

20-YEAR MONITORING OF PHYSICAL DEVELOPMENTAL CHARACTERISTICS IN SCHOOL-AGE CHILDREN AND ADOLESCENTS LIVING IN KURSK

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The study was aimed to compare physical developmental characteristics in children and adolescents aged 7–18 living in Kursk for the years 2000–2001 and 2019–2020. The study was carried out in general educational institutions located in different urban areas of Kursk in 2000–2001 and 2019–2020. The standard anthropometric measurements, instruments and statistical methods were used. A total of 20,083 school-age children and adolescents were examined. The inclusion criteria were as follows: school-age children and adolescents staying at the educational institution at the time of the study, informed consent form properly completed, anthropometric measurements correctly performed. Statistical processing of the results was carried out using the Statistica 10.0 software package. The 20-year monitoring of physical development characteristics performed in school-age children and adolescents living in Kursk revealed the significant increase in height and body weight in all age and gender groups. The harmonious body acceleration manifestations associated with the muscle strength increase were observed in the context of sociomedical progress in Kursk.

Keywords: school-age children, physical development, monitoring, long-term longitudinal data

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Compliance with ethical standards: Ethics Committee protocol № 108 dated October 24, 2016. The informed consent was obtained for all study participants. The study does not harm the participants and is consistent with ethical principles of biomedical research.

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МОНИТОРИНГ ФИЗИЧЕСКОГО РАЗВИТИЯ ШКОЛЬНИКОВ ГОРОДА КУРСКА В ДИНАМИКЕ ДВАДЦАТИ ЛЕТ НАБЛЮДЕНИЯ

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Целью данного исследования явилась сравнительная оценка показателей физического развития детей 7–18 лет, проживающих в г. Курске за периоды 2000–2001 гг. и 2019–2020 гг. Исследование проводилось на базе общеобразовательных организаций, размещённых в различных районах г. Курска в период с 2000–2001 гг. и 2019–2020 гг. Использовалась стандартная антропометрическая методика, инструментарий и методы статистической обработки. Общее количество обследованных школьников составило 20083 ученика. Критерии включения в выборку – дети и подростки школьного возраста, находящиеся в момент проведения исследования в образовательной организации, наличие корректно заполненного информированного согласия и корректно проведенного антропометрического исследования. Статистическая обработка полученных данных проводилась с использованием пакета статистического анализа Statistica 10.0. Проведенный в данном исследовании мониторинг физического развития школьников города Курска в динамике двадцати лет наблюдения выявил достоверное увеличение показателей длины и массы тела во всех возрастно-половых группах школьников. На фоне положительных медико-социальных изменений в городе Курске зафиксированы проявления процесса акселерации, которые носят гармоничный характер и сопровождаются увеличением показателей мышечной силы.

Ключевые слова: школьники, физическое развитие, мониторинг, многолетняя динамика

Вклад авторов: А. М. Черных — научное руководство, сбор материала, написание статьи; А. С. Кремлева, А. И. Белова — сбор материала, статистическая обработка, поиск литературы.

Соблюдение этических стандартов: Протокол заседания ЭК № 108 от 24.10.2016. Добровольное информированное согласие было получено для каждого участника. Поведенное исследование не подвергает опасности участников и соответствует требованиям биомедицинской этики.

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The long-term longitudinal studies of physical development characteristics as a measure of country's children health are an important issue, because these allow the researchers to yield a long-term forecast and propose measures to improve the country's reproductive and labor potential, as well as the demographic situation [1–8].

Currently, the physical developmental characteristics in children and adolescents are considered the criterion of their health, which includes assessment of the level and harmony of physical development [9, 10].

The reports has been published concerning the long-term longitudinal data on the children's physical development obtained both in different regions of the Russian Federation and abroad [11–14].

The study demonstrates the 20-year longitudinal data on the physical developmental morphofunctional characteristics in school-aged children and adolescents living in Kursk.

Aim. Comparison of physical developmental characteristics in children and adolescents aged 7–18 living in Kursk for the years 2000–2001 and 2019–2020.

METHODS

The study was carried out in general educational institutions located in different urban areas of Kursk in 2000–2001 and 2019–2020. The standard anthropometric measurements, instruments and statistical methods were used [15–17].

A cohort of 20,083 school-age children and adolescents was examined. Inclusion criteria: school-age children and adolescents staying at the educational institution at the time of the study, informed consent form properly completed, anthropometric measurements correctly performed.

The study did not harm the participants or infringe upon their rights in accordance with ethical principles of biomedical research mandated by the World Medical Association Declaration of Helsinki (2013).

Statistical processing of the results was carried out using the Statistica 10.0 software package (StatSoft, USA).

Results

When analyzing the 20-year longitudinal data on the physical developmental characteristics of children and adolescents aged 7–18 attending general educational institutions in Kursk, the improvement can be seen (Tables 1, 2).

The significant ($p \leq 0.01–0.05$) height increase was observed in all age and gender groups. In 2000–2001 the height of boys aged 7 was 117.0 cm, and in 2019–2020 it was 121.6 cm, i.e.

the increase was 4.6 cm. In 2000–2001 the height of girls aged 7 was 115.8 cm, and in 2019–2020 it was 119.6 cm, i.e. the increase was 3.8 cm.

In 2000–2001, by the end of growth, the young men aged 18 had the height of 166.1 cm, and in 2019–2020 they had the height of 176.1 cm, i.e. the increase was 10.0 cm. In 2000–2001 the height of girls aged 18 was 157.3 cm, and in 2019–2020 it was 170.6 cm, i.e. the increase was 13.3 cm.

The annual change in average height starts to decline after 17 in young men, and after 15 in girls, since the growth ends, however, the growth curves are typical.

The significant ($p \leq 0.01$) body weight increase was observed in school-age children and adolescents of all age and gender groups. Thus, in 2000–2001 the 7-year-old boys' body weight was 21.7 kg, and in 2019–2020 it was 23.4 kg, i.e. the increase was 1.9. In 2000–2001 the body weight of girls aged 7 was 21.4 kg, and in 2019–2020 their body weight was 23.1 kg, i.e. the increase was 1.5 kg.

In 2000–2001, the 18-year-old young men's body weight was 58.7 kg, and in 2019–2020 it was 65.2 kg: the increase was 6.5 kg. In 2000–2001 the body weight of girls aged 18 was 52.1 kg, and in 2019–2020 their body weight was 58.9 kg: the increase was 5.8 kg.

The increase in height and body weight was accompanied by an increase in muscle strength of the hand in school-age children and adolescents of all age and gender groups (see Figure).

Table 1. Height of school-age children and adolescents living in Kursk, measured in 2000–2001 and 2019–2020, $M \pm m$

| Age, years | Number of observations | $M \pm m$ | σ | Number of observations | $M \pm m$ | σ | p |
|---------------|------------------------|------------|----------|------------------------|------------|----------|---------------|
| 2000–2001 гг. | | | | 2019–2020 гг. | | | |
| Boys | | | | | | | |
| 7 | 247 | 117,0±0,29 | 4,57 | 320 | 121,6±0,26 | 4,92 | $p \leq 0,01$ |
| 8 | 419 | 121,0±0,26 | 5,41 | 351 | 126,2±0,26 | 5,07 | $p \leq 0,01$ |
| 9 | 469 | 125,3±0,26 | 5,81 | 375 | 130,4±0,21 | 6,24 | $p \leq 0,01$ |
| 10 | 452 | 128,3±0,30 | 5,32 | 448 | 135,9±0,26 | 5,65 | $p \leq 0,01$ |
| 11 | 371 | 133,1±0,30 | 5,89 | 323 | 140,1±0,25 | 4,73 | $p \leq 0,01$ |
| 12 | 329 | 137,7±0,37 | 6,97 | 283 | 145,4±0,26 | 4,57 | $p \leq 0,01$ |
| 13 | 224 | 142,2±0,41 | 6,12 | 275 | 150,5±0,21 | 5,32 | $p \leq 0,01$ |
| 14 | 168 | 147,8±0,42 | 5,48 | 153 | 155,9±0,28 | 4,84 | $p \leq 0,01$ |
| 15 | 154 | 154,7±0,56 | 6,88 | 242 | 163,7±0,20 | 4,85 | $p \leq 0,01$ |
| 16 | 184 | 161,1±0,44 | 6,11 | 145 | 170,2±0,27 | 3,34 | $p \leq 0,01$ |
| 17 | 141 | 165,3±0,50 | 5,99 | 123 | 174,5±0,27 | 3,11 | $p \leq 0,01$ |
| 18 | 70 | 166,1±0,73 | 6,03 | 112 | 176,1±0,29 | 3,24 | $p \leq 0,05$ |
| Girls | | | | | | | |
| 7 | 249 | 115,8±0,29 | 4,71 | 291 | 119,6±0,31 | 4,93 | $p \leq 0,01$ |
| 8 | 488 | 120,0±0,18 | 4,22 | 432 | 123,7±0,20 | 5,48 | $p \leq 0,01$ |
| 9 | 463 | 124,1±0,21 | 4,68 | 412 | 127,8±0,25 | 5,33 | $p \leq 0,01$ |
| 10 | 519 | 128,4±0,22 | 5,21 | 451 | 134,1±0,24 | 5,2 | $p \leq 0,01$ |
| 11 | 432 | 132,1±0,27 | 5,83 | 415 | 140,8±0,25 | 4,35 | $p \leq 0,01$ |
| 12 | 363 | 139,0±0,64 | 5,16 | 381 | 147,2±0,23 | 5,82 | $p \leq 0,01$ |
| 13 | 252 | 144,2±0,36 | 5,95 | 426 | 153,7±0,21 | 5,68 | $p \leq 0,01$ |
| 14 | 236 | 150,8±0,69 | 6,11 | 353 | 159,4±0,27 | 4,27 | $p \leq 0,01$ |
| 15 | 226 | 153,9±0,35 | 5,34 | 212 | 162,1±0,34 | 5,04 | $p \leq 0,01$ |
| 16 | 205 | 155,6±0,33 | 4,79 | 184 | 164,6±0,35 | 4,89 | $p \leq 0,01$ |
| 17 | 137 | 156,6±0,38 | 4,58 | 112 | 167,7±0,43 | 3,57 | $p \leq 0,01$ |
| 18 | 69 | 157,3±0,62 | 5,33 | 109 | 170,6±0,38 | 4,43 | $p \leq 0,01$ |

Table 2. Body weight of school-age children and adolescents living in Kursk, measured in 2000–2001 and 2019–2020, M±m

| Age, years | Number of observations | M ± m | σ | Number of observations | M ± m | σ | p |
|---------------|------------------------|-----------|------|------------------------|-----------|------|--------|
| 2000–2001 rr. | | | | 2019–2020 rr. | | | |
| Boys | | | | | | | |
| 7 | 247 | 21,7±0,15 | 2,47 | 320 | 23,4±0,15 | 2,75 | p≤0,01 |
| 8 | 419 | 23,6±0,12 | 2,68 | 351 | 25,7±0,14 | 2,78 | p≤0,01 |
| 9 | 469 | 25,7±0,16 | 3,53 | 375 | 28,1±0,14 | 3,04 | p≤0,01 |
| 10 | 452 | 27,4±0,13 | 2,86 | 448 | 30,6±0,13 | 2,93 | p≤0,01 |
| 11 | 371 | 30,1±0,19 | 3,94 | 323 | 34,5±0,18 | 3,34 | p≤0,01 |
| 12 | 329 | 32,9±0,19 | 3,81 | 283 | 37,4±0,21 | 3,65 | p≤0,01 |
| 13 | 224 | 36,2±0,25 | 3,89 | 275 | 41,6±0,21 | 3,57 | p≤0,01 |
| 14 | 168 | 41,1±0,30 | 4,03 | 153 | 46,5±0,22 | 3,64 | p≤0,01 |
| 15 | 154 | 46,4±0,28 | 3,57 | 242 | 53,2±0,21 | 3,23 | p≤0,01 |
| 16 | 184 | 52,3±0,30 | 4,05 | 145 | 59,7±0,21 | 2,68 | p≤0,01 |
| 17 | 141 | 56,4±0,23 | 3,14 | 123 | 63,3±0,19 | 2,21 | p≤0,01 |
| 18 | 70 | 58,7±0,32 | 2,74 | 112 | 65,2±0,24 | 2,24 | p≤0,01 |
| Girls | | | | | | | |
| 7 | 249 | 21,4±0,14 | 2,46 | 291 | 23,1±0,17 | 2,42 | p≤0,01 |
| 8 | 488 | 22,9±0,10 | 2,48 | 432 | 25,3±0,15 | 2,76 | p≤0,01 |
| 9 | 463 | 24,8±0,10 | 2,45 | 412 | 26,9±0,19 | 3,02 | p≤0,01 |
| 10 | 519 | 27,1±0,12 | 2,86 | 451 | 29,6±0,14 | 2,23 | p≤0,01 |
| 11 | 432 | 29,9±0,12 | 2,74 | 415 | 34,4±0,11 | 2,45 | p≤0,01 |
| 12 | 363 | 33,6±0,16 | 3,18 | 381 | 37,9±0,13 | 2,81 | p≤0,01 |
| 13 | 252 | 37,9±0,20 | 3,34 | 426 | 43,8±0,13 | 2,92 | p≤0,01 |
| 14 | 236 | 42,7±0,19 | 4,03 | 353 | 48,5±0,16 | 2,21 | p≤0,01 |
| 15 | 226 | 46,3±0,20 | 3,11 | 212 | 53,6±0,21 | 2,13 | p≤0,01 |
| 16 | 205 | 49,0±0,28 | 4,07 | 184 | 57,1±0,23 | 2,24 | p≤0,01 |
| 17 | 137 | 51,7±0,31 | 3,69 | 112 | 58,8±0,27 | 2,87 | p≤0,01 |
| 18 | 69 | 53,1±0,44 | 3,72 | 109 | 58,9±0,22 | 2,34 | p≤0,01 |

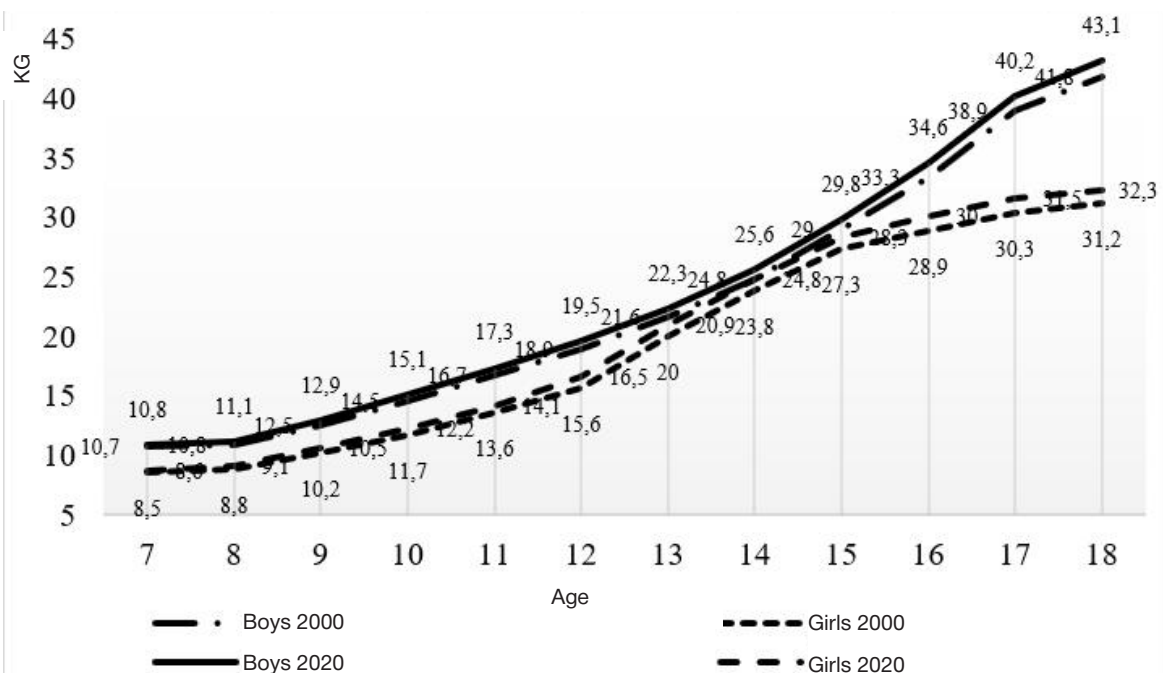


Fig. Muscle strength measurements of the hand in girls and boys aged 7–18 living in Kursk, obtained in 2000–2001 and 2019–2020, M

During the 20-year monitoring the muscle strength of the right hand in 18-year-old young men (by the end of growth) increased by 1.3 kg, and in girls the muscle strength of the right hand increased by 1.1 kg.

DISCUSSION

Realization of growth is driven by genetic and environmental factors: the inherited genetic program is implemented under the influence of a complex set of factors. Negative factors can cause growth retardation and developmental delay, and the positive factors can cause the opposite. Sociomedical progress, which took place in the Kursk Region in the recent decades according to official statistics, ensured the conditions favorable to children's growth and development. This was manifested by the positive trend in the changes of physical developmental morphofunctional characteristics in school-age children [18].

Similar changes are observed both in the regions of Russia and abroad, for example in BRIC countries. Thus, the study performed in Kolkata (India) revealed positive trend in changes of height and body weight of children and adolescents aged 7–16 associated with improvement of sociomedical conditions related to socioeconomic progress in India over the recent decades [19].

Improvement of children's physical developmental characteristics associated with economic development

together with the decrease of inequalities between urban and rural areas are observed in Guangzhou (China). However, the gross domestic product growth positively correlates with the prevalence of obesity both in urban and rural areas ($R>0.90$ with $p<0.05$) [20].

According to a number of authors, economic development and urbanization trigger such problems as obesity [21, 22].

At the same time, the muscle strength decrease is observed in children and adolescents in many countries. Thus, meta-analysis performed from 1969 to 2017, which included 1,746,023 children and adolescents from 14 countries (China, Finland, Sweden, Belgium, New Zealand, Denmark, Spain, Norway, Mozambique, Poland, USA, Lithuania, Portugal, Canada), showed a constant decline in strength in the young people [23].

Our study revealed the improvement of dynamometric performance. This in fact highlights the harmonious pattern of body acceleration manifestations in the region.

CONCLUSION

The 20-year monitoring of physical development characteristics performed in school-age children and adolescents living in Kursk revealed significant increase in height and body weight in all age and gender groups. The harmonious body acceleration manifestations associated with the muscle strength increase were observed in the context of sociomedical progress in Kursk.

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