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COMPARATIVE CHARACTERISTICS OF IRON DEFICIENCY STATES IN CHILDREN OF NEPAL AND THE NORTH CAUCASUS, TAKING INTO ACCOUNT THE ADHERENCE TO TRADITIONAL NUTRITION AND VEGETARIANISM

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СРАВНИТЕЛЬНАЯ ХАРАКТЕРИСТИКА ЖЕЛЕЗОДЕФИЦИТНЫХ СОСТОЯНИЙ У ДЕТЕЙ НЕПАЛА И СЕВЕРНОГО КАВКАЗА С УЧЕТОМ ПРИВЕРЖЕННОСТИ ТРАДИЦИОННОМУ ПИТАНИЮ И ВЕГЕТАРИАНСТВУ

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Iron deficiency conditions are widespread diseases. Nepal, as well as the North Caucasus, refer to mountainous territories in connection with which the question of the influence of the geographic climate area of accommodation on the frequency of iron deficiency states is. The purpose of the study: to determine the frequency of iron deficiency states in children of one year of life in Nepal and the Kabardino-Balkarian Republic, living in conditions of lowland and middle mountains, taking into account the commitment to traditional nutrition and vegetarianism. A study of 228 children was conducted one year of life: 83 children were from Nepal and 145 children from Kabardino-Balkarian Republic. The high frequency of iron deficiency in children of one year of life in Nepal (44.5 %) and the North Caucasus (62 %) was revealed. So, with the same amount of iron coming from food, living in the Municipality leads to a greater frequency of latent iron deficiency than in children living at a lower height relative to sea levels both in Nepal and in the CBD. Children from families of traditional vegetarianism did not differ from the studied indicators from children whose families had no such restrictions on nutrition.

Keywords: children of one year of life, latent iron deficiency, iron deficiency anemia, middle mountains

Железодефицитные состояния являются широко распространёнными заболеваниями. Непал, как и Северный Кавказ, относится к горным территориям, в связи с чем возникает вопрос о влиянии климатогеографической зоны проживания на частоту железодефицитных состояний. Цель исследования: определить частоту железодефицитных состояний у детей одного года жизни в Непале и Кабардино-Балкарской Республике, проживающих в условиях низкогорья и среднегорья, с учётом приверженности традиционному питанию и вегетарианству. Проведено исследование 228 детей 1 года жизни: 83 ребенка – жители Непала, 145 детей – Кабардино-Балкарской Республики. Выявлена высокая частота железодефицитных состояний у детей первого года жизни в Непале (44,5 %) и на Северном Кавказе (62 %). Таким образом, при одинаковом количестве железа, поступающего с пищей, проживание в среднегорье приводит к большей частоте латентного дефицита железа, чем у детей, проживающих на более низкой высоте относительно уровня моря, как в Непале, так и в КБР. Дети из семей традиционного вегетарианства не отличались по изучаемым показателям от детей, в чьих семьях не было подобных ограничений по питанию.

Ключевые слова: дети первого года жизни, латентный дефицит железа, железодефицитная анемия, среднегорье

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ID – iron deficiency
IDA – iron deficiency anemia
HCT – hematocrit
HGB – hemoglobin
KBR – Kabardino-Balkarian Republic
MCH – mean concentration hemoglobin
MCHC – mean corpuscular hemoglobin concentration
MCV – mean corpuscular volume
RBC – red blood cells
RDW – red cell distribution
SF – serum ferritin
s-TfR – soluble transferrin receptors

Iron deficiency states are among the most widespread diseases in the world. The frequency of occurrence of iron deficiency states is not the same in different countries and depends on social and economic factors [1, 2]. According to the World Health Organization (2021), 42 % of children less than five years of age and 40 % of pregnant women in the world are anemic. Iron deficiency is recorded in 25–60 % of young children [3–5].

The prevalence of iron deficiency anemia in children in Nepal, according to different authors, ranges from 35 to 48 % [6, 7]. The incidence of iron deficiency in young children in Nepal is not well understood. There are works by individual authors on the prevalence of ID up to 43 % in children of Nepal aged 6–23 months [8].

Nepal, like the North Caucasus, belongs to the mountainous territories. In this regard, the question naturally arises about the influence of the climatic and geographical zone of residence on the frequency of iron deficiency states in these sites. There are data of studies in the literature on the effect of high altitude conditions on the erythron system, based on which the conclusion about adaptation to hypoxia of red blood cells by increasing the number of erythrocytes and hemoglobin was made. The peculiarities of erythroid hematopoiesis associated with changes in the altitude of residence above sea level are due to intensive and intense erythropoiesis in conditions of physiological iron deficiency. Separate works on the influence of the middle mountains of the North Caucasus on the erythrocytic system and iron metabolism have been published [9, 10].

A distinctive feature of Nepal is the commitment of a large group of the population to vegetarianism. The issue of the effect of vegetarianism in children on hematopoiesis is not sufficiently covered in the literature, and the results are contradictory [11–13]. We have not found any studies on the effect of traditional vegetarianism, which was observed in several generations, on the state of the erythrocyte system of an infant.

With this in mind, we set the goal of the study: to determine the frequency of iron deficiency and iron deficiency anemia in children of one year of age in Nepal and the Kabardino-Balkarian Republic, living in low and middle mountains, taking into account adherence to traditional nutrition and vegetarianism.

Material and Methods. To study the frequency of iron deficiency and iron deficiency anemia, a randomized controlled study was conducted on 228 children one year of age, of which 83 children were born in Nepal and 145 children – in the Kabardino-Balkarian Republic. Inclusion in the study groups was carried out in parallel. The criteria for inclusion of children in the study were: age – one year of life; the first dispensary group of health; satisfactory condition at the time of the survey; absence of acute inflammatory diseases during the last month; children without feeding defects in the first year of life; vaccination more than two weeks before the study; lack of taking prophylactic doses of iron preparations for various subjective reasons; signed informed consent of the parents for the study. All children were from socially well-off families. Complementary foods were introduced in a timely manner: the first complementary foods were cereals, the second – vegetable purees, the third – meat dishes in children of the traditional diet, and the absence of such in children from vegetarian families.

The criteria for excluding children from the study were: prematurity; intrauterine growth retardation; intrauterine infections; the presence of chronic somatic pathology; previous acute illness within four weeks before the start of the study; vaccination within two weeks before study entry; taking iron supplements; irrational feeding, refusal of parents to participate in the study.

The first group consisted of the children of Nepal, who lived in the low and middle mountains (I – 83 children), and the second – the children of the KBR, also from two geographical zones (II – 145 children).

After a clinical and laboratory study, children were identified without signs of IDA and ID: group IA – residents of the low mountains of Nepal (25 children), group IIA – residents of the low mountains of the KBR (30 children). Group IB (21 children) and IIB (25 children) consisted of children without signs of iron deficiency states who lived in the middle mountains of Nepal and the KBR, respectively. Groups III (38 children) and IV (45 children) were Nepalese children from families where traditional vegetarianism was traced for more than three generations and from non-vegetarian families (omnivores).

Altitudes above sea level are measured by satellite altimetry (Branching Ltd., 4.0.3.2015).

The study of blood parameters of children in Nepal was carried out in the eastern region of Nepal – the city of Biratnagar, the village of Khile, and the Biratnagar hospital. The study of blood parameters in children of the KBR was carried out in the pediatric departments of the State Healthcare Institution «City Children's Polyclinic № 1» (Nalchik), the district outpatient clinic of the Chereksky district of the KBR.

Biochemical studies were carried out at Birat International Reference Laboratory PVT. Ltd, Biratnagar Hospital (Nepal), at the Departments of Microbiology, Virology, and Immunology, Federal State Educational Institution of «Kabardino-Balkarian State University named after I. I. HM. Berbekov». The duration of the study was six weeks. The study was carried out after the approval of the ethical committee at the Medical Faculty of the Kabardino-Balkarian State University. All children were examined with the permission of the administration of children's clinics, the Ministry of Health and Population of Nepal (Kathmandu). According to the Declaration of Helsinki on the conduct of scientific research, all examinations of children were performed after the parents signed informed consent.

The study of capillary blood of residents of Nepal was carried out on the Siemens Advia centaur XP analyzer, residents of the KBR – on an automatic hematological analyzer BC-5300 from Mindray. The following erythro-

cyte parameters were determined: red blood cells (RBC), hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean concentration hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution (RDW). Venous blood in an amount of 2 ml was used to determine the content of serum ferritin (SF), soluble transferrin receptors (s-TfR) using the Siemens ADVIA Chemistry XPT apparatus in Nepal, AIFR-1 «Uniplan» – in the KBR. We used test systems from Veda. Lab and Vector-Best, respectively (reagent kits for enzyme immunoassay to determine serum concentrations). To take into account the results of measurements, calibration graphs were constructed.

An increase in the content of s-TfR>2.9 μg/ml, according to national recommendations, is considered the criteria for latent iron deficiency [1, 14, 15]. The criteria for hypochromic anemia were supposed to be a decrease in the concentration of hemoglobin less than 110 g/l, MCH less than 27 pg and SF less than 12 μg/l [16–18].

Statistical studies and analysis of the results were performed using the standard software package «Microsoft Excel 2010», Statistica for Windows 13.0 (StatSoft, USA). The Shapiro – Wilk test was used to determine the type of data distribution. For parametric quantitative data, the arithmetic mean and the error of the arithmetic mean (M±m) were determined. Intergroup differences in the analysis of quantitative parametric data calculated using the Student's t-test, in case of abnormal distribution in groups, according to the Mann – Whitney U-test. The study of the relationship of variables was performed by calculating the Pearson correlation coefficient (r). Differences between patient groups were considered significant at $p<0.05$.

Results and Discussion. The frequency of iron deficiency in children living in Nepal was 44.5 %. Of these, ID accounted for 20.5 % of the number of all children, IDA – 24 %. The frequency of iron deficiency states in children living in the KBR was 62 %, of which the frequency of ID was 47.6 %, and IDA was 14.5 %.

It found that with a change in the height of residence, the frequency of iron deficiency conditions changed (Table 1). The study of laboratory blood parameters of healthy children living in the lowlands of Nepal and the KBR showed no significant differences (RBC – 4.4±0.23 и 4.0±0.31×10^{12}/l; Hb – 114±2.3 и 116±2.5 g/l; MCH – 28.5±0.4 и 28.5±0.6 pg; MCV – 83.9±2.5 и 82.2±2.7 fl; MCHC – 338±11.5 и 339±10.5 g/l; RDW – 15.8±2.3 и 15.0±1.6 %; SF – 34.5±18.5 и 40.1±14.7 μg/l; s-TfR – 2.1±0.32 и 2.5±0.25 μg/ml). The results obtained correspond to the average indicators of healthy children presented in the literature [18, 19].

Table 1

Blood parameters of healthy children living at different heights of Nepal

Parameter	Group IA (n=25)	Group IB (n=21)	Reliability of differences (p)
RBC (x 10^{12}/l)	4.4±0.23	4.7±0.17	p=0.003
Hemoglobin(g/l)	114.0±2.3	123.0±4.4	p=0.004
MCH (pg)	28.5±0.4	28.0±0.6	p>0.05
MCV (fl)	83.9±2.5	82.8±2.0	p>0.05
MCHC (g/l)	338±11.5	337±10.5	p>0.05
RDW (%)	15.8±2.3	16.2±1.5	p>0.05
Serum ferritin (μg/l)	34.5±18.5	25.5±9.4	p>0.05
s-TfR (μg/ml)	2.1±0.32	2.6±0.18	p=0.005

To study the influence of living in the middle mountains on the erythrocyte system, a comparative analysis of the studied indicators of children living in the low and middle mountains was carried out, making it possible to identify similar patterns in Nepal and the KBR (Table 2).

Table 2

Blood parameters of healthy children living at different heights of the KBR

Parameter	Group IIA (n=30)	Group IIB (n=25)	Reliability of differences (p)
RBC (x 10^{12}/l)	4.0±0.31	4.8±0.2	p=0.003
Hemoglobin (g/l)	116.0±2.5	124.0±4.1	p=0.004
MCH (pg)	28.5±0.6	27.6±0.3	p=0.04
MCV (fl)	82.2±2.7	80.4±3.5	p>0.05
MCHC (g/l)	339±10.5	332±11.5	p>0.05
RDW (%)	15.0±1.6	18.6±1.8	p=0.004
Serum ferritin (μg/l)	40.1±14.7	30.1±8.7	p>0.05
s-TfR (μg/ml)	2.5±0.25	3.2±0.15	p=0.005

With an increase in the height of residence, an increase in the number of erythrocytes, hemoglobin, and s-TfR and a tendency to a decrease in the level of ferritin were noted. There were no significant differences in MCH, MCV, MCHC and RDW in the compared groups.

When comparing the laboratory parameters of children living in the middle mountains of Nepal and the KBR, no significant differences were found either.

In connection with the adherence to various types of nutrition of children living in Nepal, the question arose about possible differences in blood counts.

It should be noted that the frequency of breastfeeding among children living in Nepal was slightly higher and amounted to 56 % versus 52 % among children living in the KBR. Artificial feeding in both groups was carried out with adapted artificial feeding; the difference was artificial feeding based on soy (9 %) in Nepalese children. Complementary foods were introduced on time in both groups: the first complementary food was vegetable puree, the second was porridge, while in Nepal, rice-free porridges were more often introduced, and the third complementary food dish among the inhabitants of the KBR was broth and then meat purees, which were not introduced among the inhabitants of Nepal.

As shown in Table 3, there were no significant differences in blood levels of the level of soluble blood receptors and ferritin, depending on the nature of nutrition.

Table 3

Blood parameters of vegetarians and omnivores living in Nepal

Parameter	Group III (n=38)	Group IV (n =45)	Reliability of differences (p)
RBC (x 10^{12}/l)	4.6±0.3	4.5±0.2	p>0.05
Hemoglobin (g/l)	113.0±6.5	118.0±7.0	p>0.05
MCH (pg)	28.4±0.7	32.3±2.5	p>0.05
MCV (fl)	80.5±1.2	83.5±3.0	p>0.05
MCHC (g/l)	310.0±18.2	342.0±22.5	p>0.05
RDW (%)	13.4±2.3	14.7±1.4	p>0.05
Serum ferritin (μg/l)	32.0±18.6	36.0±15.2	p>0.05
s-TfR (μg/ml)	2.5±0.18	2.7±0.15	p>0.05

A survey of 228 children one year of age with an assessment of red blood and iron metabolism showed a high incidence of iron deficiency in both children living in Nepal and children from the KBR (44.5 % and 62.0 %, respectively).

The structure of iron deficiency conditions differed in these regions. In Kabardino-Balkaria, a significant pro-

portion was a latent iron deficiency, while in Nepal, iron deficiency anemia was observed twice as often as in the KBR. These features were noted among children living in the low mountains and the middle mountains.

The revealed differences in blood parameters in healthy children of one year of age living at different altitudes above sea level are associated with the adaptation of the erythroid system to the conditions of the middle mountains. With an insufficient iron intake and the stimulating effect of mountain hypoxia on erythropoiesis, there is an increased consumption of iron from the depot, as evidenced by an increase in the concentration of s-TfR in children and a tendency to a decrease in the level of serum ferritin living in the middle mountains.

Large-scale studies of iron deficiency anemia in non-vegetarian children aged 6–23 months from Nepal [8], 12–23 months from Uganda [20] showed no significant effect of micronutrient supplementation on anemia and physical development. In the works devoted to studying the impact of vegetarianism in children aged 2–18 years on iron deficiency anemia, only a tendency to a decrease in hemoglobin level was noted with the same number of red blood cells in these children [12, 13]. In the works of other researchers [21, 22], the prevalence of IDA in omnivores and vegetarians in the age groups of 6–18 years did not differ significantly. We did not find any studies in which the influence of traditional vegetarianism on the development of a latent and overt iron deficiency in children aged 12 months living in mountainous areas would be studied.

In our study, an analysis of the parameters of erythrocytes, the level of ferritin and transferrin receptors in children whose families have been vegetarian for many generations in comparison with children from families with a traditional diet, showed the absence of significant differences in blood parameters, which may be associated with adaptation to this type of diet.

Conclusions. A high frequency of iron deficiency conditions in children of one year in Nepal and the North Caucasus has been revealed, which requires the development of prevention methods, early diagnosis of latent iron deficiency, and treatment of this group of children. Stimulation of erythropoiesis in children of one year of age occurs already at low altitudes above sea level (1000 m). For the same amount of dietary iron, living in middle altitudes results in a higher incidence of latent iron deficiency than in children living at lower elevations relative to sea level in both Nepal (11.9 % and 29.3 %) and KBR (54 % and 33.3 %). Given this, it is advisable to include them in the risk group for the development of iron deficiency conditions. In our study, children from families of traditional vegetarianism did not differ in the studied indicators from children whose families did not have such dietary restrictions.

The conducted research does not cover the entire depth of the problem of iron deficiency conditions in young children. The results obtained indicate the need to continue research in this area. Further genomic research will clarify the genesis of children's adaptation to vegetarianism.

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CHRONIC PAIN SYNDROME IN ADOLESCENTS

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ХРОНИЧЕСКИЙ БОЛЕВОЙ СИНДРОМ В ПОДРОСТКОВОЙ ПОПУЛЯЦИИ

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Chronic pain is one of the crucial problems nowadays. This work aimed to study the prevalence and features of chronic pain syndrome in adolescents. An anonymous questionnaire survey was conducted among 5910 adolescents aged 14–18 years using the original questionnaire and the Hospital anxiety and depression scale (HADS) aimed at identifying chronic pain symptoms. The variables obtained are to be subjected to statistical analysis.

A significant prevalence of chronic pain among adolescents (14.6 % of the study group) has been revealed. The female gender is undoubtedly a personal factor increasing the risk of CP development (the ratio of girls who reported the presence of CP had been 75.4 %). The prevalence rate of pain multiple localization (in 862 teens with chronic pain) and the presence of additional concomitant symptoms worsened overall health has been detected. The results obtained in the study have demonstrated an urgent need for multidisciplinary research to determine the mechanisms of the onset and consolidation of pain syndromes to improve diagnosis and treatment to interrupt these mechanisms.

Keywords: chronic pain, anxiety, depression, affective disorders, adolescents

Хроническая боль является одной из ведущих проблем в наши дни. В работе изучалась распространенность и особенность синдрома хронической боли у подростков. Было обследовано 5910 человек в возрасте 14–18 лет с помощью оригинального опросника, направленного на выявление симптомов хронической боли, и Госпитальной шкалы тревоги и депрессии (Hospital anxiety and depression scale, HADS). Полученные переменные были подвергнуты статистическому анализу.

Выявлена значительная распространенность хронической боли среди подростков (14,6 % исследованной группы). Женский пол, несомненно, является персональным фактором, повышающим риск формирования хронической боли (доля девушек среди испытуемых, сообщивших о наличии хронической боли, составляет 75,4 %). Отмечена широкая распространенность множественных локализаций ощущений (47,3 % лиц с хронической болью), а также