COMPONENT COMPOSITION OF THE BODY IN CHILDREN WITH CHRONIC KIDNEY DISEASE ACCORDING TO THE RESULTS OF BIOIMPEDANSOMETRY

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ABSTRACT

Body composition reflects the dynamic processes in a child's development. The recommended restrictive diets for patients with advanced chronic kidney disease (CKD) contribute to a high risk of sarcopenic muscle wasting as diagnosed by bioimpedancemetry.

The aim of the study. *To assess BMI and body composition in children with CKD, to identify features of body composition in patients with different BMI Z-score values. Materials and methods. The physical development of 110 children with CKD of different stages was assessed. Patients were divided into two clusters: Group 1 (92 children) with BMI from 10.95 to 21.5 kg/m^2, BMI Z-score did not exceed +2.0 (without obesity); Group 2 (18 children) – BMI from 24.11 to 37.2 kg/m^2, Z-score BMI – more than +2.0 (obese). All underwent bioimpedancemetry, the proportion of fat and active cell mass was assessed. The comparison was carried out by nonparametric statistics methods.*

Results. *Changes in body composition were revealed: children without obesity had severe protein-energy deficiency in 7 cases (7.6 %). The difference in the proportion of fat mass in children of different groups, Me [Q1; Q3]: Group 1 – 18.00 % [14.00; 22.00], Group 2 – 35.00 % [21.98; 41.00], (Mann – Whitney U-test: U = 279.5, p = 0.00001). In Group 1, the active cell mass was 53.50 % [51.00; 56.00], in Group 2 – 41.50 % [39.00; 47.00] (U = 174.5, p = 0.000001), there were no significant differences in other parameters of bioimpedancemetry.*

Conclusions. *The proportion of active cell mass is lower in overweight children, with a significant predominance of the proportion of fat mass, which indicates the depletion of protein reserves due to their redistribution and possible insufficient alimentary intake in advanced stages of CKD.*

Key words: *children, chronic kidney disease, nutritional status, physical development, bioimpedance measurement, sarcopenia*

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КОМПОНЕНТНЫЙ СОСТАВ ТЕЛА ДЕТЕЙ С ХРОНИЧЕСКОЙ БОЛЕЗНЬЮ ПОЧЕК ПО РЕЗУЛЬТАТАМ БИОИМПЕДАНСОМЕТРИИ

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РЕЗЮМЕ

Актуальность. *Компонентный состав тела отражает динамические процессы в развитии ребёнка. Рекомендованные ограничительные диеты для пациентов с продвинутыми стадиями хронической болезни почек (ХБП) способствуют высокому риску саркопенического истощения мышц, что диагностируется биоимпедансометрией.*

Цель исследования*. Оценить ИМТ и компонентный состав тела детей с ХБП, выявить особенности состава тела у пациентов с разными значениями Z-score ИМТ.*

Материалы и методы. *Оценено физическое развитие 110 детей с ХБП разных стадий. Пациенты разделены на два кластера: группа 1 (92 ребёнка) – с ИМТ от 10,95 до 21,5 кг/м^2, Z-score ИМТ не превышал +2,0 (без ожирения); группа 2 (18 детей) – ИМТ от 24,11 до 37,2 кг/м^2, Z-score ИМТ – более +2,0 (с ожирением). Всем проведена биоимпедансометрия, оценивалась доля жировой и активной клеточной массы. Сравнение проводилось методами непараметрической статистики.*

Результаты. *Выявлены изменения компонентного состава тела: у детей без ожирения имелась тяжёлая белково-энергетическая недостаточность в 7 случаях (7,6 %). Доказано различие содержания доли жировой массы у детей разных групп (Me [Q1; Q3]): в группе 1 – 18,00 [14,00; 22,00] %, в группе 2 – 35,00 [21,98; 41,00] %, (U-критерий Манна – Уитни: U = 279,5; p = 0,00001). В группе 1 активная клеточная масса составила 53,50 [51,00; 56,00] %, в группе 2 – 41,50 [39,00; 47,00] % (U = 174,5; p = 0,000001), по остальным показателям биоимпедансометрии статистически значимых различий не получено.*

Заключение*. Доля активной клеточной массы ниже у детей с избыточной массой тела, при значительном преобладании доли жировой массы, что свидетельствует об истощении белковых запасов за счёт их перераспределения и возможного недостаточного алиментарного поступления при продвинутых стадиях ХБП.*

Ключевые слова*: дети, хроническая болезнь почек, нутритивный статус, физическое развитие, биоимпедансометрия, саркопения*

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INTRODUCTION

Pathology of the urinary system in the pediatric population ranks second in prevalence after respiratory diseases. Chronic kidney disease (CKD), a concept accepted in internal medicine, has entered pediatric nephrology as well. CKD in pediatrics has some peculiarities. Criteria for diagnosing and staging CKD in children adapted in the 2012 KDIGO (Kidney Disease Improving Global Outcomes). Congenital kidney disease is the main cause of chronic kidney disease in children. Congenital anomalies of the kidney and urinary tract (CAKUT) are the most common causes, accounting for 60 % of cases of CKD in children [1]. Genetically determined pathologies (cystinosis, oxalosis, hereditary nephritis, interstitial nephritis) account for 20–30 %. Glomerular lesions (mainly focal segmental glomerulosclerosis and lupus nephritis) account for 10 to 20 %. Diabetic nephropathy and hypertension are rare causes of chronic kidney disease in children compared with adults [2]. Obesity-related nephropathy is a condition recognised in both therapeutic and pediatric nephrology. The risk of accelerated development of chronic kidney disease is associated with low birth weight, often accompanied by a low number of nephrons in the kidneys [3].

Chronic kidney disease in children is accompanied by changes in metabolic processes, intoxication and comorbid diseases of the gastrointestinal, cardiovascular and endocrine systems [4–6]. Irreversible changes entail disorders of physical development and nutritional status, requiring thorough diagnosis and proper tactics for their correction [7, 8]. Nutritional status is a complex of clinical, anthropometric and laboratory indicators that characterise the quantitative ratio of muscle and fat mass of the patient's body. Nutritional status disorders are associated with protein-energy malnutrition, developmental delay, and mineral and bone disorders [9]. Anaemia is a frequent complication in children with chronic kidney disease, the prevalence of which increases as the disease progresses [1]. There are standards for the diagnosis and correction of protein-energy malnutrition, but there is no acceptable definition of this condition for children with chronic kidney disease and therefore no accurate diagnostic criteria [10]. Assessment of nutritional status in children is also complicated by the absence of a gold standard, specific abnormalities in body composition and a slowly progressive disease [11]. The causes of protein-energy malnutrition in children with progression of chronic kidney disease are diverse and are associated with impaired intake and assimilation of essential nutrients [9]. This is caused by poor appetite; dysgeusia may occur against the background of taking a large number of drugs and intoxication. Increasing chronic kidney disease is often accompanied by digestive disorders: vomiting associated with gastroesophageal reflux, delayed bowel voiding due to motility disorder. Numerous studies have proven the close association between nephropathy and impaired gut microbiota already in the onset of CKD. Impared microbiome and toxic endothelial damage interfere with the hydrolysis and nutrient absorption [12]. Any inflammation, infectious or immunopathological, causes metabolic acidosis and oxidative stress, increasing as kidney function declines. This entails aggravation of endothelial dysfunction, impaired permeability of cell membranes, and also changes the ratio of components in the intra- and extracellular space. Assessment of nutritional status and its correction at early stages of chronic kidney disease is the most important task of the pediatric nephrologist. Anthropometry (measurement of height, body mass and calculation of BMI) is the main method of detecting such abnormalities. However, body composition of children with chronic kidney disease, at least from stage 3 onwards, is peculiar; anthropometry is unable to identify the real degree of protein-energy malnutrition. Patients with chronic kidney disease are at high risk of sarcopenic muscle wasting and thus at increased risk of mortality [13, 14]. Most of the existing studies evaluating the correlation between chronic kidney disease and sarcopenia have been conducted in adult dialysis patients [15–19]. There are few current studies that suggest the use of bioimpedanceometry as a component of diagnosis of impaired physical development and nutritional status. Bioimpedanceometry in children with chronic kidney disease is of particular interest and in the future may become an indispensable component of diagnostics of nutritional status of a child [20, 21].

THE AIM OF THE STUDY

To assess the deviation of BMI Z-score and biocomponent body composition of children with chronic kidney disease, to identify the features of body composition in patients with different values of BMI Z-score.

MATERIALS AND METHODS

A continuous prospective single-center study describing a series of hospital cases (patients with chronic kidney disease) was conducted in the pediatric urology and nephrology departments of St. Petersburg State Pediatric Medical University of the Ministry of Health of Russia.

Study period: January 2016 – December 2021, with no unplanned shifts in the time intervals of the study. There were no additional specific factors whose effect during the study period could have influenced the conclusions. The main indicator of the study: distribution of patients according to body fat mass, clarification of the percentage of children with active cell mass deficiency in groups of children with normal and increased body mass index.

Inclusion criteria: 2 to 18 years of age and a confirmed diagnosis of chronic kidney disease. Exclusion criteria: chronic kidney disease before the age of 2 years; patients who failed to perform bioimpedance study due to psycho-emotional agitation and children old-

er than 2 years with height less than 95 cm were not included in the study.

The diagnostic inclusion criteria for chronic kidney disease, were reduced results of glomerular filtration rate, which was determined by the Rehberg test or the Schwartz equation. Chronic kidney disease was divided into 5 stages. Stage 1 CKD is characterised by the glomerular filtration rate more than 90 ml per minute, the absence of manifestations of nephropathy. At Stage 2 CKD, the glomerular filtration rate was 60–89 ml per minute, and there were initial signs of nephropathy. Stages 3A and 3B CKD are characterised by a reduced glomerular filtration rate of 59 to 30 ml per minute and signs of severe nephropathy, shriveling and scarring of renal tissue. Stage 4, severe, of CKD was identified when the glomerular filtration rate ranged from 29 to 15 ml per minute. Stage 5 CKD, kidney failure, is diagnosed when the glomerular filtration rate is less than 15 ml per minute.

Each patient underwent anthropometry (height, body weight and BMI assessment) and bioimpedanceometry using the DIAMANT-AIST apparatus. Physical development data were assessed using WHO Anthro and WHO AnthroPlus, free-access programmes from the official website of the World Health Organisation (WHO). The Z-score of body mass index (BMI), nondimensional statistic indicator used to compare values of different dimensionality, was evaluated. We studied the distribution of patients by body fat percentage, specifying the percentage of children with active cell mass deficiency in the groups of children with normal and increased BMI. We also studied possible differences in the percentage of fat, active cell mass, BMI and Z-score of BMI in different stages of chronic kidney disease, BMI and Z-score of BMI in children of different sexes. When the amount of extracellular/intracellular fluid was assessed, it was noted that none of the patients has oedema syndrome.

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The study was conducted in compliance with the World Medical Association Declaration of Helsinki. Parents (guardians) or the patient himself or herself over the age of 15 years signed a written consent to allow diagnostic and anthropometric procedures to be carried out for the study.

Methods of statistical processing

The sample size was not pre-calculated. The data were described and statistically analysed using Statistica v. 10.0 statistical software package (StatSoft Inc., USA). The data distribution was assessed by calculating Pearson's χ^2 test (Pearson's chi-squared test). Descriptive statistics (median (Me), 25 % and 75 % percentiles [Q1; Q3]) were used for data without normal distribution.

The Mann – Whitney U-criterion (*U*) was used to identify and evaluate the differences of quantitative parameters in two independent samples without normal distribution, and the Kruskal – Wallis test was used in three or more independent samples. The fairness of the tested hypothesis was assessed by the "*p* value", $p < 0.05$ was taken as the critical value.

RESULTS

A group of 130 children was evaluated: 20 cases had criteria for non-inclusion (less than 95 cm, younger than 2 years, psychoemotional reactions in bioimpedanceometry). Thus, the group was represented by 110 patients (65 boys and 45 girls). The sample size was limited to the number of patients staying in the specialised departments of the clinic during the period of anthropometric and bioimpedance studies.

The children included in the study had the following causes of chronic kidney disease: surgical disorders of urodynamics (high-grade vesicoureteral reflux, primary obstructive megaureter, hydronephrosis, multiple malformations of the urinary system, spinal disorders of urination), or manifestations of nephrotic syndrome, glomerulonephritis, systemic lupus erythematosus, systemic vasculitis. All patients suffered from chronic kidney disease, and children with urodynamic disorders were treated in the urology department, where they underwent surgical interventions aimed at correcting the disorders; nephrological patients were treated for the underlying disease in a specialized nephrology department.

Stage 1 CKD was found in 50 (45.45 %) children. Stage 1 CKD was diagnosed in 13 (11.81 %) patients. Stage 3B CKD was detected in 20 (18.18 %) patients, Stage 4 CKD, severe, was found in 13 (11.81 %) patients. This group had residual kidney function. Children had significant somatic and biochemical abnormalities and were registered in a dialysis centre. Stage 5 CKD, kidney failure, was present in 14 (12.72 %) children, in some cases already receiving renal replacement therapy (RRT) or preparing to switch to hemodialysis, with significant somatic, biochemical and anthropometric deviations from age norms.

The data set of 110 patients who were included in the study was clustered and two clusters were formed according to BMI. Group 1 (1st cluster) included 92 patients with BMI between 10.95 and 21.5 kg/m^2, BMI Z-score not exceeding +1.0. 50 patients had BMI Z-score less than –1. Group 2 (2nd cluster) included 18 patients with excessive BMI by Z-score and a BMI score between 24.11 and 37.2 kg/m^2. BMI Z-score was more than +2.0. This gave reason, according to WHO criteria, for the diagnosis of obesity in 18 patients (16.36 % of the total number of children) [22].

Further comparison of the two groups was carried out by such bioimpedancemetry indicators as the percentage of fat mass and the percentage of active cell mass, which allows to assess the reserves and saturation of muscle tissue and tissues of internal organs with protein, and to diagnose fat protein replacement in some cases.

TABLE 1

DISTRIBUTION OF CHILDREN OF THE FIRST CLUSTER ACCORDING TO Z-SCORE OF BODY MASS INDEX

Age group	Malnutrition		Standard	Body mass excess (BME)		Total
	Z-score < –3	Z-score from –3 to –2	Z-score from –2 to –1	Z-score from –1 to +1	Z-score from +1 to +2	
Early childhood*	2	4	10	17	3	36
Middle childhood**	2	7	8	11	2	30
Adolescence***	3	4	9	7	3	26
Total	7	15	27	35	7	92

Note. * – children 3–7 years old of both sexes; ** – children 7–11 years old (girls) and 7–12 years old (boys); *** – children 11–18 years old (girls) and 12–18 years old (boys).

52 children out of 92 in the first cluster had stage 1–2 CKD and 40 had stage 3–5 CKD. Overweight was found in 4 children with stage 1–2 CKD. Among patients with stage 3–5 CKD, overweight was found in 9 patients. There were no children with obesity among them (Table 1).

92 (83.63 %) had normal or low BMI (Group 1) and 18 (16.36 %) had obesity according to WHO criteria (Group 2). There was a statistically significant difference between the groups: the age of Group 1 was 8.63 [2.64; 17.69] years and the age of Group 2 was 15.27 [7.27; 18.97] years ($U = 377.5$; $p = 0.0002$). Children with low or normal index values showed half the median age at clustering (Fig. 1).

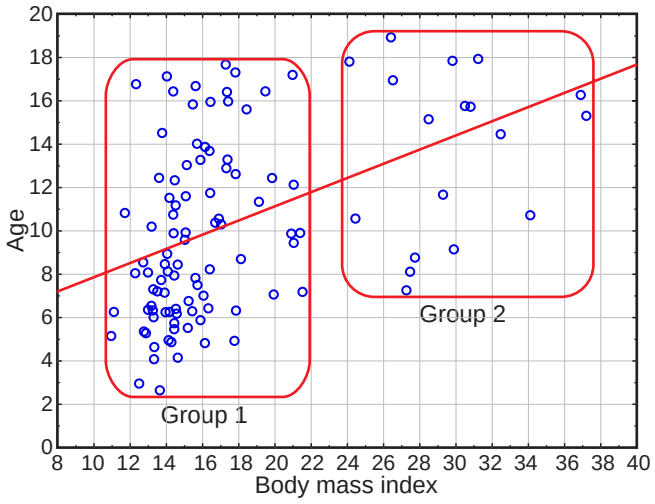

FIG. 1.

Distribution of body mass index in Groups 1 and 2 depending on age, with the formation of two clusters

According to bioimpedanceometry data, the percentage of fat mass in Group 1 was 18.00 [14.00; 22.00] %, which corresponded to 9.6 % deficiency, 85.1 % normal and 5.3 % excess fat mass; in Group 2 the percentage of fat mass was 35.00 [21.98; 41.00] %, which corresponded to 25 % normal and 75 % excess. Thus, the increase in fat mass deviation was more significant in Group 2 ($U = 279.5$; $p = 0.00001$) (Fig. 2).

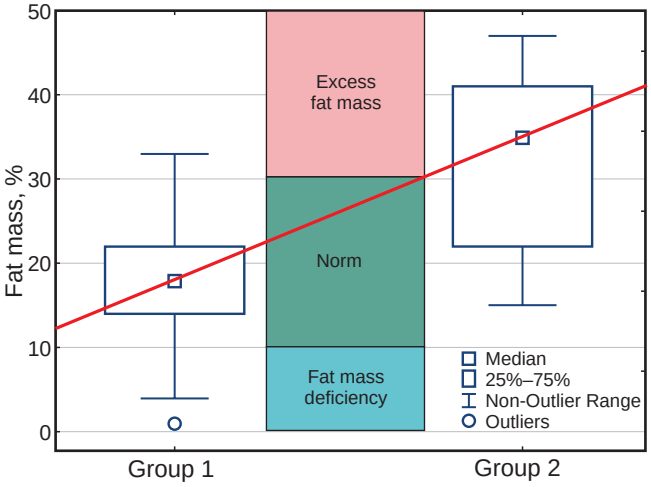

FIG. 2.

Comparison of deviations in the content of fat mass in Groups 1 and 2 (%)

In Group 1, active cell mass was 53.50 [51.00; 56.00] %, deficiency of active cell mass was noted in 19.1 %, excess in 7.4 %. In Group 2, active cell mass was 41.50 [39.00; 47.00] %, deficiency of active cell mass was noted in 81.0 %, excess was not found in any case. When analysed, there

was a statistically significant difference in the proportion of active cell mass in patients of Groups 1 and 2 ($U = 174.5$; $p = 0.000001$), with the development of a significant deficiency of active cell mass in Group 2 (Fig. 3). These patients have a significantly reduced amount of deposited muscle protein, due to redistribution and possibly insufficient alimentary intake, due to protein restriction in the diet of children with advanced chronic kidney disease.

When assessing the proportion of fat and active cell mass in subgroups of children with different stages of chronic kidney disease (stage 1–5), no statistically significant differences were obtained, according to the Kruskal – Wallis test (Table 2).

When anthropometric indicators were assessed in subgroups of children with different stages of chronic kidney disease by BMI Z-score, no statistically significant differences were obtained (Kruskal – Wallis test: $H = 2.123676$; $p = 0.7130$). Also, subgroup differences in BMI ($H = 2.776229$; $p = 0.5959$) were not proven (Table 3).

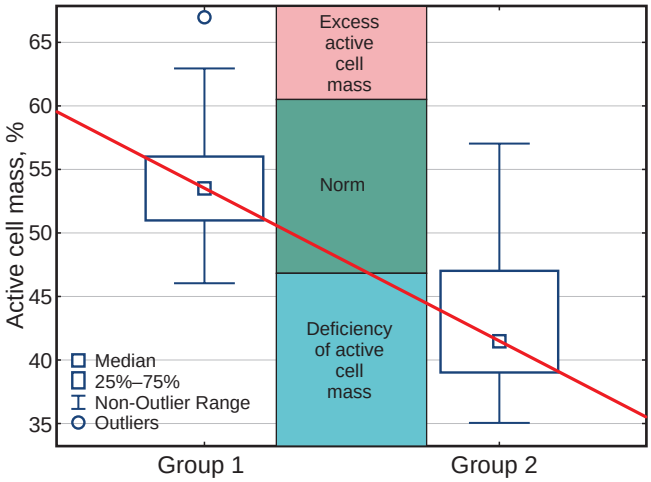

FIG. 3.
Comparison of the actual content of active cell mass in Groups 1 and 2 (%)

TABLE 2

THE PROPORTION OF ACTIVE CELL AND FAT MASS IN CHILDREN, DEPENDING ON THE STAGE OF KIDNEY DISEASE, Me [Q1; Q3]

Stage (*n*)	Age	Fat mass percentage, %	Active cell mass percentage, % ($p = 0.36$)
Stage 1 ($n = 50$)	8.51 [6.39; 11.68]	18.00 [14.00; 24.00]	53.50 [49.00; 56.00]
Stage 2 ($n = 13$)	10.74 [6.26; 15.99]	26.00 [18.00; 30.00]	49.00 [46.00; 53.00]
Stage 3 ($n = 20$)	9.92 [7.12; 15.88]	18.50 [16.00; 22.50]	52.50 [49.00; 55.00]
Stage 4 ($n = 13$)	11.18 [10.30; 13.90]	19.00 [18.00; 23.00]	54.00 [52.00; 55.00]
Stage 5 ($n = 14$)	12.96 [6.35; 14.53]	20.00 [15.00; 24.00]	52.00 [50.00; 54.00]

TABLE 3

MEDIAN DATA OF BODY MASS INDEX AND Z-SCORE OF BODY MASS INDEX IN CHILDREN DEPENDING ON THE STAGE OF KIDNEY DISEASE, Me [Q1; Q3]

Stage (*n*)	Body mass index ($p = 0.59$)	Z-score of body mass index ($p = 0.71$)
Stage 1 ($n = 50$)	15.26 [13.70; 18.11]	–0.97 [–1.94; 1.16]
Stage 2 ($n = 13$)	14.40 [13.58; 21.37]	–0.74 [–2.83; 0.82]
Stage 3 ($n = 20$)	15.90 [14.43; 23.20]	–0.83 [–1.46; 1.97]
Stage 4 ($n = 13$)	16.71 [15.23; 17.36]	–0.42 [–1.47; 0.15]
Stage 5 ($n = 14$)	15.65 [13.79; 17.84]	–1.14 [–2.08; –0.38]

TABLE 4

INDICATORS OF BODY MASS INDEX AND Z-SCORE OF BODY MASS INDEX IN CHILDREN DEPENDING ON GENDER, ME [Q1; Q3]

Stage	Sex	*n*	Body mass index ($p = 0.63$)	Z-score of body mass index ($p = 0.39$)
Stage 1	boys	$n = 30$	14.75 [13.70; 16.90]	–1.28 [–2.44; 0.32]
	girls	$n = 20$	16.15 [13.70; 20.37]	–0.56 [–1.47; 2.05]
Stage 2	boys	$n = 4$	17.35 [12.20; 27.74]	–0.16 [–5.74; 1.41]
	girls	$n = 9$	14.40 [14.20; 19.10]	–0.74 [–2.83; 0.63]
Stage 3	boys	$n = 12$	15.81 [14.44; 22.16]	–0.89 [–1.46; 0.41]
	girls	$n = 8$	15.90 [14.43; 24.18]	1.00 [–1.67; 2.14]
Stage 4	boys	$n = 10$	16.85 [16.17; 17.36]	–0.27 [–1.47; 0.23]
	girls	$n = 3$	15.23 [14.48; 19.50]	–0.49 [–1.62; –0.09]
Stage 5	boys	$n = 9$	14.40 [13.65; 18.42]	–0.79 [–2.08; –0.38]
	girls	$n = 5$	15.70 [15.61; 17.83]	–1.50 [–1.87; –0.61]

No subgroup differences by sex were found in BMI ($U = 1383.5$; $p = 0.6331$) and Z-score BMI ($U = 1323.0$; $p = 0.3980$) (Table 4).

DISCUSSION

The determination of active cell mass, the content of which characterises the percentage of metabolically active cells, is of great practical importance. Active cell mass includes mass of skeletal muscle, internal organs and nervous tissue. The percentage of active cell mass reflects muscle functional activity and indirectly allows us to estimate the physical strength reserve of an individual [20, 23]. There was a decrease in active cell mass percentage in Group 2 by more than a quarter compared to Group 1: 53.50 [51.00; 56.00] and 41.50 [39.00; 47.00] %. In Group 1, deficiency of active cell mass was detected in 19.1 % of cases, in Group 2 – in 81 % of cases. Percentage of fat mass in Group 1 was almost half that of Group 2 children (18.00 [14.00; 22.00] and 35.00 [21.98; 41.00] %). Excess fat mass in Group 1 was diagnosed in 5.3 % of children, in Group 2 excess fat mass was found in 75 % of cases. Adolescent obese patients are characterised by excess fat mass and its prevalence over active cell mass in the body component composition [24, 25]. According to a number of authors, excess fat mass and its prevalence over active cell mass progresses with age and becomes one of the predictors of early development of sarcopenia among adults [20].

The study of nutritional status of patients with CKD often reveals anthropometric abnormalities [26, 27], associated with the peculiarity of nutrition of children in this group (significant limitation of alimentary protein intake) [28], existing fluid and electrolyte disorders that progress with increasing course of CKD and a glomerular filtration rate decline. The percentage of active cell mass of a child with a normal or low BMI of 73.5 % corresponds to the norm, while in Group 2, there is a drop in the percentage of active cell mass and its replacement by fat cells due to muscle protein resorption, which leads to an increase in the percentage of fat

mass. According to bioimpedanceometry data, children with a high body mass index (Group 2) suffering from chronic kidney disease have in most cases active cell mass deficiency (mass of muscles and internal organs), which against the background of the body's load of fat replacement tissue significantly reduces physical abilities to move and vital activity. Children with chronic kidney disease may have both average anthropometric indicators and body mass deficiency or obesity [26]. Patients with chronic kidney disease face serious challenges in maintaining adequate nutrition and growth [28]. Our study showed a higher content of adipose tissue in children with excessive body weight on the background of chronic kidney disease, due to the replacement of active cell mass, which can be interpreted, in fact, as steatosis (adipose degeneration) of the macroorganism. The study allowed for the first time in Russia to assess the state of fat and active cellular components of patients with renal pathology, with the formation of evidence-based conclusions about significant differences in the groups of children with low/normal and excessive body weight, which contributes to the understanding of the formation of nutritional status of these patients. The results obtained in the prospective study have a high level of statistical significance and allowed us to make valid conclusions [29]. To develop precise recommendations for daily protein supplementation for children with deficiency of active cell mass on the background of chronic kidney disease and steatosis (adipose degeneration), further studies are needed to assess the influence of factors of alimentary and renal metabolism, the state of the macroorganism, family and social factors.

Study limitations

There was no objective possibility to fully take into account the peculiarities and quality of nutrition of patients, social status, duration of the disease and effectiveness of the treatment for the study. Thus, it is possible that the actual values of fat and active cell mass in subgroups of children with chronic kidney disease and different social status may slightly differ. A larger sample size could allow for in-depth exploratory analyses in subgroups, assessing possible correlations and other influencing factors.

CONCLUSION

Our study revealed that all children with chronic kidney disease can be divided into two groups based on obesity, according to BMI values and WHO criteria. The biocomponent composition of the patients' body was proved to differ in the percentages of fat and active cell mass. Almost 85 % of children in Group 1 have normal fat mass, while in Group 2 the percentage of such patients is almost 4.5 times lower, and most children have excess body fat mass. In the group of children without obesity, there was severe protein-energy deficiency in 7 cases (7.6 %). Children with pathologically high values of BMI Z-score (more than +2) have a significant deficiency of active cell mass against the background of excess adipose tissue due to resorptive-replacement processes and insufficient nutritional intake, which corresponds to the criteria of sarcopenia [21]. The results of the study demonstrate the necessity of using bioimpedanceometry for complex diagnostics of nutritional status disorders for each particular child with chronic kidney disease, regardless of the stage of the disease.

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Conflict of interest

The authors declare the absence of a conflict of interest.

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