

## ОСОБЕННОСТИ ФИЗИЧЕСКОГО РАЗВИТИЯ И УРОВНЯ НУТРИЕНТОВ У ДЕТЕЙ С РАССТРОЙСТВАМИ АУТИСТИЧЕСКОГО СПЕКТРА

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**Цель.** Изучить состояние физического развития и уровень кальция и железа крови у детей и подростков с расстройствами аутистического спектра (РАС) с учетом особенностей пищевого поведения. **Материалы и методы.** 64 детям и подросткам в возрасте от 2,5 до 15 лет с РАС проводилась оценка физического развития по стандартам ВОЗ, оценка содержания сывороточного железа и общего кальция в крови. Родители детей проходили анкетирование по вопросам, посвященным особенностям пищевого поведения у их ребёнка. **Результаты.** Нарушение нутритивного статуса при расстройствах аутистического спектра у 21,9% детей и подростков проявляется повышением индекса массы тела и у 18,7% – его снижением. Ожирение 1-2 степени зарегистрировано у 12,5%, белково-энергетическая недостаточность 1 степени – у 6,2% обследуемых детей. При лабораторной оценке выявлено снижение уровня сывороточного железа у 37,3% детей, общего кальция – у 45,1%. При этом, у детей, длительно соблюдающих безглютеновую диету, уровень железа с возрастом возрастает, в отличие от детей, не соблюдающих диетотерапию ( $p < 0,05$ ). Подавляющее большинство детей с РАС имеют избирательный аппетит (73,4%), при этом в питании преобладают легко усваиваемые углеводы. **Заключение.** Существенных изменений в показателях физического развития у детей с РАС в сравнении с популяцией не установлено. При этом, у детей с РАС наблюдаются более низкие показатели сывороточного железа и кальция, которые могут корректироваться соблюдением диеты.

**Ключевые слова:** аутизм; расстройства аутистического спектра; физическое развитие; железо; кальций; нутриенты; пищевое поведение.

## PECULIARITIES OF PHYSICAL DEVELOPMENT AND OF LEVEL OF NUTRIENTS IN CHILDREN WITH AUTISTIC SPECTRUM DISORDERS

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**Aim.** To study the state of physical development and the level of calcium and iron in children and adolescents with autistic spectrum disorders taking into account the characteristics of eating behavior. **Materials and Methods.** 64 children aged 2.5 to 15 years with autistic spectrum disorders were assessed for physical development according to WHO standards, and for iron and total calcium in the blood. Parents of children were surveyed on issues related to the peculiarities of eating behavior in their children. **Results.** In 21.9% of children and adolescents with autistic spectrum disorders, alteration of nutritional status was manifested by an increase in the body mass index and in 18.7% – by a decrease in it. 1<sup>st</sup>-2<sup>nd</sup> degree obesity was found in 12.5%, 1<sup>st</sup> degree protein-energy insufficiency in 6.2% of the examined children. Laboratory tests revealed a decreased level of serum iron in 37.3% of children, and of total calcium in 45.1%. At the same time, in children being kept on gluten-free diet for a long time, iron level increased with age, in contrast to



those who did not use diet therapy ( $p < 0.05$ ). The vast majority of children with autistic spectrum disorders exhibited a selective appetite (73.4%) with predomination of easily digestible carbohydrates in their diet. **Conclusion.** No significant alterations in the parameters of physical development of children with autistic spectrum disorders were found in comparison with the population. With this, in children with autistic spectrum disorders lower parameters of serum iron and calcium were observed that could be corrected by following a diet.

**Keywords:** autism; autistic spectrum disorders; physical development; iron; calcium; nutrients; eating habits.

Evaluation of physical development and determination of the content of nutrients in blood permits dynamic observation of the nutritional status and the general health condition of children. Alteration of physical development is sometimes one of the first clinical manifestations of a chronic disease in a child. Further monitoring of anthropometric parameters may be an additional indicator for analysis of the dynamics of the course of the disease and of the effectiveness of conducted treatment. Parameters of physical development of children may also vary depending on the course of perinatal period, delivery terms, social conditions, environmental factors, nutrition, etc. [1-3].

Children with autistic spectrum disorders (ASD) were found to have a reduced psychophysical tone. This produces a negative influence on physical development and motor abilities of patients [4]. One of ASD peculiarities is a selective appetite that may also contribute to changes in physical development. It was also found that deficit of nutrients produces a negative impact on cognitive functions of children [5-4].

Elimination diets (gluten-free and casein-free) are not included into the international therapeutic protocols of management of patients with autism. The existing scientific research works do not clarify this question. They both confirm and reject the effectiveness of gluten-free diet (GFD) and casein-free diet (CFD) as a therapeutic means for ASD in part of correction of behavioral disorders and gastrointestinal symptoms [6]. H.D. Pusponogoro, et al. (2015) showed that following elimination diets for two weeks did not give

any therapeutic effect [7]. On the contrary, research of F. Ghalichi, et al. (2016) demonstrated a positive clinical dynamics in case of inclusion of GFD into a course of therapy of children with ASD: after 6-week keeping to GFD, in 40 of 80 patients (50%) the incidence of gastrointestinal symptoms declined from 40.5% to 17.10%, while in the control group (40 individuals) the incidence of symptoms changed insignificantly (from 42.45% to 44.05%,  $p > 0.05$ ) [8]. Data of effectiveness of diet therapy in treatment for ASD indirectly evidence intolerance to gluten in a part of children which, in turn, may influence the level of physical development and provision of an organism with nutrients including calcium and iron [9-11].

Provision with calcium and iron in childhood is of primary importance for formation of organs and systems, for physical development and formation of intellectual potential of a child. However, literature data on the problem of deficit of nutrients in children with ASD are scarce.

The *aim* of research was to study the condition of physical development and the level of calcium and iron in blood of children and adolescents with disorders in the autistic spectrum taking into account peculiarities of eating behavior.

### Materials and Methods

Into the research 64 children with ASD were included living in the territory of the Voronezh region, and their parents. The age of children was from 2.5 to 15 years (lower quartile – 6 years, median – 8 years, upper quartile – 11 years, mean age – 6.3 years).

Physical development of patients was evaluated using percentile tables recommended by WHO [12]. Parents answered questions of a specially designed questionnaire concerning peculiarities of nutrition of their children.

Material for evaluation of the levels of calcium and iron was venous blood of patients taken from the cubital vein in the morning in fasting condition. Calcium was determined by a unified colorimetric method (with the average values given in mmol/l), and serum iron – by colorimetric «Zgelezo-Vital» method without deproteinization (with the average values given in  $\mu\text{mol/l}$ ). The analysis was carried out on the biochemical photometric kinetic analyzer ABhFk-02 «NPP-TM» (Russia) with use of kits of AO Vital Development Corporation (Russia). By technical reasons blood was taken from 51 children.

All stages of the study were performed according to Law of RF, international ethical standards and normative documents of research organizations. The conducted research was approved by the Local ethical committee of N.N. Burdenko Voronezh State Medical University (Protocol №1 of 25.01.2017). Parents signed Informed consent for participation in the study.

Statistical analysis of the data was carried out using applied program package Statistica 10.0 (Statsoft Inc., USA). Methods of descriptive statistics and correlation analysis were used. Differences were considered statistically significant at  $p < 0.05$ .

### Results and Discussion

In evaluation of the body length depending on age, this parameter in most children (41 individuals, 64.1%) was in the interval between 15<sup>th</sup> and 85<sup>th</sup> percentile which indicates the average height of these children. 4.6% of the examined children (3 children) had low body length (<3<sup>d</sup> percentile), in 12.5% of children (8) this parameter was below the average (3<sup>d</sup>-15<sup>th</sup> percentiles), in 11.0% (7) this parameter was above the norm (85<sup>th</sup>-97<sup>th</sup> percentiles), in 7.8% of children (5) the parameter was high (>97<sup>th</sup> percentile, Figure 1).

Analysis of body mass depending on age showed that in 70.3% (45) of children the parameter had the value characteristic of 15<sup>th</sup>-85<sup>th</sup> percentiles. Body mass above average values (85<sup>th</sup>-97<sup>th</sup> percentiles) was determined in 6.2% (4) of patients, 9.4% (6) of examined children had high body mass (>97<sup>th</sup> percentile). Reduction of body mass below average values (3<sup>d</sup>-15<sup>th</sup> percentile) was recorded in 4.7% (3) of children, and low body mass – (<3<sup>d</sup> percentile) – in 9.4% (6 children, Figure 1).

The analysis of distribution of body mass index (BMI) depending on age showed that more than half the children (59.4%, 38 children) had normal BMI (15<sup>th</sup>-85<sup>th</sup> percentiles), 6.2% (4) of children had low parameter (<3<sup>d</sup> percentile), 12.5% (8) had reduced parameter (3<sup>d</sup>-15<sup>th</sup> percentiles), in 9.4% (6) of children the parameter was above the average value (85<sup>th</sup>-97<sup>th</sup> percentiles), in 12.5% (8) it was >97<sup>th</sup> percentile.

So, parameters of physical development of children with ASD in cohort study practically did not differ from those of children of the Voronezh region [11]. Thus, the incidence of the average height in the general cohort of children of the Voronezh region was only 2.8% higher than in children with ASD. Difference in the mean values of BMI depending on age was also minimal and made 1.9%, here, excessive body mass was more characteristic of children of 8-10 years of age.

Reduction in the level of serum iron relative to the age-related norms was found in 37.3% of the examined children and adolescents (19 individuals), with the average value  $11.9 \pm 5.5 \mu\text{mol/l}$ .

The incidence of iron-deficiency anemias in schoolchildren in the world is 25.% and in preschoolers – 47.4%. The territories of the Russian Federation with highest incidence of iron deficiency conditions are North Caucasus, Eastern Siberia and North, where the latent deficit of iron is found in 50-60% of children [14]. According to WHO experts, from the point of view of importance to

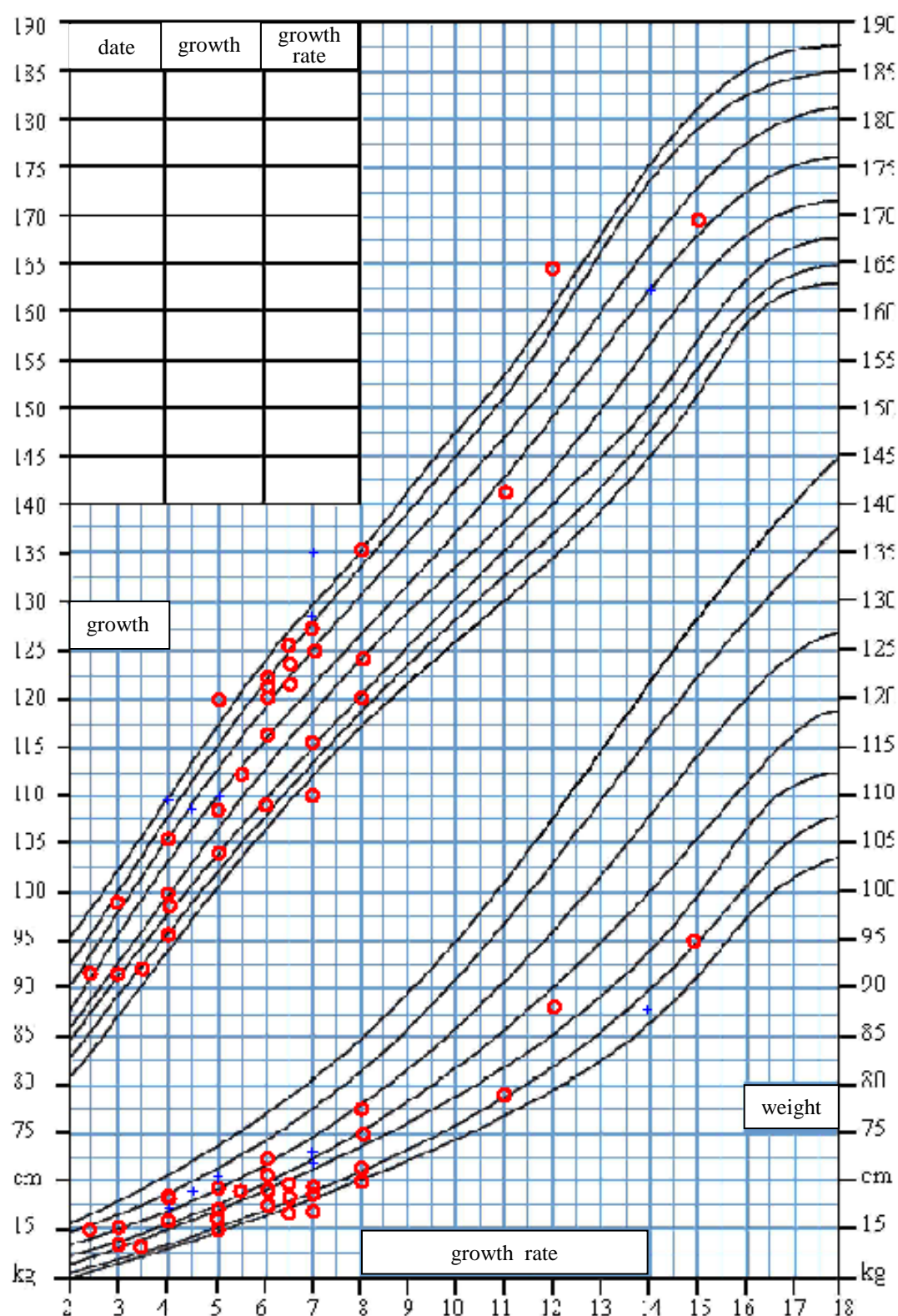


Fig. 1. Physical development of children and adolescents with ASD

*Note:* red mark – parameters of children and adolescents of male gender, blue – of female gender, the results are given on the height-weight-age nomogram [13]



the public health, the incidence of anemia in the population may be classified as low – up to 5-19.9%, moderate – 20-39.9% (the cohort of children and adolescents studied by us fell into this category – 37.7%) and significant –  $\geq 40\%$ . Significant incidence of anemia requires measures at the government level [15].

Survey of parents revealed that at the moment of blood taking 13 children had been kept on GFD for a long time (for not less than 6 months). Correlation analysis of dependence of the content of serum iron in blood on age of patients with and without diet therapy showed a positive correlation relationship in children kept on GFD/CFD ( $r=0.552$ ,  $p\leq 0.05$ ), that is, increase in the concentration of serum iron with age. However, in children not following these diets, a small but statistically significant negative correlation relationship with age was found ( $r=-0.076$ ,  $p\leq 0.05$ ). This result reflects a favorable influence of diet therapy on provision of an organism of a child with ASD with iron.

It was found that approximately half the children (45.1%, 23 children) had a reduced level of calcium in blood. Correlation analysis of the relationship between concentration of the total calcium in blood serum and age *in the whole cohort of the examined individuals* did not show any correlations. However, after division of the patients into groups on the basis of keeping to the diet, correlations were revealed: in patients who did not follow the diet  $r = -0.111$ ,  $p\leq 0.05$ , in children kept on GFD/CFD –  $r=0.003$ ,  $p\leq 0.05$ .

Survey of parents of children subjected to laboratory diagnosis showed that 73.4% of children with ASD (47) were selective in food. The obtained results agree with the research of V. Postorino, et al. (2015) who evaluated the role of food selectivity in behavioral and gastroenterological manifestations in children with autism. The authors did not detect any significant differences in gastroenterological symptoms and adaptive potentials between patients with ASD without limitation

in the diet and those with selective appetite. However, it was found that children with food selectivity presented with more severe behavioral disorders, with their parents having a higher level of stress [16].

In our study 76.6% of children and adolescents with ASD (36) preferred flour confectionary, 36.2% (17) – sausage products, 65% (31) used chocolate and sweets in high amounts, 57.4% of children (27) rejected plant products, 55.3% (26) showed selectivity in milk products.

Thus, the given work conducted with the aim to study the level of physical development and to determine lack of macronutrients, confirms the fact that alterations of the nutritional status are rather common in children with autistic spectrum disorders and are of clinical and scientific interest from the point of view of individualization of therapy and personification of correction of complications of the conducted treatment.

### Conclusions

1. No significant changes in parameters of physical development of children with autistic spectrum disorders in comparison with the population were revealed. In 21.9% of children and adolescents with disorders of autistic spectrum alterations in the nutritional status were manifested by increase in body mass index, and in 18.7% – by its reduction. I-II degree obesity was found in 12.5% of patients, and I degree protein-energy insufficiency – in 6.2%.

2. Laboratory tests revealed latent iron deficit in 37.3%, and hypocalcemia in 45.1% of children. With this, in children kept on gluten-free/casein-free diet, iron level increased with age ( $r=0.552$ ,  $p\leq 0.05$ ), in contrast with those who did not use diet therapy ( $r = -0.076$ ,  $p<0.05$ ).

3. On the basis of the results of surveying parents of children and adolescents, in 73.4% of them food selectivity was recorded with predomination of easily digested carbohydrates.

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#### Дополнительная информация [Additional Info]

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