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IRON DEFICIENCY IN ADOLESCENTS OF THE SAKHA REPUBLIC (YAKUTIA)

The article is devoted to an urgent problem – iron deficiency conditions in children in the Far North. The aim of the study was to study the prevalence and risk factors for the development of iron deficiency anemia in children of the Republic of Sakha (Yakutia). Among the 200 adolescents aged 12 to 17 years examined, iron deficiency anemia was detected in 28% and latent iron deficiency in 30%. The group of examined 56 adolescents with iron deficiency anemia was divided into two groups: 32 girls and 24 boys. The presence of anemia was confirmed by laboratory indicators. Risk factors for the development of iron deficiency anemia in girls were heavy and prolonged menstruation, fasting, refusal to eat meat, intense physical activity, gastritis and colitis, and in boys - pubertal growth spurt, intense physical activity, refusal to eat meat.

Keywords: anemia, iron, hemoglobin, transferrin, adolescents.

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Introduction. Iron deficiency anemia (IDA) and latent iron deficiency are a pressing problem in modern pediatrics. IDA is observed in 6-40% of the child population depending on the region of residence. Over the past fifteen years, the incidence of anemia in children has increased 3.7 times. The highest prevalence of iron deficiency is observed in the Northern territories, where latent iron deficiency is detected in 50-60% of children [1, 2]. Of all anemias, 80% is IDA. Regional statistics on the frequency of anemia in children and adolescents in Russia vary greatly, reaching maximum figures in the republics of the North Caucasus and the northern territories of Russia. According to statistics for 2023, the incidence of anemia in adolescents aged 15 to 17 in the Republic of Sakha (Yakutia) was 4161 cases per 100 thousand adolescent population, which is a high figure

for the Russian Federation (1694 per 100 thousand adolescent population) [5]. The prevalence of IDA in children changes with age and depends on the child's gender. During the period of rapid growth, iron deficiency reaches 50% and prevails in girls, they grow faster and experience menstrual blood loss. Literature data on the prevalence of IDA in children indicate not only the socio-medical significance of iron deficiency conditions, but also the importance of the influence of micro- and macroecological regional elements. Over the past two decades, the incidence of IDA in children of the Republic of Sakha (Yakutia) has changed, which requires further study.

Objective of the study: to study the prevalence and risk factors for the development of IDA in adolescents of the Republic of Sakha (Yakutia).

Materials and methods. We analyzed the data of 200 patients who visited the outpatient clinic of the Republican Hospital No. 1 - National Center of Medicine, using the free sampling method. The inclusion criteria in the study group were: the child's age from 12 to 17 years and complaints of weakness, fatigue, frequent acute respiratory viral infections. The exclusion criteria from the group were congenital pathology of the hematopoietic system (megaloblastic anemia, thrombocytopenic purpura, hemolytic anemia, etc.). Girls predominated in the study group (60%), by age, children were most often aged 12 to 15 years - 65%,

the remaining children (35%) were aged 15 to 17 years.

The adolescents underwent an in-depth study of venous blood from the cubital vein on an empty stomach. Blood was tested to determine the general extended blood test, iron-binding capacity of serum, blood iron level, ferritin and transferrin saturation coefficient. When comparing statistical differences in groups, a nonparametric evaluation criterion, the Mann-Whitney method, was used. The critical value of the significance level (p) was taken to be 0.05.

Results and discussion. According to the results of the analysis of 200 adolescents who visited the clinic for various diseases, half of them were found to have iron deficiency conditions: IDA was found in 56 (28%) and latent iron deficiency in 60 (30%) adolescents.

All children with identified IDA complained of weakness - 80% (160 children), fatigue 100% (200 children), dizziness in 50% (100 patients), taste perversion in 20% of those examined - children had a desire to eat chalk, earth, etc., pale skin and mucous membranes were noted in 100% of those examined, headaches were noted in 80% of those examined (160 children).

Table 1 shows the distribution of latent iron deficiency and IDA by gender in adolescents from 12 to 17 years old.

Thus, as can be seen from Table 1, latent iron deficiency and IDA were more often observed in adolescent girls.

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According to the World Health Organization (WHO, 2021), the global prevalence of anemia among adolescents (15–19 years) remains significant, with IDA accounting for about 50% of all cases of anemia in children and adolescents. The exact rates vary by region, but on average, IDA is detected in 10–20% of adolescents in developed countries and up to 30–40% in developing countries [13].

The Global Burden of Disease (GBD) 2019 study found that the global age-standardized prevalence of anemia in 2019 was 23,176.2 per 100,000 population, with higher rates among adolescent girls (especially 15–19 years) due to menstrual blood loss [8].

In developing countries such as South Asia and sub-Saharan Africa, the prevalence of IDA among adolescents can reach 35–50%, which is associated with malnutrition, infections (e.g. malaria), and low availability of iron-rich foods [8, 10].

Data for circumpolar regions are limited, but studies indicate an increased prevalence of IDA among indigenous peoples. For example, among Inuit and other indigenous children in Canada, IDA is found in 20–30% of adolescents; in Scandinavia, the prevalence of IDA is lower (about 10–15%) among the Sami, due to better access to health care and iron fortification programs, but is still higher among adolescent girls [9].

The prevalence of IDA in Russia varies greatly by region: from 6% in large cities with good medical infrastructure to 40% in rural and northern regions [2, 3]. This is higher than the European average, but lower than in South Asia or Africa.

An analysis of laboratory parameters of IDA blood in adolescents was conducted. Table 2 shows the data on the content of hemoglobin and erythrocytes in the general blood test.

As can be seen from Table 2, adolescents had low red blood cell counts per unit volume of blood and hemoglobin, while the decrease in hemoglobin in adolescent girls was statistically significantly lower than in boys.

Table 1
Distribution of iron deficiency conditions in adolescents depending on gender

Iron deficiency conditions	Girls	Boys
Latent iron deficiency, n=60	36 (60%)	24 (40%)*
Iron deficiency anemia, n=56	32 (57%)	24 (43%)

Note. In table 1-3 *p<0.05.

Table 2
Comparison of general blood test parameters in adolescents with iron deficiency anemia by gender (girls n=32, boys n=24)

Standards of indicators	Hemoglobin		Erythrocytes	
	120-150 g/l		4.0-5.2 · 10 ⁹ /l	
Groups	girls	boys	girls	boys
Values	90.0±0.05 г/л	115.2±0.03 г/л*	3.3±0.08·10 ⁹ /л	3.9±0.06·10 ⁹ /л

International standards for diagnosing IDA in adolescents include hemoglobin levels below 12 g/dl for girls and 13 g/dl for boys (WHO). According to literature, adolescents with IDA often have average hemoglobin values of 9–11 g/dl [7, 10], which correlates with the results of this study.

All children with IDA (56 people) had their blood tested to determine serum iron-binding capacity, blood iron levels, ferritin, and transferrin saturation coefficient. The data obtained were compared among girls and boys. Table 3 also provides international standards for diagnosing IDA in adolescents.

As can be seen from the table, the average values of all the studied parameters of the blood ferrum complex were below the generally accepted norms. In this study, statistically significantly lower ferritin levels (10 µg/l), serum iron levels (4.3 µmol/l) and an increase in the iron-binding capacity of the serum (81.8 µmol/l) were found in adolescent girls than in adolescent boys, which corresponds to international data on a more severe course of IDA in girls due to physiological iron losses [11].

Analysis of laboratory parameters indicates a decrease in iron per unit volume of blood (serum iron), as well as transport forms of blood proteins containing iron (ferritin), a decrease in the blood iron saturation coefficient (transferrin saturation coefficient), an increase in the level of the parameter reflecting the amount of iron that can be transported by the blood throughout the body (total iron-binding capacity of the blood serum) [7].

When ascertaining the data of the anamnesis of the disease, the following factors contributing to the development of iron deficiency anemia were identified: refusal to eat meat (beef, horse meat, venison), spurt growth, intense physical activity, heavy menstruation in girls (Table 4).

Risk factors for the development of IDA in girls include fasting, abstinence from meat, weight-loss diets, gastritis, and colitis. The main predisposing factor for IDA in girls was found to be heavy and prolonged menstruation.

Risk factors for the development of iron deficiency in boys include a pubertal growth spurt, intense physical activity, and abstinence from meat.

Table 3
Comparison of ferrum complex levels in blood serum in adolescents with IDA by gender (girls n=32, boys n=24)

Standards of indicators	TIBC		Serum iron blood		Transferrin saturation coefficient		Ferritin	
	45.3-77.1 µmol/l		8.95-30.43 µmol/l		15-45%		15-150 mcg/l	
Groups	girls	boys	girls	boys	girls	boys	girls	boys
Values	81.8±0.05 µmol/l	77.2±0.03 µmol/l	4.3±0.08 µmol/l	7.09±0.06* µmol/l	10±0.0%	11±0.03%	10± 0.07 mcg/l	15±0.03* mcg/l

TIBC – total iron-binding capacity of serum

Table 4

Risk factors for the development of iron deficiency conditions in adolescents

Risk factors	Girls, n=32	Boys, n=24
Abstinence from red meat (beef, horse meat, venison)	13 (41%)	6 (25%)
Weight loss diets	5 (16%)	-
Pubertal growth spurts	-	12 (50%)
Intense physical activity	3 (9%)	9 (38%)
Heavy and prolonged menstruation	22 (69%)	-
Gastritis and colitis	7 (22%)	4 (17%)

In developing countries, the high prevalence of IDA is associated with nutritional deficiencies (low intake of heme iron), parasitic infections (malaria, helminthiasis), and chronic diseases. For example, in India, 52–63% of adolescents have anemia, with IDA prevalent due to vegetarian diets and low socioeconomic status. [12] In developed countries such as the United States and Europe, IDA is less common (5–10% among adolescents), but remains a problem among risk groups (vegetarians, girls with heavy menstruation). Iron screening and food fortification programs reduce the prevalence of anemia [11].

According to the literature, in circum-polar regions, the main risk factors include: limited access to iron-rich foods due to geographic isolation; a shift from traditional diets to diets low in red meat (e.g. replacing beef with chicken or canned meats with lower iron bioavailability); environmental factors such as cold climates, which increase energy requirements and the burden on iron metabolism [6].

Conclusion. Among adolescent patients living in Yakutia and seeking medical attention with various diseases, half were found to have iron deficiency conditions: IDA was found in 28%, latent iron deficiency in 30% of adolescents. This study indicates a high prevalence of pathology in the region and correlates with data from a number of regions of the Russian Federation [2, 4].

The work on the study of the presence of IDA in adolescents is confirmed by the results of laboratory tests: reduced levels of ferritin (10–15 µg / l), serum iron (4.3–7.1 µmol / l), transferrin saturation coefficient (10–11%), erythrocytes (3.3–3.9 · 10⁹ / l), hemoglobin (90–115 µmol / l) and a high level of iron-binding capacity

of blood serum (77.2–81.8 µmol / l). The main factor contributing to the development of IDA in adolescents is the discrepancy between the body's iron stores and needs. The main risk factors for IDA in adolescent girls include heavy and prolonged menstruation, as well as refusal to eat meat and fasting. In adolescent boys, the risk factors for IDA are: pubertal growth spurt, intense physical activity and refusal to eat meat.

During examination of adolescents from 12 to 17 years old, a thorough anamnesis is collected (to identify risk factors), a complete blood count and the level of serum iron, transferrin, ferritin and total iron-binding capacity of the blood serum are required. Children with IDA and latent iron deficiency are recommended to eat foods rich in iron (meat, liver, etc.), treat gastrointestinal diseases, limit intense physical activity, and take iron supplements. Girls should be examined by an obstetrician-gynecologist.

Adolescence is a period of increased iron demand, which not only affects the iron level in the blood, but also the general condition of the adolescent child.

The authors declare no conflict of interest.

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