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Dynamics of Distribution of the Body Mass Index of Schoolchildren in the Republic of Belarus

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ABSTRACT

In the early 1980s, (before the Chernobyl nuclear power plant accident), in the 1990s and 2000s, 8-year-old children, 13-year-old and 17-year-old teenagers were studied in cities of the Republic of Belarus as a part of anthropometric programme. The character of distribution of the variants of body mass index (BMI) among the groups studied has been analyzed. Changes of the specific mass of individuals with deficiency of weight and overweight over time were revealed. Gender differences in the chronological dynamics of the morphological status formation of the children of the Republic of Belarus were shown.

Key words: *schoolchildren, body mass index, body weight deficit, overweight, Republic of Belarus.*

Introduction

For the XX century, full of multiple socio-economic and political upheavals, the appearance of a secular trend, i.e. wavy changes of morphological and functional indicators in a series of generations over time among the population is naturally. In different countries in different decades this process manifested itself in different ways depending on the specific historical situation [4, 7]. However, in general, in most socially and economically developed countries, the vector of changes in the biological status of people was directed toward acceleration, i. e. accelerating the morphological development and puberty of the child's organism, increasing the reproductive period in women, slowing the aging process and increasing life expectancy.

Among the environmental factors affecting the formation of a child's body and the achievement of definitive body size, socio-economic conditions play a decisive role in a state. In this view, favorable living conditions contribute to the optimal implementation of the hereditary development programme [6, 8, 15]. At the same time as a result of accelerated rates of development, people reach larger body sizes, they have earlier sexual maturation. Unfavorable living conditions (wars, economic crises, epidemics, etc.) retard the development of the organism, adversely affect the indicators of the physical development of the population.

The last decades of the twentieth century in the Republic of Belarus had some socio-economic and environmental characteristics. Until 1986 (Chernobyl accident), these two indicators were characterized by relative well-being and stability, which contributed to the harmonious formation of a child's body. Then, the Chernobyl disaster created an increased radiation background in many settlements of the republic, which was already in the late 1980s and early 1990s. Adversely affected the formation of a number of morphophysiological indicators of the physical development of children, its hormonal and immune status, reflected in the level and structure of morbidity[5]. Unfavorable for the developing organism also was the information pressure intensified in the education system by the beginning of 2000s, as a result of which the free time and the amount of physical exertion in schoolchildren were sharply reduced.

One of the important indicators reflecting the level of socio-economic and ecological well-being of a state is the frequency of the cases of extreme variants of BMI among the population that characterize the deficiency of weight or overweight. BMI, according to auxiliologists, is universal and nowadays is widely used in anthropological studies of BMI, not being an accurate reflection of the amount of fat in the body, characterizes the proportionality of the ratio of body weight and its length[1-3, 12-14, 16, 17].

Material and Methods

In the early 1980s, (before the Chernobyl nuclear power plant accident), in the 1990s and 2000s, 8-year-old chil-

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TABLE 1.
THE TOTAL NUMBER OF STUDIED SCHOOLCHILDREN OF THE REPUBLIC OF BELARUS FOR DIFFERENT PERIODS

Age	Boys	Girls
1980s		
8 years	211	204
13 years	215	207
17 years	206	203
1990s		
8 years	172	183
13 years	184	182
17 years	173	165
2000s		
8 years	327	190
13 years	471	498
17 years	188	229

dren, 13-year-old and 17-year-old teenagers were studied in cities of the Republic of Belarus as a part of anthropometric programme. In such a case it was recognized that the morphological status of these groups at the time of the study was formed during puberty due to two growth spurts associated with the increased energy expenditure of the organism. BMI was determined by formula: body weight (kg) / body length (m^2). (Table 1)

The total number of studied groups in the 1980s amounted to 1,246 (632 boys and 614 girls), in 1990s – 1,059 (529 boys and 530 girls), in 2000s – 1,903 (986 boys and 917 girls). The quantitative saturation of the sex and age groups is presented in Table 1.

The basis for the evaluation of individual BMI indicators for children of Belarus was international standards (Table 2), established in 2000 [10] and 2007 by WHO [11]. (Table 2)

In chronologically different groups taking into account gender, the proportion (in percent) of individuals classified according to BMI as an extreme variant was determined: with insufficient body weight of degree 1 and its deficiency, degrees 2 and 3, and also with overweight and obesity.

Results

The analysis of the factual information was based on the distribution of extreme BMI variants presented in Tables 3 and 4. In connection with the small number of groups with a body mass deficit, degrees 2 and 3 were combined into one group (Table 3).

When comparing the frequency of occurrence of cases with body weight deficiency in chronologically different samples, the fact of increasing the share of this indicator since 1990s is obvious, and the lowest percentage was recorded in sex and age groups studied in the 1980s.

The earlier maturation of girls and the pubertal period associated with the acceleration of growth processes in the 1980s was already characterized by a sharp increase in the proportion of 13-year-old girls in the proportion of cases with a lack of body weight of degree 1 (12.6%) as a result of asthenization of their physique.

In the 1990s, the incidence of such cases in all age groups of girls increased from 4.8 to 7.8%. Among boys at the age of 13 years, the process of asthenia is more pronounced: lack of body weight – 15.8%, and at 17 years – 14.7%, that is, several times higher than in the 1980s (against 1.9 and 3.4% respectively).

By the early 2000s the percentage of body weight deficiency in boys with degree 1 at the age of 8 years (12.1%) and 13 years (20.3%) increased significantly, as well as

TABLE 2
INTERNATIONAL STANDARDS OF BMI INDICATORS IN CHILDREN ESTABLISHED IN 2000S BY WHO

BMI indicators	Boys	Girls
8 years		
Deficiency of body mass of degree I	less than 14,15	less than 14,02
Deficiency of body mass of degrees II and III	less than 13,11 и 12,42	less than 13,00 и 12,31
Over weight	more than 18,44	more than 18,35
Obesity	more than 21,60	more than 21,57
13 years		
Deficiency of body mass of degree I	less than 15,84	less than 16,26
Deficiency of body mass of degrees II and III	less than 14,48 и 13,59	less than 14,85 и 13,92
Over weight	more than 21,91	more than 22,58
Obesity	more than 26,84	more than 27,76
17 years		
Deficiency of body mass of degree I	less than 18,05	less than 18,25
Deficiency of body mass of degrees II and III	less than 16,58 и 15,60	less than 16,77 и 15,78
Over weight	more than 24,46	more than 24,70
Obesity	more than 29,41	more than 29,69

TABLE 3
SEX AND AGE VARIABILITY IN THE FREQUENCY OF OCCURRENCE (%) OF OVERWEIGHT IN SCHOOLCHILDREN OF THE REPUBLIC OF BELARUS ON THE BASIS OF THE BMI ESTIMATE IN ACCORDANCE WITH INTERNATIONAL WHO STANDARDS

Age	The value below which the lack of body weight is determined			
	degrees 2+3	degree 1	degrees 2+3	degree 1
	boys		girls	
1980s				
8 years	1,0	6,2	0,5	0
13 years	0,9	1,9	3,4	12,6
17 years	0	3,4	0,5	2,5
1990s				
8 years	0	1,0	1,3	6,4
13 years	3,2	15,8	4,5	7,8
17 years	2,1	14,7	0,5	4,8
2000s				
8 years	1,7	12,1	0,7	3,5
13 years	0,9	20,3	6,7	20,3
17 years	0	9,1	1,2	5,5

among 13-year-old girls (as in boys – up to 20.3%), but in comparison with the 1990s the proportion of such cases was significantly reduced by 17 years – up to 9.1% among boys and up to 5.5% among girls.

The total cases of body weight deficit of degrees 2 + 3 throughout the study period are quite rare (vary about 1%) in all sex and age groups. However, their share in 13 years is slightly increased among boys in the 1990s – up to 3,2%, and among girls gradually increases towards the beginning of the 2000s: in the 1980s – up to 3.4%, in the 1990s – up to 4,5%, in the 2000s – up to 6.7%.

Thus, among adolescents of both sexes, studied in different decades, we can more often observe a deficit of body mass associated with the acceleration of the development of adolescents due to increased energy costs in the prepubertal and puberty periods. An increase in the percentage of individual among 13-year-olds in Belarus with deficiency of weight with the course of time is evidence of an increase in the tension of the mechanisms of adaptation of the developing organism during critical periods in the ascending stage of ontogeny. A more pronounced sensitivity of the male organism to significant energy expenditure was also revealed during the acceleration of the growth process, which begins later than in girls. In the 2000s, a lack of body weight of degree 1 among 13-year-old children of both sexes is found already in every fifth schoolchild, which indicates the state of stress during the period of hormonal adjustment from the body. However, due to the inclusion of compensatory mechanisms, by the age of 17 the proportion of such cases has decreased noticeably among girls and, to a lesser extent, among young men.

Dynamics over time of the percentage of individuals with increased body weight and obesity is also of interest in connection with possible disruptions in metabolism, due to the increase in hypodynamia in schoolchildren with intense intellectual stress (intellectual stress) and prolonged work on the computer. Most researchers also believe that the change in BMI toward an increase in its values is associated with unhealthy eating habits [9], with a decrease in physical activity of school children and with a reaction to stressful situations.

Table 4 presents the age and sex distribution of BMI variants that reflect body overweight and obesity.

TABLE 4
AGE AND SEX VARIABILITY OF THE FREQUENCY OF OCCURRENCE (%) OF OVERWEIGHT AND OBESITY AMONG SCHOOLCHILDREN OF THE REPUBLIC OF BELARUS ON THE BASIS OF THE BMI ESTIMATE IN ACCORDANCE WITH INTERNATIONAL WHO STANDARDS

Age	Body overweight		Obesity	
	boys	girls	boys	girls
1980s				
8 years	7,6	11,3	1,0	2,0
13 years	8,4	2,4	0	1,9
17 years	7,3	14,9	1,5	0,5
1990s				
8 years	14,6	7,7	0	0
13 years	3,8	4,9	0	0,5
17 years	5,7	5,9	0	0
2000s				
8 years	14,4	10,5	2,8	3,2
13 years	9,6	10,4	1,3	1,4
17 years	13,0	5,4	1,1	0,9

According to the nature of the distribution of individuals with fat metabolism disorders, more successful situation was observed in boys in the 1980s and in the 1990s, with the exception of an increased percentage of children with an overweight at the age of 8 years (14.6% in the 1990s against 7.6% % in the 1980s). However, obesity, noted among boys at the age of 8 in the 1980s only in 1% of cases and in 17-year-olds – in 1.5%, in the sample of the 1990s wasn't observed at all. Among the girls, the distribution was somewhat different, namely, in the 1980s there was an increase in the incidence of cases with body overweight at the age of 8 (11.3%) and at the age of 17 years (14.9%), and in the 1990s body weight decreases markedly (7.7% and 5.9%, respectively). That is, there is a move towards asthenization of the girls' body. In the 1980s the cases of obesity among girls ranged from 2.0% at 8 to 0.5% at 17, then in the 1990s, no one case was noted.

By the 2000s the picture has changed significantly. With the preserved frequency of occurrences of overweight cases among 8-year-olds (14.6% and 14.4%, respectively) since the 1990s, the proportion of this symptom is more than doubled among males at the age of 13 (9.6% against 3.8%) and at the age of 17 (13% against 5.7%). Cases of

obesity among boys occur at the age of 8 in 2.8% of cases, at the age of 13 – in 1.3%, and at the age of 17 – in 1.1%.

In the 1980s and 1990s, there were frequent cases with body overweight among girls at the age of 8, and in 2000 – among boys. At the age of 13, the frequency of this indicator prevailed among boys in the 1980s, and in the 1990s and 2000s, there is a slight predominance of frequencies among girls compared with boys. In this case, the proportion of cases with body overweight in the samples of both sexes in 2000 is higher. The cases of body overweight are more frequent among girls at the age of 17 in the 1980s, but in the 1990s the percentage of this cases decreased significantly and we can observe the same situation for both sexes. In the 2000s the frequency of such cases increases noticeable and begins to dominate among young men in comparison with girls for whom it remains at the level of the 1990s. Perhaps the pressure of a complex of negative environmental factors, intensified at the beginning of the XXI century in a number of cases leads to an increase in the estrogen-testosterone index, which provokes an increase in body fat in the male body.

Conclusions

Analysis of changes of the distribution of body mass index variants over time, which help to determine deficiency or overweight of body and obesity, guided by the WHO international standards established in 2000 and 2007, revealed a number of patterns.

Among the urban schoolchildren of Belarus at the age of 8, 13 and 17 studied in the early 1980s, (before the accident at the Chernobyl nuclear power plant), in the beginning of the 1990s and 2000s, childhood appeared to be the most vulnerable to unfavorable life support factors in accordance with the general laws of body development. This period is characterized by the most intensive process of growth of various organs and tissues associated with high energy costs. In our material, this period is represented by 13-year-old boys, whose development acceleration has just begun, and 13-year-old girls, in whom this process is close to completion. According to our data, regardless of the year of study, during this period of ontogeny, the frequency of cases of body mass deficiency increases, especially among girls. The more complex the conditions of life, the more often there are low indices of the body mass index, which is reflected in our samples. By the beginning of the 2000s regardless of gender almost every fifth teenager has a deficiency of body weight.

A significant increase in the proportion of boys and girls with overweight, about a half to two times, in the sample at the beginning of the 2000s, in comparison with the 1990s, also indicates a higher metabolic rate. If in the 1990s in the total sample of boys of all ages, there was not a single case of obesity, and only in girls at the age of 13 years 0.5% of cases of obesity were registered, then in the 2000s we can observe about 2% of cases. More expressed disorders of fat metabolism in boys and young men are due to the greater sensitivity of the male organism to the effect of a complex of unfavorable factors, in particular, to a combination of hypodynamia with excessive energy of nutrition and possibly indicates changes in the hormonal status of the male body.

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DINAMIKA INDEKSA TJELESNE MASE KOD DJECE I MLADEŽI REPUBLIKE BJELORUSIJE

S A Ž E T A K

Početkom 1980-ih (prije nesreće u Černobilu nuklearne elektrane), a zatim u 1990. i 2000. godini za 8-godišnjaka, 13-godišnjaka i 17-godišnjaka mladih antropometrijskog programa u Republici Belarus gradova studirao. Priroda distribucije indeksa tjelesne mase opcija među ispitivanim skupinama. Promjene u udjelu vremena osoba s nedostatkom i prekomjerne tjelesne težine. Prikazani spolne razlike u vremenskom dinamikom formiranja morfološke statusu dječje populacije Republike Bjelorusije.