

BODY MASS INDEX OF RUSSIAN SCHOOLCHILDREN IN THE SECOND DECADE OF THE XXI CENTURY

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The aim of the study is to establish a trend in the body mass index of schoolchildren in different regions of the country. The study was carried out in 2021 as part of the all-Russian monitoring of the physical development of schoolchildren aged 7–17 years (the number of boys - 30,965, the number of girls - 33,290). The statistical software package Statistica 13 PL has been used for data processing. BMI indicators have been established for Russian schoolchildren. Some regional differences in BMI indicators and the influence of the organization of medical support factor in the region have been shown. The Pearson correlation coefficients between the BMI of schoolchildren and the availability of doctors and nurses per 10,000 of population were -0.63 and -0.39 ($p \leq 0.05$). The age and gender standards for BMI for Russian schoolchildren have been updated. A trend towards higher BMI rates in various subjects of the Russian Federation has been revealed, which may be due, among other things, to indicators characterizing the organization of the medical population in the region.

Keywords: schoolchildren, body mass index, health care**Author contribution:** Levushkin SP, Zhukov OF, Skobolina NA — trial concept and design; Skobolina EV — data collection and processing; Zhukov OF, Skobolina EV — text writing; Levushkin SP, Skobolina NA — editing.**Compliance with ethical standards:** the study has been approved by the Local Ethics Committee of Pirogov Russian National Research University (protocol No. 159 as of November 21, 2016) and conducted as a part of research work (state recording number of research and technological development AAAA-A19-119021890068-7 as of February 18, 2019), it does not endanger the participants, complied with the requirements of biomedical ethics, and voluntary informed consent has been obtained for each participant.✉ **Correspondence should be addressed:** Natalia A. Skobolina
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ИНДЕКС МАССЫ ТЕЛА У РОССИЙСКИХ ШКОЛЬНИКОВ ВО ВТОРОМ ДЕСЯТИЛЕТИИ XXI ВЕКА

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Цель исследования — установление тенденции изменения показателя индекса массы тела школьников в разных регионах страны. Исследование выполнено в 2021 г. в рамках общероссийского мониторинга физического развития школьников 7–17 лет (мальчиков — 30965, девочек — 33290). Для обработки данных использован пакет статистических программ Statistica 13 PL. Установлены показатели ИМТ у российских школьников. Показаны некоторые региональные различия показателей ИМТ и влияние на него такого фактора, как организация медицинского обеспечения в регионе. Коэффициенты корреляции Пирсона для показателя ИМТ школьников и обеспеченностью врачами и медицинскими сестрами на 10000 населения составили -0,63 и -0,39 ($p \leq 0,05$). Были обновлены возраст-половые нормативы ИМТ для российских школьников. Выявлена тенденция к более высоким показателям ИМТ в различных субъектах Российской Федерации, которая может быть обусловлена, в том числе показателями, характеризующими организацию медицинского населения в регионе.

Ключевые слова: школьники, индекс массы тела, медицинское обеспечение**Вклад авторов:** Левушкин С. П., Жуков О. Ф., Скоблина Н. А. — концепция и дизайн исследования; Скоблина Е. В. — сбор и обработка материала; Жуков О. Ф., Скоблина Е. В. — написание текста; Левушкин С. П., Скоблина Н. А. — редактирование.**Соблюдение этических стандартов:** исследование одобрено ЛЭК РНИМУ им. Н. И. Пирогова (протокол № 159 от 21.11.2016) и выполнялось в рамках НИР (номер государственного учета НИОКТР AAAA-A19-119021890068-7 от 18 февраля 2019 г.), не подвергало опасности участников, соответствовало требованиям биомедицинской этики, для каждого участника было получено добровольное информированное согласие.✉ **Для корреспонденции:** Наталья Александровна Скоблина,
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There is an increasing evidence in the literature of the high prevalence of overweight and obesity among children, adolescents and young adults. [1–6].

In a number of previous studies, it has been shown that changes in physical development indicators at the beginning of the 21st century were disharmonious due to an increase in body weight and a decrease in functional indicators. [7–8].

Because of the coronavirus pandemic, children, adolescents and young people faced a change in their lifestyle and health care, i. e., change in the facts that influence the physical development of pediatric population [9–14].

In this regard, it is of interest to study such an indicator of physical development as the body mass index (BMI) among schoolchildren in various regions of the Russian Federation. In a number of studies performed earlier, it has already been

shown that changes in physical development indicators are disharmonious in nature and are accompanied by a decrease in functional indicators and an increase in BMI [7].

The purpose of the study is to establish trends in the body mass index of schoolchildren in different regions of the country.

MATERIALS AND METHODS

The study was carried out in 2021 as part of the all-Russian monitoring of the physical development of schoolchildren aged 7–17, among which 30,965 boys and 33,290 girls were examined. A standard anthropometric technique and standard tools have been used. [15–18].

In this research section, results of studying the body mass index among sensitive groups of schoolchildren aged 11 to 15 years are reviewed in detail, as the most sensitive groups are more subject to unfavorable factors, including factors of lifestyle and health care organization. Size of every age- and gender-adjusted group amounted to at least 100 observations. According to the method developed by Otdelnova KA, this provides for 95.0% of probable significance of research result.

The conducted trial didn't expose participants to danger, corresponded to the requirements of biomedical ethics and provisions of the Declaration of Helsinki, and was accompanied with obtaining a voluntary informed consent. Inclusion criteria were as follows: a schoolchild, education at a general educational institution, examination time interval (2021), correctly conducted anthropometric trial, availability of voluntary informed consent. Exclusion criteria: another age group, another examination time interval, lack of correctly conducted anthropometric trial, lack of voluntary informed consent. The conducted trial was approved by the ethical committee of Pirogov Russian National Research University (protocol No. 159 as of November 21, 2016).

The rating of regions based on healthcare system values was taken from open sources and based on expert estimates (https://expertnw.com/upload/pdf/rating_regions_health_2019.pdf; http://vid1.rian.ru/ig/ratings/rating_regions_2020.pdf; http://vid1.rian.ru/ig/ratings/rating_regions_2021.pdf, date of referral February 25, 2022).

Statistica 13 PL (StatSoft, USA) was used to process the obtained data. Correspondence of the obtained values to the normal distribution law of variation series was preliminarily estimated when the results were processed. The obtained quantitative data had normal distribution. That's why the methods of parametric statistics using the arithmetic mean (M) and mean square deviation (σ) were applied. Student's t -test was utilized to assess the statistically significant difference in average values (the differences were significant at $p \leq 0.05$). The Pearson correlation coefficients were calculated and the regression models were built.

RESULTS

The average BMI for the sensitive group of 11-year-old schoolchildren in 2021 was 18.4 ± 0.1 kg/m² for boys and 18.2 ± 0.1 kg/m² for girls; for 15-year-old boys – 20.7 ± 0.05 kg/m², for 15-year-old girls – 20.2 ± 0.05 kg/m², respectively.

Examination of the BMI value of boys and girls at the regional level showed significant differences ($p \leq 0.05$) in national data for a number of federal constituent entities of the Russian Federation representing various federal districts which differ by climate, geographical, social, economic and other indicators (fig. 1,2).

Consistent differences in BMI among boys and girls were noted. Meanwhile, the nationwide BMI of 25–27 was 16.1–20.0 kg/m² for 11-year-old boys, 18.6–22.1 kg/m² for 15-year-old boys, and 15.8–19.9 kg/m² and 18.4–21.9 kg/m² for 11-year-old and 15-year-old girls, respectively. This allows to make a conclusion that in no federal constituent entity of the Russian Federation the BMI value went beyond the normal age.

The discovered tendency to higher BMI values in different federal constituent entities of the Russian Federation required subsequent examination, in particular, that of the effect produced by the health care system. The effect underwent changes during the coronavirus pandemic. A prognostic regression model was obtained. It described the effect of a set of factors on BMI ($p \leq 0.05$) of 11-year-old schoolchildren (Y):

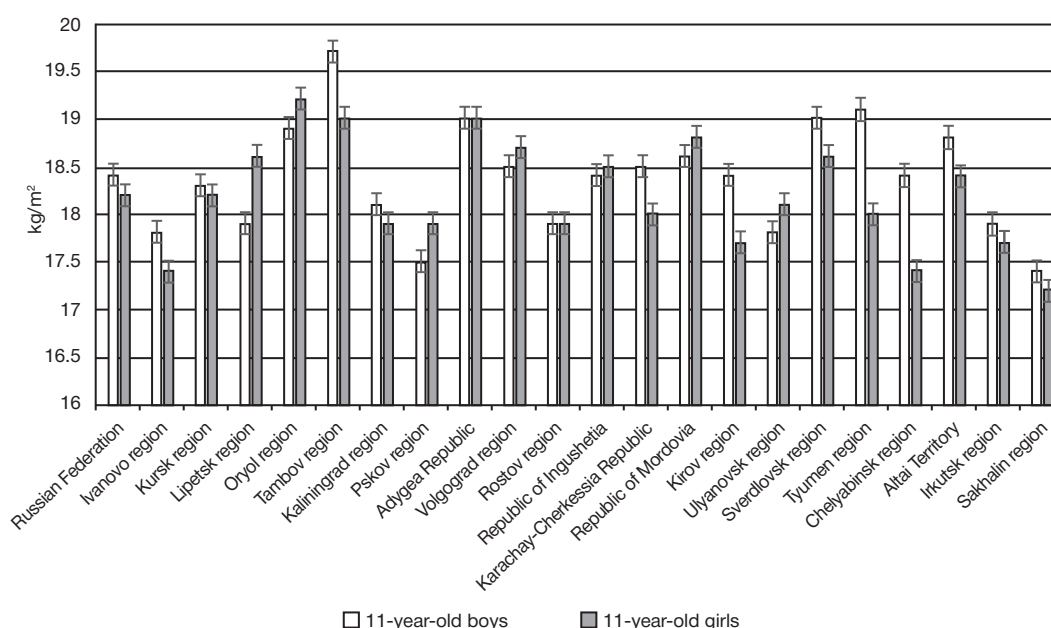


Fig. 1. BMI of 11-year-old schoolchildren from federal constituent entities of the Russian Federation, kg/m²

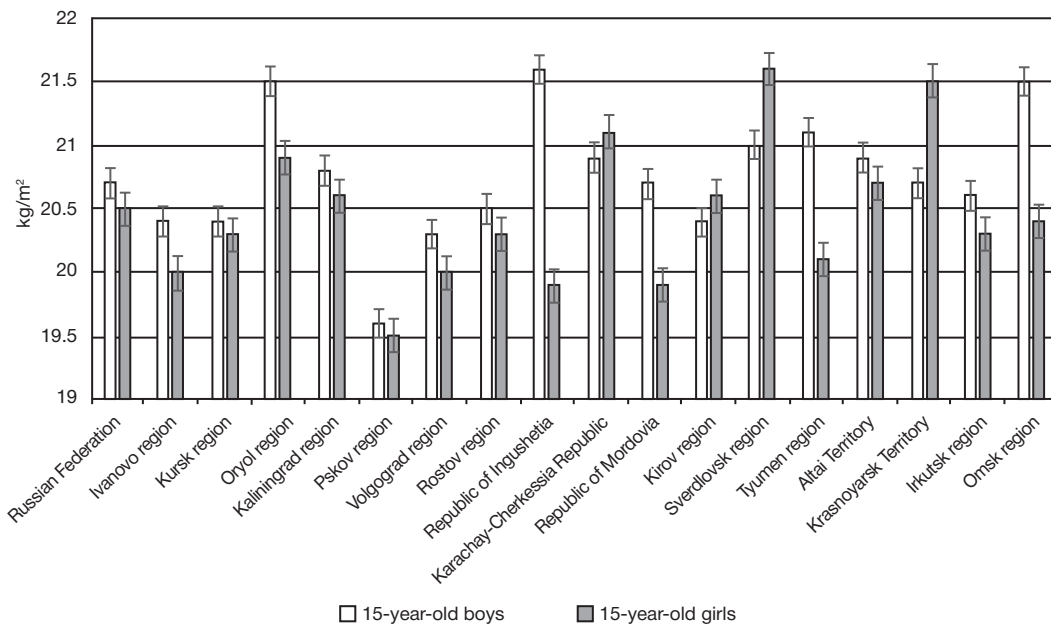


Fig. 2. BMI of 15-year-old schoolchildren from federal constituent entities of the Russian Federation, kg/m²

Table. Normative BMI values for 7- and 17-year-old schoolchildren as compared with 2004 and 2021, 25–75 centiles, kg/m²

	7-year-old boys	7-year-old girls	8-year-old boys	8-year-old girls	9-year-old boys	9-year-old girls	10-year-old boys	10-year-old girls	11-year-old boys	11-year-old girls	12-year-old boys	12-year-old girls	13-year-old boys	13-year-old girls	14-year-old boys	14-year-old girls	15-year-old boys	15-year-old girls	16-year-old boys	16-year-old girls	17-year-old boys	17-year-old girls
1	14.6–16.8	14.6–16.6	14.8–17.2	14.8–17.0	15.0–18.0	15.2–17.6	15.4–18.6	15.4–18.2	16.0–19.4	16.0–18.8	16.6–20.2	16.4–19.8	17.0–21.0	17.0–20.4	17.6–21.6	17.6–21.2	18.2–22.4	18.2–22.0	18.8–22.8	18.8–22.8	19.2–23.4	19.4–23.4
2	14.8–17.6	14.6–17.4	15.2–17.9	14.8–17.8	15.4–18.6	15.1–18.6	15.7–19.1	15.3–19.1	16.1–20.0	15.8–19.9	16.7–20.7	16.6–20.4	17.3–21.3	17.3–21.3	18.0–21.6	17.9–21.6	18.6–22.1	18.4–21.9	19.2–22.5	18.7–22.2	19.6–22.9	18.7–22.3

Note: 1 — normative values of 2004; 2 — normative values of 2021.

$$Y = 20.0 - 1.5 \cdot X_1 - 1.5 \cdot X_2, \text{ where}$$

$A = 20.0$ is a constant;

$B = -1.5$ means regression coefficients;

X denotes the independent variables in points:

X_1 — regional ranking according to basic values of healthcare system effectiveness (1 — for high rating; 0 — for low rating);

X_2 — rating of healthcare provider supply (1 — for high rating; 0 — for low rating);

The Pearson's correlation coefficients for BMI of 11- and 15-year-old children and doctor/ nurse coverage per 10,000 of people accounted for -0.63 and -0.39 ($p \leq 0.05$).

BMI values for various age- and gender-adjusted groups of Russian schoolchildren as compared with previous standards presented by Dedov II and Melnichenko GA (2004) are presented in table [19].

The presented data show a change in the BMI values of schoolchildren in the beginning and second decade of the XXI century. In research of 2021, higher BMI values were observed among the 7- to 13-year-old, no differences were found for the 14- to 15-year-old, and less high BMI values were found for the 16- to 17-year-old.

RESULT DISCUSSION

Increased overweight and obesity incidence rates are observed among children, adolescents and young people from many highly developed and developing countries [20–23].

Apart from genetic factors, deficiency of motor activity, improper nutrition, higher pace of life and associated stress, health care, etc. are the reasons for obesity in children, adolescents and young people [24–26].

The trial established the BMI values of Russian schoolchildren obtained after the change in lifestyle components and health care related to restrictive measures during the pandemic. Several regional differences in the BMI values and how provision of health care in regions influences the values were shown.

CONCLUSIONS

Age and gender-adjusted normative BMI values of Russian schoolchildren have been updated. The rising trend in BMI has been found in different federal constituent entities of the Russian Federation. It can partially be due to the values that characterize provision of health care in the region.

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