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RESEARCH ARTICLE

The Development of Toddlers in Russia: Needs and Trends

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Abstract

The level of physical development of children reflects their health status. The goal is to evaluate the anthropometric indicators of toddlers aged 1-3 in Moscow as a sample model of Russia and to identify gender and age differences. The studies were conducted in 2017-2019 in Moscow (Russian Federation). On the basis of 10 pediatric clinics, 3000 children were selected, of which 1650 boys and 1350 girls of toddler age, 1-3 years old. 4 anthropometric parameters were regularly measured (body length, body weight, circumference of the chest and head). Significant differences in all anthropometric parameters were found to be large for boys compared to girls. In boys, there was a 9.0 cm difference in body length between 2 and 1 years ($p \leq 0.001$), and 10.0 cm between 3 and 2 years ($p \leq 0.001$). In girls, the results were identical ($p \leq 0.001$). Boys aged 2 were 2.6 kg heavier than one-year-olds ($p \leq 0.001$), and at the age of three they were 1.8 kg heavier than two-year-olds ($p \leq 0.001$). Girls aged 2 had body weight 2 kg more than one-year-olds ($p \leq 0.001$), and 3-years-olds were 1.3 kg ($p \leq 0.01$) heavier compared with two-years-olds. The chest circumference in boys aged 2 is 2.5 cm larger than in one-year-olds, and 1.5 cm ($p \leq 0.001$) smaller than in toddlers aged 3. In girls the differences were 2.5 cm and 1.2 cm, respectively ($p \leq 0.01$). The head circumference for boys aged 2 was 2 cm more than the parameters of one-year-olds ($p \leq 0.001$), and for boys aged 3 - 1 cm more than two-year-olds ($p \leq 0.001$). For girls the differences were 2 cm between ages of 1 and 2, and 1 cm between ages of 2 and 3 ($p \leq 0.001$). The research results can be adapted when creating a single database of world data to identify the processes of acceleration or deceleration and the factors that determine them. The processes of changing anthropometric indicators were identified for toddlers aged 1-3. Three anthropometric indicators (head and chest circumference, body length) in boys and girls change with the same growth rate over time. The fourth indicator, body weight, changes somewhat faster in boys (0.8 kg versus 0.7 kg in girls, $p \leq 0.05$). The remaining three indicators significantly differ within groups of boys and girls between age groups ($p \leq 0.001$). Thus, age differences prevail over gender differences.

Keywords: *Early childhood, Regional standards, Socio-economic factors, Anthropometry, Body weight, Body length, Chest circumference, Head circumference.*

Introduction

In any country in the world, the most valuable human resource is children. The state of children's health determines the success and health of countries and nations in the future [1]. Therefore, studies of the basic morphometric parameters of children are needed in order to predict trends in their physical development. Such studies exist in many countries of the world [2, 3]. They allow tracking some effects of the environment on the growth processes of the child's body. However, these effects are short-term and cannot cover large time intervals, since populations are characterized by fluctuations, including morphometric parameters [4]. At the same time, acceleration of the population in the modern world is noted [5]. The most striking example of this was the experiment in which modern people tried to put on knightly armor of the

14th century and did not fit into them. Most likely, factors such as the quality of food and the level of social status have a decisive influence on a person's physical development [6]. Morphometric differences in the physical development of people, including children, point to the presence of important social, economic, environmental, hygienic and genetic factors. Constant monitoring of such parameters is extremely necessary, since it reflects the state of the child population in a particular region of our planet [7].

Extreme values of the physical parameters of development may indicate the development of various pathologies, conditioned by two forces: heredity and environment [8]. The current stage of development of the child's body is characterized by the completion of the acceleration stage in many regions of the Earth.

Most likely, this problem has its roots in the socioeconomic status of many countries, including the global economic crisis [9]. As you know, the level of physical development of children is a reliable marker of their health [10]. If the child has deviations (advancing or more often, a lag in development), then, according to reports, they positively correlate with the development of various diseases.

Methods of studying the physical development of children are characterized by simplicity and the possibility of massive collection of accurate data in a short time [11]. Comparison of morphometric data with data on diseases and indicators of demography and mortality makes it possible to draw highly accurate conclusions about environmental and hygienic situations in any region of the Earth.

Among the well-known methods for determining the level of physical development, the most accurate are measurements of anthropometry indicators [12]. These include measurements of the height of children, their body weight, as well as the circumference of the head and chest. Among pediatricians, anthropometric indicators are mandatory to be used to adequately assess the level of physical development of a particular child and ultimately serve as the basis for his inclusion in the health group [13]. Russia has a significant human resource potential - this country is twice as large as any individual country in the European Union in terms of population. At the same time, after the collapse of the USSR for objective economic reasons, the population of Russia, like many other former republics of the USSR, began to rapidly decline. This also affected the size of the pediatric population [14]. Among the anthropometric characteristics, stagnation of the growth processes, a slowdown of the acceleration processes, and even their reversal, i.e., the beginnings of the opposite process of deceleration are noted [15].

The population of children from Russia serves as a convenient model for the development of growth processes and other parameters of anthropometry for countries that went through the economic downturn. There is a need for continuous monitoring of anthropometric indicators, at least once every 5 years.

The obtained anthropometric data can be used as a model for the development of fluctuation processes in the pediatric population in such countries. This issue also determined the relevance of the present study, since the available data cover mainly earlier time periods. The World Health Organization (WHO) offers two methods to assess the level of physical development of children: WHO Anthro, as well as WHO AnthroPLUS. These methods include the possibility of calculations on an anthropometric calculator.

The calculation results allow us to evaluate for each child individually the level of his physical development, as well as the quality of the diet. Climatic conditions may play a huge role [16]. From this perspective, results of the study focused on children living in Russia may be useful in conducting similar studies in countries located in the same climatic zone.

In addition, the small number of studies devoted to the age of 1-3 gives an additional relevance to this study. Most studies cover infancy (up to 1 year) or older age groups [17, 18]. But this toddler's age (1-3 years) is the most important, since it is at this time that the shapening and development of the adaptation processes of the child's body takes place. Furthermore, in this period, nearly half of genetic disorders reveal themselves.

The purpose of this study is to study anthropometric indicators in children of 1-3 years of age using the example of toddler population of Moscow as a suitable model and to assess the possible gender and age differences between children in Russia. The objectives of the study included: a) identify gender differences in development; b) identify age-related differences in development; the authors admitted the hypothesis that the arithmetic mean values of the anthropometry of boys and girls will have statistically significant differences, larger with boys.

Material and Methods

Materials

The studies were conducted in 2017-2019 in the territory of Moscow, on the basis of 10 pediatric clinics and hospitals, where parents of toddlers aged 1-3 consulted family pediatricians. In total, the results of anthropometric measurements of 3.000 children assigned to these clinics were analyzed.

The study included children who had anthropometric indicators measured, and were accompanied by their parents regularly, every 3 months. The criteria for inclusion in the study were: a) regular visits to the pediatrician, and, accordingly, regular measurements of anthropometric indicators; b) absence of any inherited or acquired chronic disorders that could affect anthropometric indicators. Children with mental disabilities or deviations were also excluded from the sample.

With each of the parents, they concluded a written agreement on the consent to the processing of personal information and an agreement on non-disclosure of personal data. In addition, parents were notified that the study was ethical and moral. Accordingly, the exclusion criteria in the study were: a) irregular anthropometric measurements; b) abnormalities; c) the lack of parental consent. The sample included 1650 boys (55%) and 1350 girls (45%). Other data on age distribution are given in Table. 1.

Table 1: Age distribution of boys and girls 1 to 3 years

Age	Boys	Girls
1 y	500	400
2 y	500	400
3 y	650	550

Among the samples of children 1 year, 2 and 3 years old, we did not find statistically significant differences, which indicate their homogeneity and the possibility of an adequate statistical analysis

Methods

The methodology of anthropometric studies, as we have already indicated above, is simple to implement and was applied by us according to generally accepted criteria. Measurements of anthropometric indicators were carried out at the same time of the day - from 8 a.m. to 12 p.m. Data collection was carried out by family pediatricians in 10 clinics that carried out primary data processing-children distribution by gender, age, as well as measurement of anthropometric parameters. The latter included: a) children's growth; b) their body weight; c) measuring the chest circumference; d) measuring the head circumference. For this, standard tools such as a centimeter tape, height meter and accurate scales were used (measurement error ± 1 g).

The data obtained were correlated with the regional centile scale tables developed by A. V. Mazurin and I. M. Vorontsov [19] for Russia. Our data were arranged in such a way that they were ordered in an ascending order of increase in the value of the attribute. Further, the obtained series of ordered data was distributed over 100 intervals covering all fluctuations of the attribute. In the future, these data were used to calculate centiles, according to formula (1):

$$P_x = H + C/KE \quad (1)$$

Designations of the components of the formula: P_x - this centile; H - lower boundary of the interval of a given centile, C - number of parameters that must be added to a number of cases of the docentile interval in order to obtain the ordinal number of cases of centile; K - number of parameters of the centile interval, E - value corresponding to the centile interval.

Statistical Analysis

For statistical data processing we used the program Statistica v. 10.0 (Stat soft Inc., USA). The following parameters were calculated: arithmetic mean, error of the mean, median, values of the lower and upper quartiles, as well as the minimum and maximum values for each of the measured anthropometric indicators. The samples corresponded to the normal distribution, which determined the choice of parametric methods of statistical analysis.

Characteristic values in the samples were compared as independent, using the nonparametric Mann-Whitney test. Correlation relationships were analyzed using Pearson correlation values. A $p \leq 0.05$ value was taken as the baseline level of significance of differences.

Results

We found statistically significant differences between the sexes for most anthropometric signs at all ages (Table 2). In particular, the parameter of body length in boys is higher than in girls throughout the entire observed age interval. For a group of boys of one year and two years received a statistically significant difference of 9.0 cm ($p \leq 0.001$). Further, between boys of two and three years of age, this difference increased and amounted to 10.0 cm ($p \leq 0.001$).

For groups of girls, a statistically significant difference was also obtained, at approximately the same level - 9.0 cm between the first and second years of life ($p \leq 0.001$) and 10 cm between the second and third ($p \leq 0.001$). In terms of growth rates between boys and girls over the course of all three years, thus, there are no statistically significant differences.

Table 2: Average values of 4 anthropometric measurements in groups of toddlers aged 1-3 (arithmetic mean ± standard error; median (25-75% quartile), min, max values

Age group	Gender	Body length (in cm)	Body weight (in kg)	Chest circumference, cm	Headcircumference, cm
1 y	Boys	77.0 ± 2.0 (75.0-79.0), 69.0-84.0	9.6 ± 0.8 (8.9-10.4) 6.6-12.9	48.0 ± 2.0 (46.0-50.0) 41.0-55.0	47.0 ± 1.0 (46.0-48.0) 43.0-51.0
	Girls	76.0 ± 2.0 (74.0-78.0) 65.0-81.5	8.9 ± 0.4 (8.5-9.3) 6.8-12.1	47.0 ± 2.0 (45.0-49.0) 42.0-54.5	46.0 ± 1.0 (45.0-47.0) 42.0-50.0
Significance level		0.001	0.001	0.001	0.001
2 y	Boys	86.0 ± 2.0 (84.0-88.0) 79.0-97.0	12.2 ± 0.9 (11.3-13.1) 9.1-16.5	50.5 ± 1.5 (49.0-52.0) 43.0-57.0	49.0 ± 1.0 (48.0-50.0) 45.0-53.0
	Girls	85.0 ± 2.0 (87.0-89.0) 71.0-91.0	11.9 ± 0.9 (11.0-12.8) 9.7-15.5	49.5 ± 1.0 (48.5-50.5) 42.5-55.5	48.0 ± 0.5 (47.5-48.5) 45.0-52.0
Significance level		0.05	0.001	0.001	0.001
3 y	Boys	96.0 ± 2.0 (94.0-98.0) 87.5-109.0	14.0 ± 1.5 (12.5-15.5) 12.2-21.0	52.0 ± 1.0 (53.0-54.0) 46.0-60.5	50.0 ± 1.0 (51.0-52.0) 47.0-54.0
	Girls	95.0 ± 2.0 (93.0-97.0) 80.0-108.0	13.2 ± 1.0 (12.2-14.2) 10.3-18.3	50.7 ± 0.8 (49.9-51.5) 47.0-58.0	49.0 ± 1.0 (48.0-50.0) 45.5-52.0
Significance level		0.001	0.001	0.001	0.001

Despite the fact that growth processes in boys and girls under 3 years proceed at the same pace, in another indicator - body weight, girls lag behind boys in the entire period of research. Boys aged 2 have body mass indicators of 2.6 kg higher ($p \leq 0.001$) than those aged 1, and aged 3 differ by 1.8 kg compared with the age of two years ($p \leq 0.001$). Girls aged 2 are heavier than those aged 1 by 2 kg ($p \leq 0.001$), and aged 2 are 1.3 kg ($p \leq 0.01$) heavier than two-year-olds. Thus, the tendency to gain body weight decreases with age. The difference between weight gain between boys and girls is also significant ($p \leq 0.05$).

The chest circumference is also significantly different in all years. For boys aged 1 and 2, the difference was 2.5 cm, for those aged 2 and 3 it was 1.5 cm ($p \leq 0.001$). For girls this difference was 2.5 cm in the first case and 1.2 cm ($p \leq 0.01$). The difference in growth between boys and girls is unreliable, which indicates the same growth rate.

The head circumference in boys aged 2 was 2 cm more than those aged ($p \leq 0.001$), and for those aged 3 it was 1 cm ($p \leq 0.001$).

For girls aged 2, this indicator was 2 cm and 1 cm for those aged 3 compared with 2-years-olds ($p \leq 0.001$). There are also no significant differences in changing the parameters of the head circumference between boys and girls. That is, growth processes proceed at the same rate. An analysis of the correlations of the studied anthropometric parameters with continuous trait variability showed the presence of reliable Pearson correlations ($p \leq 0.05$, Table 3).

Table 3: The values of the Pearson correlation coefficient between the severity of anthropometric signs and the age of toddlers (1-3 years)

Anthropometric sign	1 y	2 y	3 y
Body length	0.35	0.67	0.65
Body mass	0.69	0.74	0.87
Chest circumference	0.75	0.55	0.81
Head circumference	0.60	0.48	0.57

Body length parameter of both boys and girls is closely interconnected with body weight, as well as with the circumference of the chest ($p \leq 0.05$). Moreover, body weight has a strong positive relationship with the other three parameters throughout all three years of research ($p \leq 0.05$). For the head circumference, it is interconnected with the length of the body and its mass ($p \leq 0.05$). All this confirms the already known from the literature information about the relationship between the four anthropometric parameters in children.

Discussion

In our work, we established regional standards of anthropometric indicators of toddlers for the city of Moscow (Russia). These data can be used as standard for countries with economies in transition and developing countries, among children of the Caucasian race. Of course, such indicators will differ among children of different races [18, 20]. The average indicators of body weight and growth will differ within the same racial group, in this case, the level of economic and social development of the country will be important, as well as local climatic features, [21, 22, 20].

The peoples inhabiting the North of Europe have higher growth rates, for example, the Dutch, the Norwegians. Accordingly, children will also have large growth and body weight parameters [23, 24]. Moscow is located in more northern latitudes compared to the Netherlands, but the anthropometric parameters of toddlers are smaller. Thus, anthropometry is influenced by factors other than the place of residence. It follows that the factors determining anthropometric indicators will differ in different regions in terms of the intensity of the impact. We found that out of the four considered anthropometric indicators, three (body length, head and chest circumference) increases in boys and girls at the same rate with increasing age, and body weight increase was greater among boys.

Boys in all cases have large anthropometric parameters compared to girls. Despite the fact that our data are not fundamentally new for anthropometry and confirm already known trends [25, 28], they are presented for the first time in the research region for this age group, and can be an addition to a few works on the early childhood.

Constant monitoring of regional data will allow us to identify negative trends and factors that determine them in time. Based on this, it also becomes possible to compare the severity of one of the four anthropometric indicators with each other in different age groups of children, and, as a result, make adequate conclusions about the degree of influence of environmental factors on these indicators. Regional data on anthropometry [29] can be combined into a single database, the analysis of which by time and regional factors will reveal general and particular global trends.

In addition, it will become possible to finally clarify the question of which trend prevails on a global scale- acceleration or deceleration, and which factor is dominant in its manifestation.

Conclusions

Patterns in changes in anthropometric indicators are established among toddlers aged 1-3. For three of their four indicators (head and chest circumference, body length), the same increase is observed in boys and girls throughout the entire observation period. For body weight, in boys, growth happens at a faster pace (0.8 kg versus 0.7 kg in girls, $p \leq 0.05$). For other anthropometric indicators within the groups of boys and girls, a significant difference between the years was established ($p \leq 0.001$). Thus, age differences prevail over gender differences [30].

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