Original article

UDC 616.5-002-053.2-056.52-007.1-08+613.2+616-073.788+616.74-007.23
https://doi.org/10.56871/CmN-W.2026.75.79.018

Features of body composition in children with atopic dermatitis and different physical development

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For citation: Al-Nawaiseh Kh.Z.H., Myslinchuk E.S., Bolshakova E.S., Sakovtseva A.A., Markovskaya I.N., Zavyalova A.N. Features of body composition in children with atopic dermatitis and different physical development. *Children's Medicine of the North-West*. 2026;14(1):229–238. (In Russ.). https://doi.org/10.56871/CmN-W.2026.75.79.018.

Received: 19.11.2025 **Revised: 22.01.2026** **Accepted: 20.03.2026**

ABSTRACT. ***Introduction.*** Atopic dermatitis is one of the most common dermatological diseases in children and adolescents. Like any chronic disease requiring dietary restrictions, it can affect physical development and nutritional status. ***Aim*** – to identify features of body composition in children with atopic dermatitis and different nutritional status based on the body mass index (BMI) Z-score. ***Materials and methods.*** This single-center, cross-sectional cohort study included 74 patients with atopic dermatitis aged 6 to 17 years 11 months (mean age 13.6 years), comprising 40 (54%) boys and 34 (46%) girls. Physical development was assessed using Z-scores. Nutritional status was initially evaluated using the BMI Z-score. Body composition was subsequently determined using bioimpedance analysis. ***Results.*** According to the SCORAD index, a moderate disease course was observed in 59 patients (78%; more frequently in the second childhood and adolescent periods), and a severe course in 15 patients (22%). Satisfactory nutritional status was found in 48 children (66%), obesity in 3 (4%), and overweight in 10 (14%). Undernutrition of varying degrees was detected in 12 patients (16%). In the group with undernutrition, body composition was characterized by a deficit in active cell mass (%ACM) in 66.7%, adequate fat mass (%FM), and a moderate excess of skeletal muscle mass (%SMM) in all children with a BMI Z-score <–1. Among overweight patients, %FM exceeded the norms in 20% and was sharply exceeded in 60%, while %ACM was within age norms in 70%, as was %SMM in 50%. All obese patients had a sharp excess of %FM; among them, 25% had a deficit in both %ACM and %SMM against the background of this excess. Notably, one-third (27%) of children with satisfactory nutritional status according to BMI Z-score had a sharp excess of %FM, and another 18% had an excess relative to sex- and age-specific norms. Only one-third of children with average BMI Z-score values demonstrated normal levels of %ACM, %SMM, and %FM. ***Conclusions.*** Based on the BMI Z-score, satisfactory nutritional status was observed in two-thirds of children with atopic dermatitis (66%), while 13% had deficient and 21% had excess nutritional status or obesity. In each nutritional status group, patients were identified with excessive fat accumulation accompanied by reduced active cellular and skeletal muscle mass. These alterations in body composition began even with satisfactory nutritional status and were more frequent among adolescents and young adults with severe skin lesions according to the SCORAD index.

KEYWORDS: *atopic dermatitis, nutritional status, body composition, bioimpedance analysis, sarcopenia*

Funding. This study was not supported by any external sources of funding.

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Оригинальная статья

https://doi.org/10.56871/CmN-W.2026.75.79.018

Особенности компонентного состава тела у детей с атопическим дерматитом при разном физическом развитии

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Для цитирования: Аль-Навайсех Х.З.Х., Мыслинчук Е.С., Большакова Е.С., Саковцева А.А., Марковская И.Н., Завьялова А.Н. Особенности компонентного состава тела у детей с атопическим дерматитом при разном физическом развитии. *Children's Medicine of the North-West.* 2026;14(1):229–238. https://doi.org/10.56871/CmN-W.2026.75.79.018.

Поступила: 19.11.2025 **Одобрена: 22.01.2026** **Принята к печати: 20.03.2026**

РЕЗЮМЕ. ***Введение.*** Атопический дерматит является одним из самых часто встречающихся дерматологических заболеваний у детей и подростков. Как любое хроническое заболевание, требующее ограничений в питании, может влиять на физическое развитие и нутритивный статус детей. ***Цель*** — выявить нарушения в компонентном составе тела у детей при разном нутритивном статусе по показателю Z-score индекса массы тела (ИМТ) у детей с атопическим дерматитом. ***Материалы и методы.*** В одноцентровое одномоментное когортное исследование вошли 74 пациента с атопическим дерматитом в возрасте от 6 лет до 17 лет 11 месяцев (средний возраст 13,6 года), 40 (54%) из них — мальчики, 34 (46%) — девочки. Изучено физическое развитие по Z-score, нутритивный статус первоначально оценивали по Z-score ИМТ, на втором этапе методом биоимпедансометрии определяли компонентный состав тела. ***Результаты.*** По шкале SCORAD у 59 (78%) пациентов заболевание сопровождалось среднетяжелым течением (чаще в период второго детства и у подростков), а у остальных 15 (22%) — тяжелым течением. Удовлетворительный нутритивный статус был у 48 (66%) пациентов, ожирение — у 3 (4%), избыток массы тела — у 10 (14%) детей. Недостаточность питания разной степени выявлена у 12 (16%) пациентов. В компонентном составе тела для них характерен дефицит доли активной клеточной массы (%АКМ) — у 66,7%, удовлетворительное содержание доли жировой массы (%ЖМ) и умеренный избыток доли скелетно-мышечной массы (%СММ) — у всех детей, имеющих Z-score ИМТ менее –1. У пациентов с избыточной массой тела превышали нормативы %ЖМ — у 20%, а резко превышали у 60%. При этом %АКМ был в пределах возрастных норм у 70%, как и доля СММ — у 50%. Среди пациентов с ожирением у всех отмечено резкое превышение %ЖМ, при этом у 25% дефицит и доли %АКМ, и доли %СММ, что на фоне избытка %ЖМ *является саркопенией*. Треть (27%) детей с удовлетворительным нутритивным статусом по Z-score ИМТ имели резкое превышение %ЖМ, еще 18% — превышение нормальных для половозрастных значений доли %ЖМ, и только треть детей со средними показателями Z-score ИМТ демонстрировали средние показатели доли %АКМ, %СММ и %ЖМ. ***Выводы.*** Удовлетворительный нутритивный статус по данным Z-score ИМТ наблюдался у двух третей детей с атопическим дерматитом (66%), у 13% — дефицитный и у 21% пациентов — избыточный нутритивный статус и ожирение. В каждой группе детей с разными нутритивными статусами выявлены пациенты с избыточным накоплением жировой массы на фоне снижения активной клеточной и скелетно-мышечной массы. Старт изменений в компонентном составе тела начинается еще при удовлетворительном нутритивном статусе. Чаще это были пациенты с тяжелым поражением кожи по шкале SCORAD, подросткового и юношеского возраста.

КЛЮЧЕВЫЕ СЛОВА: *атопический дерматит, нутритивный статус, компонентный состав тела, биоимпедансометрия, саркопения*

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

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ISSN 3034-6312 (Print) ISSN 3034-6320 (Online)

INTRODUCTION

The physical development of children against the background of chronic diseases has been evaluated in numerous scientific publications [1–3], and skin diseases are no exception [4, 5]. It is recognized that severe pathology of organs responsible for vital functions is typically associated with a deceleration of physical development (body mass deficit, growth stagnation) [6–8]. At the same time, the impact of chronic dermatoses on the nutritional status and physical development of children remains insufficiently studied [4, 9, 10]. This gap persists despite the considerable prevalence of atopic dermatitis in the pediatric population (15–20% according to various studies) [11, 12] and highlights the need for an in-depth investigation of this issue.

Of particular importance is the examination of the relationship between atopic dermatitis severity and physical development. Moderate-to-severe and severe disease course exerts a systemic effect on the child's body, extending beyond skin involvement [13, 14]. Sleep disturbances, dietary restrictions, skin condition (hyperemia, dryness, pruritus), and psycho-emotional stress create a vicious cycle capable of critically influencing the body's growth and developmental processes [15, 16].

Researchers note the polymorphic spectrum of this problem, ranging from deficiency to excess, which necessitates a clear differentiation by severity. On the one hand, children with mild atopic dermatitis most frequently present with excess body weight and obesity [14, 17–19]. This is attributed to the side effects of topical corticosteroids and physical inactivity due to reduced physical loads [20]. On the other hand, a number of authors report the development of deficiency states and delays in physical development in children with moderate and severe forms of atopic dermatitis [10, 21, 22]. This is linked to chronic inflammation, protein loss through damaged skin, and strict elimination diets [9, 22–25].

AIM

The aim of this study was to identify disturbances in body composition in children with atopic dermatitis and different nutritional status as defined by body mass index (BMI) Z-score.

MATERIALS AND METHODS

This single-center, cross-sectional cohort study enrolled 74 patients with atopic dermatitis aged 6 years to 17 years 11 months (mean age, 13.6 years); 40 (54%) were boys and 34 (46%) were girls.

All children underwent a unified examination protocol at the Dermatovenereology Department of a tertiary-level clinic (Saint Petersburg State Pediatric Medical University, Ministry of Health of the Russian Federation). The protocol included collection of life and disease history and assessment of skin involvement severity using the SCORAD scale. Physical development, including height and body mass, was evaluated, and BMI (kg/m²) was calculated. Physical development and nutritional status were assessed using WHO Anthro Plus reference tables with determination of Z-scores. To verify nutritional status disturbances, body composition was analyzed by bioimpedance analysis using the MEDASS system (Russia). The following key parameters were assessed in relation to sex- and age-specific reference values: fat mass (FM) and its percentage (%FM), active cell mass (ACM) and its percentage (%ACM), and skeletal muscle mass (SMM) and its percentage (%SMM). Patterns of physical development were analyzed by age, sex, and severity of skin involvement according to the SCORAD scale.

Legal representatives and children over 15 years of age provided written informed voluntary consent for the conduct / possible conduct of diagnostic and anthropometric procedures before enrollment in the study. The study was approved by the Ethics Committee of Saint Petersburg State Pediatric Medical University on 08 November 2023, Protocol No. 32/01.

Statistical analysis was performed using StatTech software, version 3.1.8. Categorical variables are presented as absolute numbers and percentages (%). Continuous variables were tested for normality of distribution using the Kolmogorov–Smirnov test and the Shapiro–Wilk test. When the distribution deviated from normal, the Kruskal–Wallis test was applied. When statistically significant differences were identified, the Mann–Whitney U test was applied. A two-tailed p-value of <0.05 was considered statistically significant.

RESULTS

The 74 patients (100%) were stratified into four age groups: first childhood (n=33, 45%), second

ISSN 3034-6312 (Print) ISSN 3034-6320 (Online)

childhood (n=17, 23%), adolescence (n=10, 13%), and youth (n=14, 19%). The first childhood group predominated in the study sample. Pruritus, xerosis, desquamation, lichenification, and skin infiltration were documented in 100% of the children enrolled in the study. Cutaneous hyperemia was observed in only 24% of the children. According to the SCORAD severity grading, 59 (78%) patients had moderate atopic dermatitis and the remaining 15 (22%) had severe disease. The most pronounced SCORAD changes in severe atopic dermatitis were found among adolescent boys (Fig. 2).

Assessment of physical development (body mass, height, and BMI) across the different age groups revealed a noteworthy pattern. Specifically, a leftward shift of indicators (into the deficit zone) was observed in children of first childhood, while a tendency toward a rightward shift (into the area of excess values) was noted in adolescents and youths (Fig. 1).

Nutritional status was initially assessed using BMI Z-scores. Two-thirds of the children (n=48; 66%) had a satisfactory nutritional status (corresponding to an average BMI Z-score). Obesity was diagnosed in 3 patients, and overweight in 10 children. Malnutrition of varying severity (undernutrition) was identified in 12 patients. Body mass deficit and growth retardation were diagnosed in the first and second childhood periods in the setting of moderate atopic dermatitis. Starting from adolescence, physical development indicators exhibited a rightward shift, reaching the range of high values by youth. Among children with deficient BMI Z-scores (corresponding to a low BMI Z-score), 75% had moderate atopic dermatitis according to the SCORAD scale. Overall, deficient BMI Z-scores predominated in girls across all age periods, with the exception of adolescence. Among children with excess BMI Z-scores (corresponding to overweight and obesity according to Z-score BMI), 86% also had moderate atopic dermatitis according to the SCORAD scale. This group was predominantly composed of male patients of adolescent and youth age ($p < 0.005$).

Body composition was assessed by age using qualitative indicators separately for children with satisfactory nutritional status according to BMI Z-score, for children with deficient nutritional status, and for those with excess nutritional status. The bioimpedance analysis data were scored as follows: 1 — deficient, 2 — satisfactory, and 3 — excess. A score of 4 denoted values exceeding

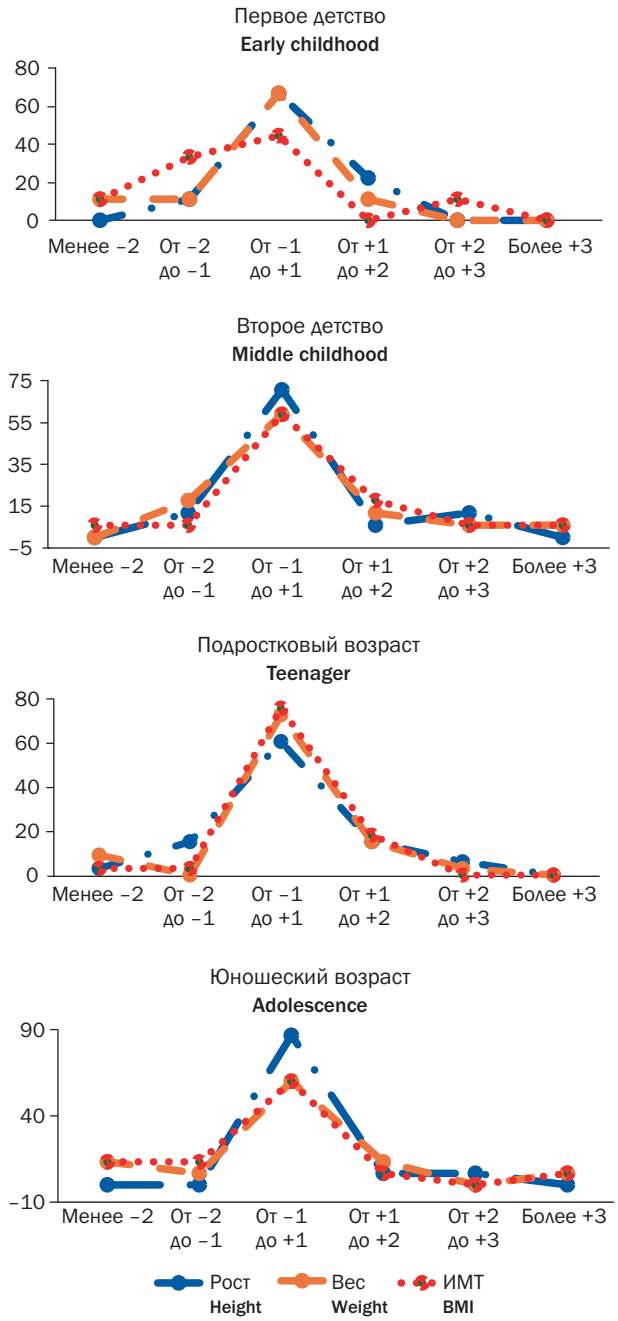

Fig. 1. The Z-score indicators of children's physical development by age (the figure is prepared by the authors using their own data)

Рис. 1. Показатели Z-score физического развития детей в зависимости от возрастного периода (рисунок подготовлен авторами по собственным данным)

100% of age-specific reference values, adjusted for height.

Among children with deficient BMI Z-scores (n=12; 16%), a deficit of active cell mass percentage (%ACM) was characteristic in 66.7%. At the same time, the percentage of fat mass (%FM) was satisfactory and the percentage of skeletal muscle mass

ISSN 3034-6312 (Print) ISSN 3034-6320 (Online)

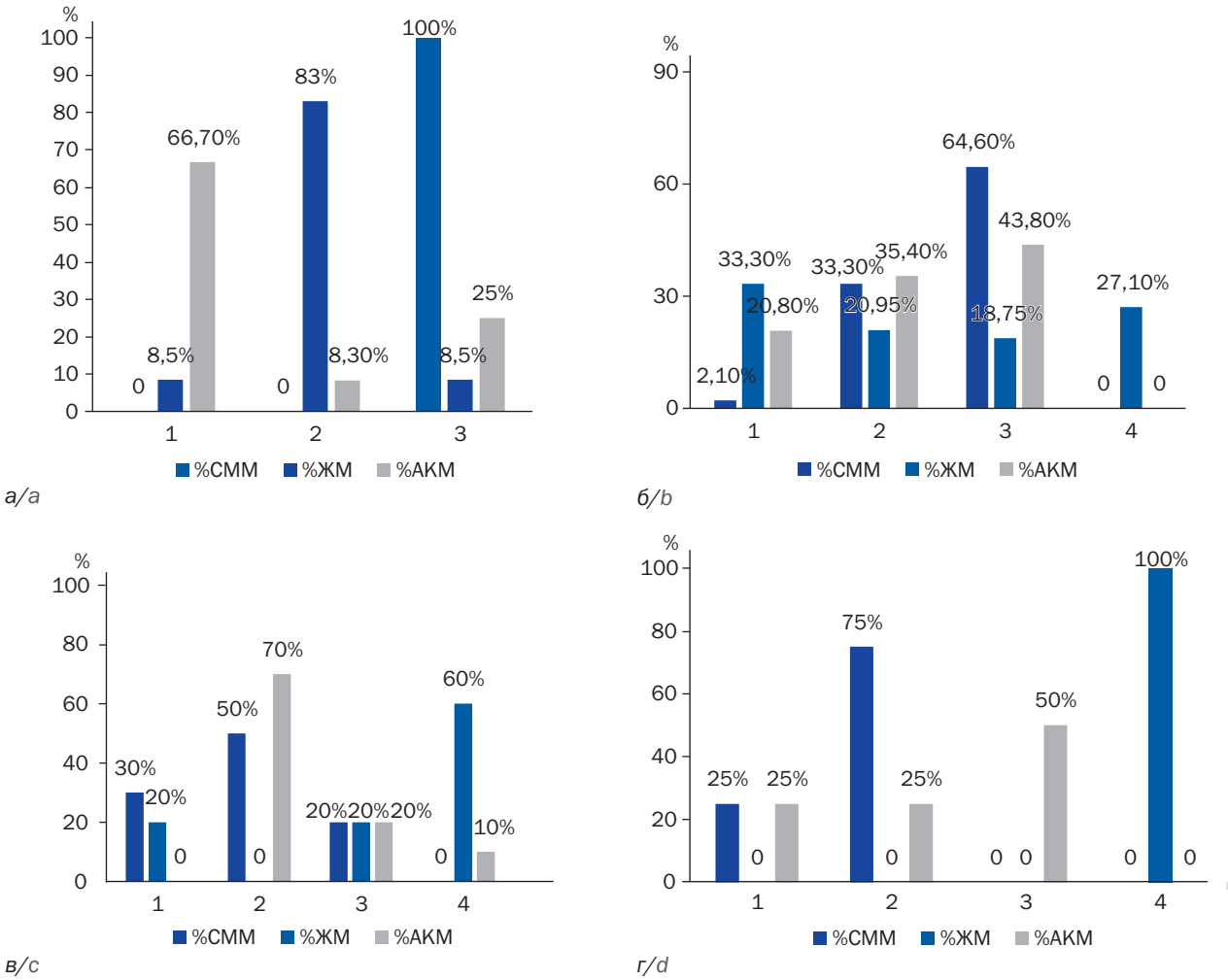

Fig. 2. Individual indicators of body composition (proportion of skeletal muscle mass (%CMM), proportion of fat mass (%ЖМ), proportion of active cell mass (%АКМ)) in children with low BMI Z-score indicators: *a* — with low BMI Z-score indicators; *b* — in children with average BMI Z-score; *c* — overweight according to the Z-score BMI; *d* — in obese children according to Z-score BMI. Columns: 1 — deficiency indicators, 2 — average values, 3 — excess indicators; 4 — excess of more than 100% depending on age standards considering growth (the figure is prepared by the authors using their own data)

Рис. 2. Отдельные показатели компонентного состава тела (доли скелетно-мышечной массы (%СММ), жировой массы (%ЖМ), активной клеточной массы (%АКМ)) у детей: *а* — дефицитный нутритивный статус; *б* — удовлетворительный нутритивный статус (Z-score ИМТ); *в* — избыточный нутритивный статус (Z-score ИМТ); *г* — ожирение (Z-score ИМТ). Столбцы: 1 — дефицитные показатели; 2 — средние значения; 3 — избыточные показатели; 4 — превышение более 100% в зависимости от возрастных нормативов с учетом роста (рисунок подготовлен авторами по собственным данным)

(%SMM) was moderately excessive in all children with a BMI Z-score below −1 (Fig. 2, *a*).

In patients with excess BMI Z-scores, the percentage of fat mass exceeded reference values in 20% of cases and was markedly excessive in 60%. Concurrently, the percentage of active cell mass fell within age-specific reference values in 70% of patients, and the percentage of skeletal muscle mass was within normal limits in 50% of those examined. Of particular note are children with a deficit of skeletal muscle mass percentage against the background of excess body mass according to BMI, a condition that may be regarded as sarcopenia (Fig. 2, *c*) [26, 27].

Among patients with obesity, a marked excess of fat mass percentage was observed in all cases, whereas 25% exhibited a deficit of both %ACM and %SMM, which, in the setting of excess %FM, is regarded as sarcopenia (Fig. 2, *d*).

Of greatest interest are patients with satisfactory BMI Z-scores. Their body composition proved to be the most heterogeneous. One-third (27%) of

ISSN 3034-6312 (Print) ISSN 3034-6320 (Online)

these children had a markedly excessive %FM, another 18% had an excess of %FM relative to sex- and age-specific reference values, and only one-third of children with satisfactory BMI Z-scores demonstrated average values of %ACM, %SMM, and %FM. Excess body mass and obesity were more frequently encountered among boys in the adolescent and youth age group ($p < 0.005$).

DISCUSSION

This study included predominantly children with severe atopic dermatitis. Physical development indicators varied across age periods. However, body composition data in children with satisfactory nutritional status according to BMI Z-score revealed fat mass accumulation in 18% and a marked excess relative to age- and sex-specific reference values in 27% of children. Physical development indicators in children with chronic diseases do not always reflect the true nutritional status [4]. Both satisfactory values of skeletal muscle mass, active cell mass, and fat mass, as well as various combinations of %SMM, %ACM, and %FM proportions, may be concealed behind deficient or excess body mass or BMI Z-scores [2, 24, 27, 28]. In the long-term course of chronic diseases requiring systemic therapy, the proportion of patients with excess body mass and obesity increases toward adolescence and youth [5]. Notably, the onset of changes in body composition occurs while mean BMI Z-scores still fall within the satisfactory range [29], a pattern also observed in our study. The replacement of active cell mass and skeletal muscle mass by fat mass, together with the initiation of fat mass accumulation in the setting of average body mass relative to height and satisfactory nutritional status according to BMI Z-score, may be regarded as the onset of obesity [9, 10, 18, 25]. These changes also mark the onset of metabolic risk in these patients [29].

CONCLUSIONS

Satisfactory nutritional status according to BMI Z-score was documented in two-thirds of children with atopic dermatitis (66%), whereas deficient nutritional status was identified in 13% and excess nutritional status and obesity in 21% of patients. In each nutritional status group, patients with excessive fat mass accumulation against the background of reduced active cell mass and skeletal muscle mass were detected. In patients with excess body mass and obesity, these alterations are an anticipated finding: a marked excess and predominance of fat mass percentage over active cell mass and skeletal muscle mass were observed in 100% of cases. By contrast, similar alterations were identified for the first time in the group of children with satisfactory nutritional status. Only one-third of children with satisfactory nutritional status according to BMI Z-score demonstrated average body composition values for age and physical development. Among the remaining children, one-third (33%) exhibited a fat mass deficit, 18% had an excess, and 27% had a marked excess (exceeding 100%) of fat mass percentage relative to reference values in body structure. All these patients had severe skin involvement according to the SCORAD scale and were of adolescent and youth age.

ADDITIONAL INFORMATION

Authors' contribution. Kh.Z.H. Al-Nawaiseh — examination of patients, bioimpedance measurement, anthropometric research, article preparation; E.S. Myslinchuk — analysis of anthropometric data, graphic representation of anthropometric drawings; E.S. Bolshakova — examination of patients, permission to work with patients; A.A. Sakovtseva — bioimpedance measurement, data analysis; I.N. Markovskaya — article writing, analysis of body component composition, graphic representation of body component composition; A.N. Zavyalova — article idea, article editing.

All authors read and approved the final version before publication.

Competing interests. The authors declare that they have no competing interests.

Consent for publication. Written consent was obtained from legal representatives of the patient for publication of relevant medical information within the manuscript.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Х.З.Х. Аль-Навайсех — осмотр пациентов, биоимпедансометрия, антропометрические исследование, оформление статей; Е.С. Мыслинчук — анализ антропометрических данных, графическое изображение антропометрических рисунков; Е.С. Большакова — осмотр пациентов, разрешение на работу

ISSN 3034-6312 (Print) ISSN 3034-6320 (Online)

с пациентами; А.А. Саковцева– биоимпедансометрия, анализ данных; И.Н. Марковская – написание статьи, анализ компонентного состава тела, графическое изображение компонентного состава тела; А.Н. Завьялова – идея статьи, редактирование статьи.

Все авторы прочли и одобрили финальную версию перед публикацией.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Информированное согласие на публикацию. Авторы получили письменное согласие законных представителей пациентов на публикацию медицинских данных.

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ISSN 3034-6312 (Print) ISSN 3034-6320 (Online)

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ISSN 3034-6312 (Print) ISSN 3034-6320 (Online)