 years for the period from 50s to 70s of the 20th century. These sexual distinctions are caused naturally by earlier beginning of the first acceleration of growth in girls.

Substantial growth of anthropometrical parameters between 1950 and 1972–1973 was explained by many factors. Growth of the general well-being of the population that has been caused by the improvement of quality of food, sanitary and hygienic conditions in kindergartens and schools, and also the general microclimate in which the child grew (without great stresses) has had a great influence on the physical development. The dynamics noted is the reflection of the process of the acceleration observed during this period in many countries of the world.

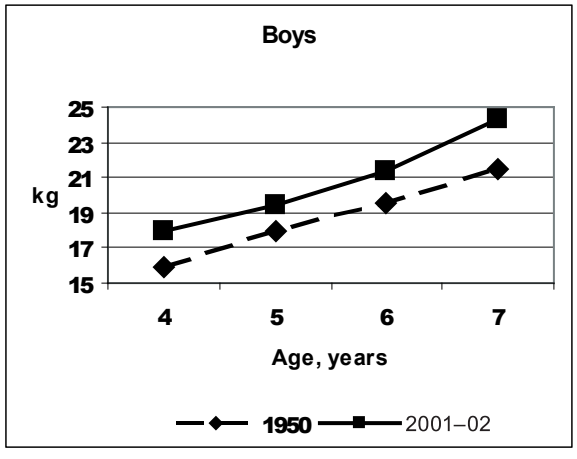
Unfortunately, there are no data about the physical development of preschool children in 1980s that permit to characterize

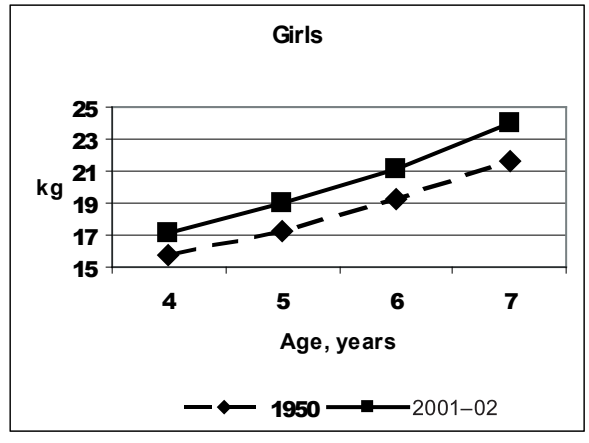
Height



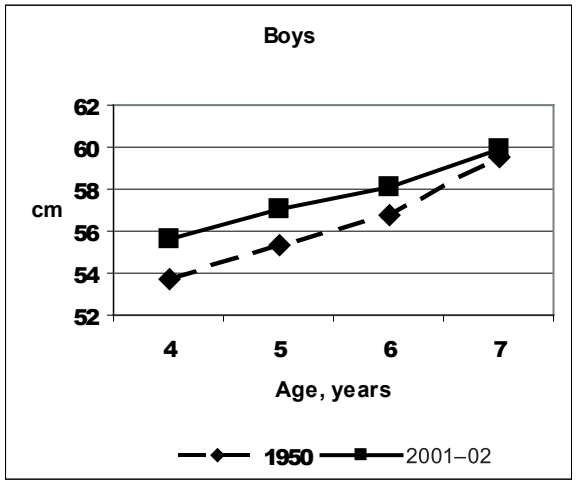


Weight





Chest circumference



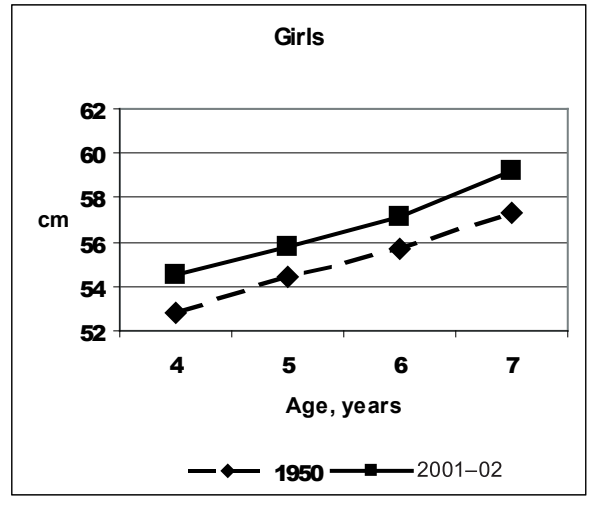


Fig. 2. Variability in time of the basic anthropometric parameters in children of 4–7 years from Minsk, Belarus (1950 – 2001–2002)

the dynamics of growth processes during this period in greater detail. The comparison of data 1972–1973 and 1990–1991 shows a significant deterioration of basic parameters: boys' height by 1.0–1.7 cm, girls' by 0.4–1.2 cm (in 4 year old boys – $p < 0.02$), and also boys' weight by 0.2–1.5 kg, girls' by 0.2–1.3 kg (in 5 and 7 year old girls – $p < 0.02$, in 7 year old boys – $p < 0.05$). Only at the age of 6 years in children of both sexes the height increased by 0.4–1.1 cm, and 6 year old boys' weight by 0.3 kg, also increased slightly. The chest circumference during this period increased, and the increase in boys of 4, 6 years is statistically significant. Exception was made to 7 year old boys and 5 year old girls, in whom a reduction of the given parameter is marked.

The specified situation has reflected, firstly, a stabilization (and in some cases retardation) of growth processes in children and adolescents of the Republic, secondly, deterioration of the economic and ecological conditions which developed as a result of the Chernobyl disaster, and the reorganizations of the political and economic life in the Republic. The Republic of Belarus has undergone rapid political, social and economic transformation since the late 1980s. The combined influence of these factors has undoubtedly impacted first of all the variability of such indices as body weight and height. The chest circumference was impacted to a smaller extent as a parameter more inert and more slowly changing under environmental pressure.

Next stage included periods from 1990–1991 to 2001–2002. As a whole our data for Minsk in 2001–2002 have shown different vectors of changes in time as height, and weight of children of 4–7 years in comparison with similar parameters in 1990–1991. In a number of age and sex groups there was an increase in indices, while in others – reduction (Table 2). The chest circumference has changed direction and began to decrease, except for the children of 4 years of both sexes and girls of 5 years, in whom some increase was observed.

The analysis of intersexual distinctions has shown that in Minsk girls of 4–7 years during the period researched the chest circumference is less than in boys by 0.7–2.3 cm (except for children of 1923 when in boys of 5 and 6 years the given parameter was less than in girls). Height and weight in this time interval in boys and girls differ slightly.

DISCUSSION

When the BSSR (January 01, 1919) was established, Minsk became the capital of the Republic, and gradually the city quickly became a large industrial, administrative, scientific and cultural centre. In the capital, a little bit better, than in the province, sanitary and hygienic actions developed, and there was an increase in the living standard of the population. These circumstances also explain the fact that in Belarus Minsk is a unique place where monitoring of physical development of the children's population on a regular basis was conducted. On the basis of the results of regular monitoring we can draw conclusions about secular trends in the 20th century.

Less than over the last 100 years, the population of Minsk has increased considerably. In 1913 the population was 106.7 thousand, in 1933 – 180.8, in 1950 – 273.6, in 1959 – 509.5, in 1970 – 916.6, in 1980 – 1308.6, in 1999 – more than 1700.0. Now Minsk is the capital of the Republic of Belarus, a city with the greatest density and quantity of the population in the country, where the high level of industry development causes significant pollution of the environment. The environment of the big city significantly influences the growth and physical condition of the population living in it. According to our data, the physical development of modern children aged 4–7 years from Minsk has its own peculiarities (34), although eventually and with better development of the social infrastructure in small towns and in countryside the distinctions in parameters decrease (1). Belarusian society has changed dramatically from a largely agricultural society at the beginning of the 20th century to a largely urban one in the second half of the century.

Thus, the dynamics of the basic parameters of physical development of 4–7 year old Minsk children from the period 1923 to 2001–2002 was investigated. The time interval from 1923 to 1950 is characterized by gracilization of the children's constitution: while the body height increased noticeably, the weight and chest circumference changed slightly. From 1950 to 1972–1973 the intensive acceleration, shown in essential increase in anthropometrical parameters owing to the improvement of quality and conditions of the population life, is marked. From 1972–1973 to 1990–1991 deceleration of parameters of body mass and length is observed, while values of chest circumfer-

Table 2. **Change of the body total sizes from 1990–1991 to 2001–2002**

Indices	Age, years			
	4	5	6	7
		Boys		
Height, cm	+1.66*	+0.59	–1.53*	+1.17
Weight, kg	+0.89*	–0.10	–0.79	+0.59
Chest circumference, cm	+0.57	–0.14	–1.53***	–0.73
		Girls		
Height, cm	–0.60	+0.80	–1.21	+2.55**
Weight, kg	0.07	+0.31	–0.26	+0.87
Chest circumference, cm	+0.49	+0.29	–0.31	–0.23

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

ence continued to increase. The time interval from 1990–1991 to 2001–2002 is characterized by stabilization in the basic parameters of physical development: insignificant changes of body weight and height are noted, while chest circumference changed direction and began to decrease.

The most significant shifts in parameters of the total body sizes of children fall to the time period from 1920 to 1970 while the period from 1980 to 2000 is characterized by smaller intensity of changes. Such tendency is characteristic of many countries of the world (35–39).

CONCLUSIONS

Positive secular trends occurred in 4–7 year old children from Minsk, Belarus during 1923–2002. These secular increases can be explained by improvements in social and health indicators that reflect the overall health status of the population.

As regular supervision over the anthropological status of children and adolescents was conducted for less than 100 years in most countries the question on trends of long-term variability of the basic parameters of physical development remains open.

Received 10 November 2008
Accepted 28 November 2008

References

1. Papadimitriou A, Chiotis D, Tsiftis G, Hatzisimeon M, Maniati M, Krikos X, Tzonou A, Dacou-Voutetakis C. Secular growth changes in the Hellenic population in the twentieth century. Hormones (Athens) 2002; 1(4): 245–50.
2. Toselli S, Ventrella AR, Franzaroli G, Brasili P. Growth and secular trend in school-children from Cento, Ferrara, Italy. Coll Antropol 2006; 30(1): 65–74.
3. Vignerová J, Brabec M, Bláha P. Two centuries of growth among Czech children and youth. Econ Hum Biol 2006; 4(2): 237–52.
4. Zhen-Wang B, Cheng-Ye J. Secular growth changes in body height and weight in children and adolescents in Shandong, China between 1939 and 2000. Ann Hum Biol 2005; 32(5): 650–65.
5. Simsek F, Ulukol B, Gulnar SB. The secular trends in height and weight of Turkish school children during 1993-2003. Child Care Health Dev 2005; 31(4): 441–7.
6. Tutkuviene J. Sex and gender differences in secular trend of body size and frame indices of Lithuanians. Anthropol Anz 2005; 63(1): 29–44.
7. Malina RM, Peña Reyes ME, Tan SK, Buschang PH, Little BB, Koziel S. Secular change in height, sitting height and leg length in rural Oaxaca, southern Mexico: 1968–2000. Ann Hum Biol 2004; 31(6): 615–33.
8. Stolarczyk H, Malinowski A. Secular changes of body height and mass in the children and adolescents of Lódź. Z Morphol Anthropol 1996; 81(2): 167–77.
9. Prebeg Z. Changes in growth patterns in Zagreb school children related to socio-economic background over the period 1973–1991. Ann Hum Biol 1998; 25(5): 425–39.
10. Hoppa RD, Garlie TN. Secular changes in the growth of Toronto children during the last century. Ann Hum Biol 1998; 25(6): 553–61.
11. Danker-Hopfe H, Roczen K. Secular trends in height, weight and body mass index of 6-year-old children in Bremerhaven. Ann Hum Biol 2000; 27(3): 263–70.
12. Palczewska I, Niedźwiecka Z, Szilágyi-Pagowska I, Pawlik K. Secular growth trends in children and youth of Warsaw in the last twenty years. Med Wieku Rozwoj 2000; 4(2): 161–76. (In Polish)
13. Саливон И И. Изменение во времени характера распределения типов телосложения и их структурных особенностей у мальчиков. In Экологические проблемы природно-технических комплексов. Полоцк; 2004; 2: 141–4.
14. Година Е. З. Динамика процессов роста и развития у человека: пространственно-временные аспекты: Автореф. дис. … д-ра биол. наук. Москва; 2001.
15. WHO: Obesity: Preventing and managing the global epidemic. Report of a WHO Consultation, Geneva, Switzerland (WHO Technical Report Series, 894); 2000.
16. Loesch DZ, Stokes K, Huggins RM. Secular trend in body height and weight of Australian children and adolescents. Am J Phys Anthropol 2000; 111(4): 545–56.
17. Murata M. Secular trends in growth and changes in eating patterns of Japanese children. Am J Clin Nutr 2000; 72(Suppl 5): 1379S–83S.
18. Júlíusson P, Roelants M, Eide G, Hauspie R, Waaler P, Bjerknes R. Overweight and obesity in Norwegian children: Secular trends in weight-for-height and skinfolds. Acta Paediatr 2007; 96(9): 1333–7.
19. Eisenmann JC, Katzmarzyk PT, Arnall DA, Kanuho V, Interpreter C, Malina RM. Growth and overweight of Navajo youth: secular changes from 1955 to 1997. Int J Obes Relat Metab Disord 2000; 24(2): 211–8.
20. Martin S, Saller K. Lehrbruch der Antropologie I. Stuttgart: Fischer Verlag; 1957.
21. Эйнгорн ДЛ. Статистический ежегодник, 1923–1924. Минск; 1925: 62–9.
22. Лившиц РМ. К вопросу о физическом развитии детей дошкольного и школьного возраста. In В помощь педиатру и акушеру-гинекологу. Минск; 1953: 174–84.
23. Лившиц РМ, Красник ЛП. О физическом развитии детей дошкольного возраста. Здравоохранение Белоруссии 1957; 3: 35–6.
24. Лившиц РМ. Физическое развитие детей дошкольного возраста в городе Минске в 1963–1964 гг. In Науч.-исслед. ин-т охраны материнства и детства: Материалы науч. сессии. Минск; 1965: 29–30.
25. Лившиц РМ. Физическое развитие детей дошкольного и школьного возраста в Минске (1963–1964 гг.) In Гигиена воспитания и обучения детей и подростков. Минск; 1965: 13–6.
26. Дерюгина МП, Веренич ГИ, Врублевская МВ. Физическое развитие и заболеваемость детей в возрасте от 1 года до 7 лет, посещающих детские дошкольные учреждения города Минска. In Материалы 3-го респ. съезда дет. врачей Белоруссии. Минск; 1975: 250–2.

27. Материалы по физическому развитию детей и подростков некоторых городов и сельских местностей СССР. Ленинград; 1965.
28. Методика оценки физического развития детей. Минск; 1959.
29. Таблицы оценки физического развития детей. Минск, 1965.
30. Таблицы оценки физического развития детей: Метод. рекомендации. Минск; 1975.
31. Полина Н И., Иванова В И., Сикорский А В. Физическое развитие часто и длительно болеющих дошкольников. Здравоохранение Белоруссии 1992; 2: 47–51.
32. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity: international survey. BMJ 2000; 320: 1240–3.
33. Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. BMJ 2007; 335: 194.
34. Гурбо ТЛ. Закономерности изменчивости физического развития детей Беларуси в период первого детства (с 4 до 7 лет). Автореф. дисс. ... канд. биол. наук., 2005.
35. Vignerová J, Humeníkova L, Brabec M, Riedlová J, Bláha P. Long-term changes in body weight, BMI, and adiposity rebound among children and adolescents in the Czech Republic. Econ Hum Biol 2007; 3 : 409–25.
36. Zellner K, Jaeger U, Kromeyer-Hauschild K. Height, weight and BMI of schoolchildren in Jena, Germany – are the secular changes levelling off? Econ Hum Biol 2004; 2(2): 281–94.
37. Smith SA, Norris BJ. Changes in the body size of UK and US children over the past three decades. Ergonomics 2004; 47(11): 1195–207.
38. Krawczynski M, Walkowiak J, Krzyzaniak A. Secular chan-ges in body height and weight in children and adolescents in Poznan, Poland, between 1880 and 2000. Acta Paediatr 2003; 92(3): 277–82.
39. Li H, Leung SS, Lam PK, Zhang X, Chen XX, Wang SL. Height and weight percentile curves of Beijing children and adolescents 0–18 years, 1995. Ann Hum Biol 1999; 26(5): 457–71.