# COMPARATIVE ASSESSMENT OF PHYSICAL DEVELOPMENT OF SCHOOLCHILDREN AND CHILDREN INVOLVED IN SWIMMING

Abdalova SR, Gavryushin MYu ✉, Sazonova OV, Hamtsova RV, Tupikova DS, Frolova OV, Nurdina MS

Samara State Medical University, Samara, Russia

Health of children and adolescents is an essential criterion of well-being of the society. Monitoring of health among children is impossible without assessment of physical development of children and adolescents. Individual-based analysis of anthropometric characteristics is required to develop personalized preventive activities. Considering different levels of physical load of schoolchildren in case of a disturbed nutritional status, an approach to body mass constituent study that deviates from the normal values requires examination. The study purpose was to assess physical development and component composition in schoolchildren during a medical examination and in children involved in classic swimming at a sports club in the city of Samara. The study object involved children studying at a general educational institution and not engaged in any sports sections (first group), and children involved in classic swimming at a sports club in Samara (second group. Significant differences in basic values of body composition were found during the conducted study of physical development and component composition of schoolchildren who do not go in for sports and junior athletes.

**Key words:** hygiene of children and adolescents, physical development, anthropometric indicators, bioimpedance analysis

**Financing:** the study was supported by the Grant of the Russian President (MK-5809.2021.3).

**Author contribution:** Abdalova SR — study initiator; Sazonova OV, Gavryushin MYu — academic advising; Hamtsova RV — processing of results, manuscript editing; Tupikova DS, Frolova OV — collection of data, preparation of results; Nurdina MS — literature analysis, manuscript preparation.

**Compliance with ethical standards:** the research was approved by the Ethics Commission of the Samara State Medical University of the Ministry of Health of the Russian Federation (protocol No. 9 as of Sept. 24, 2022). Voluntary informed consent was obtained for every participant (legal representative).

✉ **Correspondence should be addressed:** Mikhail Yu. Gavryushin
ul. Chapaevskaya, 89, Samara, 443099, Russia; m.yu.gavryushin@samsmu.ru

**Received:** 23.10.2022 **Accepted:** 25.11.2022 **Published online:** 29.12.2022

**DOI:** 10.24075/rbh.2022.058

# СРАВНИТЕЛЬНЫЙ АНАЛИЗ ФИЗИЧЕСКОГО РАЗВИТИЯ ШКОЛЬНИКОВ И ДЕТЕЙ, ПРОФЕССИОНАЛЬНО ЗАНИМАЮЩИХСЯ ПЛАВАНИЕМ

С. Р. Абдалова, М. Ю. Гаврюшин ✉, О. В. Сазонова, Р. В. Хамцова, Д. С. Тупикова, О. В. Фролова, М. С. Нурдина

Самарский государственный медицинский университет, Самара, Россия

Состояние здоровья детей и подростков — это неотъемлемый критерий уровня благополучия общества. В свою очередь мониторинг состояния здоровья детской популяции не воможен без оценки физического развития детей и подростков. Анализ антропометрических признаков на индивидуальном уровне необходим для построения персонализированных профилактических мероприятий. С учетом различного уровня физических нагрузок школьников, при нарушениях нутритивного статуса подход к исследованию компонента массы тела, отклоняющегося от нормы, требует изучения. Целью исследования была оценка физического развития и компонентного состава тела у школьников в период медицинского осмотра и у детей, профессионально занимающихся классическим плаванием в спортивном клубе г. Самара. Объектом исследования были дети, обучающиеся в общеобразовательном учреждении и не занимающиеся в каких-либо спортивных секциях (первая группа), и дети-спортсмены, профессионально занимающиеся классическим плаванием в спортивном клубе г. Самара (вторая группа). Проведенное исследование физического развития и компонентного состава тела школьников, которые не занимаются спортом, и детей-спортсменов выявило достоверные различия основных показателей состава тела.

**Ключевые слова:** гигиена детей и подростков, физическое развитие, антропометрические показатели, биоимпедансный анализ

**Финансирование:** работа выполнена при поддержке гранта Президента РФ (МК-5809.2021.3).

**Вклад авторов:** С. Р. Абдалова — инициатор исследования; О. В. Сазонова, М. Ю. Гаврюшин — научное руководство; Р. В. Хамцова — обработка результатов, редактирование рукописи; Д. С. Тупикова, О. В. Фролова — сбор материала, подготовка результатов; М. С. Нурдина — анализ литературы, подготовка рукописи.

**Соблюдение этических стандартов:** исследование одобрено этическим комитетом ФГБОУ ВО СамГМУ Минздрава России (протокол № 9 от 24 сентября 2022 г.). Добровольное информированное согласие было получено для каждого участника (его законного представителя).

✉ **Для корреспонденции:** Михаил Юрьевич Гаврюшин
ул. Чапаевская, д. 89, г. Самара, 443099, Россия; m.yu.gavryushin@samsmu.ru

**Статья поступила:** 23.10.2022 **Статья принята к печати:** 25.11.2022 **Опубликована онлайн:** 29.12.2022

**DOI:** 10.24075/rbh.2022.058

Physical development is the most important objective indicator of health in our country, children and adolescents in particular, and displays the effect of psychoemotional, economic, climate, geographical and social factors on their health [1, 2]. Under modern conditions of life, over 25% of schoolchildren have disharmonious physical development, which is strongly associated with an excessive body mass and obesity [3, 4]. In the majority of cases, it results from a change in the way of life and disturbed nutrition among schoolchildren, which, in its turn, promotes prevention of a number of diseases and creates favorable conditions for a child's adaptation to the environment. According to the WHO, 340 million of people aged 5 to 19

suffer from obesity. In the Samara region, newly diagnosed obesity incidence of children is still high and amounted to 54.9 cases per 10 thousand of children in 2020 [5]. The most important constituent of health monitoring is represented by individual and collective assessment of how an adolescent's body is developed. A sharp decrease in physical development of children and adolescents has been found in the Volga Federal District in the last few years [6–8]. Incidence of non-infectious diseases, and obesity, in particular, is increased, a number of healthy children is reduced and a number of children with a chronic pathology is increasing more and more [9]. Properly organized physical education can form the basis of harmonious physical development of a child, enhance the nervous system and immunity, and improve the state of the body. Besides, sport teaches the child discipline, develops a strength of character and will power and an ability to set and achieve goals [10, 11]. During the intensive growth of children and especially athletes, excessive weight can be associated not just with predominant deposition of fat stores, but also with high values of skeletal muscle mass in accordance with anthropometric analysis. Biophysical methods display more exact results of measured body mass characteristics. The method of body composition bioimpedance analysis (BIA) was the most widespread application [12–14]. The study results are used in clinical setting to analyze the alimentary status, nutritional condition, risk of metabolic syndrome, obesity, cardiovascular and other pathologies, and as a diagnostic criterion of therapy effectiveness in various diseases [15, 16]. The need in studying the body mass component, which deviates from the normal values in case of disharmonious physical development requires examination taking into account different levels of physical load among schoolchildren.

The study purpose consisted in comparison of physical development and component composition among schoolchildren and children involved in classical swimming at a sports club in Samara.

## PATIENTS AND METHODS

The study object involved children studying at a general educational institution and not engaged in any sports sections (first group) and children engaged in classic swimming at a sports club in Samara (second group). The study was conducted at educational institutions and at a sports institution for supplementary education, respectively. Organizations, supervisors of which approved participation of children in the study, were selected. Anthropometric values and component composition analysis were measured in 110 children (54 people were schoolchildren, 56 were junior athletes) aged 9 to 12. Inclusion criteria for the first group: schoolchildren who are not engaged in sports or who go in for sports for less than 2 years, without clinical manifestations of the disease, and having the first or second group of health at the time of examination. Inclusion criteria for the second group: schoolchildren involved in classical swimming at a sports organization for supplementary education 3 and more times a week for at least two years and permanently residing in the Samara region; children without clinical manifestations of diseases and having the first or second group of health at the time of examination. Exclusion criteria for the both groups: chronic diseases; intake of medicinal preparations, marked edemas of the extremities; permanent residence outside the Samara region; refusal of parents (legal representatives) to participate in the study. Additional exclusion criteria for the second group: going in for classic swimming at a sports club 2 times a week or less; for less than two years.

Body length and mass were measured using standard instruments such as a height chart with accuracy up to 0.5 cm for body length, and VEM-150-Massa-K electronic medical scale with accuracy up to 60 g for body mass. Anthropometric values were assessed using the regional regression scale for the Samara region and Anthro-prof software product such as Programme assessing physical development of schoolchildren [17]. Component composition and phase angle were determined using Medass ABC-02 appliance as per the standard scheme and disposable bioadhesive electrodes. Percentage of adipose mass (PAM,%), active cell mass (ACM, kg), phase angle (PA, degrees), skeletal muscle mass (SMM) and percentage of SMM (%) were analyzed. During the process, special attention was paid to the angle between the right shoulder and vertical body axis, which, in accordance with the method, should constitute 45°; the right forearm should be located parallel to the body vertical axis, whereas legs should be placed on the width of the shoulder. BIA was carried out in the morning on an empty stomach or 2.5–3 hours after food intake [18]. Primary data were collected and stored in Microsoft Excel 2010 (USA). Statistical processing of the obtained materials was done with Statistica programme package (StatSoft Inc.; USA, version 13.1).

## STUDY RESULTS

Analysis of physical development in two groups has revealed a significant difference in a number of children with harmonious physical development ($p$ = 0.43). Children with disharmonious physical development due to excessive body mass are found in both groups. However, these differences were not significant ($p$ = 0.321). The first group includes children with a deficient body mass in accordance with regional regression scales; no such children were detected in the second group though three children had an excessive body length. Results of physical development in two groups are presented in table 1.

Analysis of AM (kg), AM (%), SMM (kg) and percentage of SMM (%), AAM (kg), and PA (degrees) was performed for every

**Table 1.** Results of physical development in two groups

| Values of physical development | | | Group 1 | Group 2 | $p$ |
|---|---|---|---|---|---|
| Normal (harmonious) physical development | | Abs. | 34 | 49 | – |
| | | % | 63 | 87.5 | 0.043 |
| Disharmonious physical development | BMI | Abs. | 10 | 4 | – |
| | | % | 18.5 | 7.2 | 0.321 |
| | Body mass deficiency | Abs. | 10 | – | – |
| | | % | 18.5 | – | – |
| | High body length | Abs. | – | 3 | – |
| | | % | – | 5.3 | – |

**Table 2.** Quantitative assay of BIA values

| BIA values | Schoolchildren | Junior athletes | *p* |
|---|---|---|---|
| AM (kg) | 10.8 ± 1.4 | 6.1±1.7 | 0.032 |
| AM (%) | 21.5±2.1 | 16.6±1.1 | 0.041 |
| SMM (kg) | 11.5±3.1 | 18.3±1.2 | 0.043 |
| SMM (%) | 42.3±1.1 | 52.4±4.6 | 0.031 |
| AAM (kg) | 16.3±2.1 | 19.7±4.4 | 0.487 |
| PA (degrees) | 4.3±0.44 | 6.88±1.22 | 0.049 |

**Table 3.** Gradation of BIA values

| BIA value | Gradation | Schoolchildren | Junior athletes | *p* |
|---|---|---|---|---|
| AM (%) | Normal value | 34±1.1 | 49±0.44 | 0.001 |
| | Deficiency | 10±0.23 | 3±2.3 | 0.004 |
| | Excess | 10±0.71 | – | – |
| SMM (%) | Normal value | 30±1.16 | 48±1.0 | <0.001 |
| | Deficiency | 22±0.56 | – | 0.001 |
| | Excess | 2±0.22 | 8±1.6 | 0.003 |
| ACM (%) | Normal value | 48±1.11 | 50±1.12 | 0.203 |
| | Deficiency | 5±2.23 | 2±1.34 | 0.251 |
| | Excess | 1±0.22 | 4±1.21 | 0.083 |
| PA (degrees) | Normal value | 46±0.91 | 48±2.11 | 0.033 |
| | Low | 7±0.56 | – | – |
| | High | 1±1.11 | 8±1.1 | <0.001 |

child from the examined groups (table 3). During comparison of bioimpedansometry results it has been found out that AM (kg) and AM (%) in schoolchildren is significantly higher than in children involved in swimming ($p = 0.032$). Schoolchildren had significantly lower values of SMM (kg) ($p = 0,043$ and $p = 0,031$, respectively). The values of phase angles in schoolchildren were significantly lower ($p = 0.487$) as compared with junior athletes.

However, there were no statistical significance in the values of active cell mass among schoolchildren and children who went in for sports ($p = 0.487$). Quantitative assay of BIA values is shown in table 2.

If a gradation of values is produced, it should be noted that a number of children with percentage of adipose tissue is significantly higher than a number of children in the second group (<0.001). In the first group, a number of examined children was also significantly higher ($p = 0.004$). No children with excessive adipose tissue were found in the second group.

The values of skeletal muscle mass showed opposite results, whereas the normal values were significantly higher in the first group as compared with the second one ($p = 0.003$). According to bioimpedansometry, no children with deficiency of muscular mass were detected in the second group.

Percentage of active cell mass was similar in both groups.

The value of normal phase angle was significantly lower in the first group ($p = 0.033$), with a higher high value in the second group ($p < 0.001$). A gradation of BIA values is presented in table 3.

## DISCUSSION OF RESULTS

Based on the study of anthropometric indicators, children with disharmonious physical development due to both an excessive body mass, and body mass deficiency were revealed in the group of schoolchildren. In the group of junior athletes, disharmonic physical development occurred due to excessive body mass but in a smaller number of people as compared with schoolchildren, and also a small percentage of the examined children had a high body length.

Bioimpedansometry displays the results of anthropometric studies in every group. The adipose body mass is a marker of 'hidden obesity' and allows to assay the excess or shortage of a fat constituent in the body. According to the analysis of adipose body mass in a group of schoolchildren, a great number of children with higher values displaying an excessive alimentary status and predisposition to obesity was discovered. None of the examined junior athletes had an excessive adipose body mass. In our opinion, which coincides with studies of other authors [10, 15], the adipose mass is a source of energy for an athlete and is directly associated with physical performance of athletes closely correlating with biochemical and functional parameters of the body widely used in sports.

The skeletal muscle mass values were decreased in the first group, with muscle deficiency being found in a certain percentage of those examined. The latter can be associated with a decreased physical activity of children and can result in reduced efficiency and endurance, decreased immunity, obesity and muscular spasms. Higher values of skeletal muscle mass and percentage of skeletal muscle mass were recorded in the second group among all those examined. Increased SMM values can indicate intensive physical load and constitute an essential criterion assessing physical development in junior athletes and their constitution.

There were no differences in the active cell mass analysis among two groups. According to the present study, the results of which are consistent with the results of other authors [19–21], the active cell mass indicators can be associated with individual features of the younger generation during the active growth of the body.

A phase angle is a parameter specific for bioimpedance way of obtaining data about the general condition of the body, its fitness and endurance, and rate of metabolism. The phase angle values are increased along with regular physical loads and optimal rational nutrition. Reduced values are solitarily recorded in the first group of those examined during analysis of the phase angle, and they were within a normal range for the majority. In the second group, most athletes had increased values of the phase angle typical of those who actively go in for sports.

CONCLUSIONS

Significant differences in the primary parameters of body composition were found during the performed study of physical development and component composition of schoolchildren who do not go in for sports and junior athletes. The obtained results prove that it is necessary to use anthropometric studies along with data of bioimpedance analysis, which serves as an informative technique to assess appropriateness of nutrition, physical and motor activity of children.

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