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INTERRELATION OF INDICATORS OF THYROID STATUS AND IRON METABOLISM IN SCHOOLCHILDREN OF THE ENDEMIC REGION

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S u m m a r y. The indexes of thyroid status and iron metabolism in schoolchildren from endemic region were studied. The probability of thyroid dysfunction significantly increases in terms of combined iodine and iron deficiency. A strong correlation between thyroid homeostasis (data of free triiodothyronine and thyroxine, thyroid stimulating hormone of adenohypophysis in the blood serum, urinary iodine concentration) and hemoglobin content in capillary blood, serum iron, serum ferritin was found.

K e y w o r d s**:** thyroid status, latent iron deficiency, light iodine deficiency.

INTRODUCTION

A balanced diet is an important factor in maintaining the health and development of healthy children. It is dangerous when the micronutrients enter the body inadequately, because microelementosis does not appear clinically for a long time [1, 3].

Insufficient consumption of essential micronutrients (in particular, iodine, iron, selenium) in children and adolescents negatively affects physical and mental development, reduces adaptive reserves of the organism, violates metabolic processes [3].

At the same time, the prevalence of iron deficiency anemia and iodine deficiency states in certain regions can suggest high likelihood of combined iodine and iron deficiency.

AIM OF THE STUDY

The purpose of study is to find out the relationship between thyroid status and iron metabolism in schoolchildren from endemic region.

MATERIALS AND METHOD

In total, 52 seemingly healthy children aged 6 - 11 years were examined. The subjects were divided into three groups: group 1 (8 boys and 8 girls) – children with proper iodine and iron supply (control group), group 2 (9 boys and 9 girls) – children with mild iodine deficiency [2, 3] and proper iron metabolism, group 3 (10 boys and 9 girls) – children with mild iodine deficiency and latent iron deficiency [4]. The study was carried out in compliance with the basic bioethical provisions of the Council of Europe Convention on Human Rights and Biomedicine (of 04.04.1997), the Helsinki Declaration of the World Medical Association on the Ethical

Principles for conducting of scientific medical research involving human being (1964-2008), as well as the order of Ministry of Health of Ukraine № 690 dated September 23, 2009.

To study the functional condition of the thyroid, immunoenzymatic assay (test-kit "DRG", Germany) was used, the thyroid hormones content was determined in the blood serum: free T_3 (fT_3) and T_4 (fT_4), thyroid-stimulating hormone of adenohypophysis (TSH) [5]. To determine the level of iodine supply, the index of urinary iodine excretion in single urine samples was determined according to Sandell-Kolthoff reaction and median of ioduria was assessed [11]. To characterize iron metabolism, the content of hemoglobin (Hb) in capillary blood, serum iron level, serum iron binding capacity (test-kit "Cormay", Poland) were determined. The state of the depot of iron was characterized by the level of serum ferritin (chemiluminescent method, test-system "Immulite 2000", USA) [4, 6].

Statistical processing of the data was performed using the Microsoft Excel 7.0. Mathematical Software Package using Student's criterion (t), Pearson correlation coefficient (r). The difference was assumed statistically significant at $p<0.05$.

RESULTS

To assess thyroid status indicators, the reference data on the content of serum thyroid hormones were determined in all of the examined children (Table 1). Comparative analysis revealed significant decrease in the fT_3 content in the blood serum in boys and girls from the experimental group 2 respectively at 18.4% ($p_{1-2}<0.05$) and at 16.6% ($p_{1-2}<0.05$), and in the children from the experimental group 3 – at 20.0%, $p_{1-3}<0.05$ (in boys) and at 17.9%, $p_{1-3}<0.05$ (in girls), similarly to the controls. The content of fT_4 in blood serum showed correlated changes: it was lower in boys from group 2 (16.2%, $p_{1-2}<0.05$) and group 3 (20.8%, $p_{1-3}<0.05$), in girls from group 3 (at 14.9%, $p_{1-3}<0.05$) similarly to the controls. The changes in the content of TSH of adenohypophysis were more significant: in children from the experimental group 2 the data exceeded the control data - 98.1%, ($p_{1-2}<0.01$) in boys and 2.2 times ($p_{1-2}<0.001$) in girls, in children from the experimental group 3 – 2.5 times ($p_{1-3}<0.001$) in boys and 2.7 times ($p_{1-3}<0.001$) in girls. The content of blood serum TSH in 77.8% of boys and the same number of girls with mild iodine deficiency (TSH ranged from 2.5 to 10 mD/l) was noticeable. Such results indicate the development of subclinical hypothyroidism in the examined [5]. In children with combined microelement imbalance (mild iodine deficiency and latent iron deficiency), the development of subclinical hypothyroidism was found in 90.0% of boys and in 89.0% of girls. Therefore, it can be argued that there is an increased risk of developing thyroid dysfunction under conditions of a combined microelemental imbalance. The content of iodine in the urine in the control group of children exceeded 100 mkg/l, which characterizes the proper maintenance of iodine, and in children from the experimental group 2 it ranged from 61 mkg/l to 92 mkg/l, and in the experimental group 3 – 60 mkg/l to 85 mkg/l, indicating mild iodine deficiency.

Indicators of iron metabolism are presented in Table 2. It is necessary to emphasize that in the children from group 1 (control) and the experimental group 2, the indexes of iron metabolism were within the reference data. In the experimental group 3, serum iron content ranged 12-10 μmol/l, serum ferritin – 20-12 ng/ml, serum iron binding capacity was greater than 58 μmol/l. Such data confirm the development of latent iron deficiency in children [4]. Significant discrepancies were found between the indicators of iron metabolism in children from the experimental group 3 similarly to the control group. In particular, hemoglobin content in the capillary blood was lower in girls - 14.2% ($p_{1-3}<0.05$) and in girls - 14.8% ($p_{1-3}<0.01$), the content of serum iron decreased - 27.6% ($p_{1-3}<0.01$) in boys and 52.5% ($p_{1-3}<0.01$) in girls, serum ferritin was lower in boys - 59.6% ($p_{1-3}<0.05$) and in girls at 69.0% ($p_{1-3}<0.01$) against the background of the increase of iron binding capacity in boys – at 40.1% ($p_{1-3}<0.05$) and in girls – at 58.4% ($p_{1-3}<0.01$) similarly to the controls. Differences between iron indices in children from the experimental groups 2 and 3 were correlated. Thus, hemoglobin content in capillary blood in children with mild iodine deficiency and latent iron deficiency was lower - 12.6% ($p_{1-3}<0.05$) in boys and 12.5% ($p_{1-3}<0.01$) in girls, serum iron was lower - 35.9% ($p_{1-3}<0.01$) in boys and at 43.9% ($p_{1-3}<0.01$) in girls, serum ferritin was lower in boys - 51.2% ($p_{1-3}<0.05$) and 63.7% ($p_{1-3}<0.01$) in girls, while the serum iron binding capacity was higher in boys –29.1% ($p_{1-3}<0.05$) and in girls – 42.5% ($p_{1-3}<0.01$) with similar values observed in the children with mild iodine deficiency.

The correlation between thyroid status and iron metabolism was established. In particular, a strong direct correlation was determined between the content of fT_3 in blood serum and: hemoglobin content in the capillary blood ($r=0.76$, $p<0.05$), serum iron content ($r=0.90$, $p<0.001$), serum ferritin content ($r=0.71$, $p<0.05$). A strong direct correlation was also found between serum fT_4 content and hemoglobin content in the capillary blood ($r=0.82$, $p<0.01$), serum iron content ($r=0.89$, $p<0.05$), serum ferritin content ($r=0.86$, $p<0.001$). Strong reverse correlation was found between the content of TSH in the blood serum and: hemoglobin content in the capillary blood ($r=-0.74$, $p<0.05$) and serum ferritin content ($r=-0.72$, $p<0.05$). Indicators of iron metabolism significantly affect urine iodine content. Thus, there was a close correlation between the content of urine iodine and: the content of hemoglobin in the capillary blood ($r=0.89$, $p<0.05$), serum iron content ($r=0.76$, $p<0.05$), serum ferritin ($r=0.76$, $p<0.05$). There is a strong reciprocal relationship between the concentration of iodine in the urine and the iron binding capacity of the serum ($r=-0.76$, $p<0.05$).

DISCUSSION

Iodine and iron deficiency is facilitated by geochemical features of the geographical region, malnutrition, insufficient level of medical care and excessive anthropogenic pollution of the environment. Accommodation of children in the region of high technogenic loading leads to an increased probability of developing goiter and anemia in children at primary school age [3]. Considering combined micronutrient imbalance, increased proportion of the examined children diagnosed with subclinical hypothyroidism was observed in the course of the study. At the same time, no significant gender differences were found for the risk of development of thyroid dysfunction, but a significant decrease of fT_3 content in comparison to the controls was noted primarily among boys. The most intense is the initial stage of thyroid pathology, which is accompanied by changes in the hypothalamic-pituitary-thyroid axis, decreased hemoglobin, serum ferritin, an increase in the frequency of anemia and iron deficiency. The decrease in the concentration of thyroid hormones may be due to the lack of activity of iron iodide peroxidase, which contains iron and catalyzes oxidation reactions and iodine organification during the biosynthesis of thyroid hormones [6]. In addition, iron takes part in the conversion of the amino acid L-phenylalanine into L-tyrosine in the course of hormone genesis. Revealed correlations between studied parameters allow to suggest that goiter increases the probability of anemia, and anemia increases the probability of goiter developing, too. Such a trend may also suggest violation of iron metabolism under conditions of iodine deficiency and a mutual encumbrance of two significant micronutrient deficiencies.

CONCLUSIONS

Sideropenic state is likely to alter thyroid homeostasis, even in the absence of an unfolded clinical picture of the disease. The probability of formation of thyroid dysfunction significantly increases in terms of combined iodine and iron deficiency, in the regions of high anthropogenic load and biogeochemical provinces. In general, latent iron deficiency potentiates the development of subclinical hypothyroidism under conditions of mild iodine deficiency.

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T a b l e 1. Indicators of thyroid status in children with mild iodine deficiency and latent iron deficiency (M+m)

Indexes	Group 1 (control)		Group 2 (mild iodine deficiency)		Group 3 (mild iodine deficiency and latent iron deficiency)	
	Boys (n=8)	Girls (n=8)	Boys (n=9)	Girls (n=9)	Boys (n=10)	Girls (n=9)
Free triiodothyronine (fT_3), pmol·l	6.01±0.19	5.91±0.32	4.90±0.35 $p_{1-2}<0.05$	4.93±0.24 $p_{1-2}<0.05$	4.81±0.32 $p_{1-3}<0.05$	4.85±0.31 $p_{1-3}<0.05$
Free tyrosine (fT_4), pmol·l	27.80±1.23	24.96±1.21	23.29±1.30 $p_{1-2}<0.05$	22.42±1.01	22.01±1.02 $p_{1-3}<0.01$	21.23±0.94 $p_{1-3}<0.05$
Thyroid stimulating hormone (TSH), mMO·l	1.56±0.13	1.44±0.18	3.09±0.29 $p_{1-2}<0.01$	3.22±0.25 $p_{1-2}<0.001$	3.92±0.27 $p_{1-3}<0.001$	3.91±0.32 $p_{1-3}<0.001$
Median of urinary iodine excretion, mcg·l	103.29±3.06	102.81± 2.96	72.54±7.92 $p_{1-2}<0.01$	79.21±6.01 $p_{1-2}<0.01$	70.23± 6.93 $p_{1-3}<0.01$	72.62± 6.34 $p_{1-3}<0.01$

Note: p –significant difference between respective groups.

T a b l e 2. Indicators of iron metabolism in children with mild iodine deficiency and latent iron deficiency (M+m)

Indexes	Group 1 (control)		Group 2 (mild iodine deficiency)		Group 3 (mild iodine deficiency and latent iron deficiency)	
	Boys (n=8)	Girls (n=8)	Boys (n=9)	Girls (n=9)	Boys (n=10)	Girls (n=9)
Hemoglobin, g·l	134.21±5.31	130.25±.4.21	130.28± 4.34	128.34± 3.26	115.15 ±2.32 $p_{1-3}<0.05$ $p_{2-3}<0.05$	112.32±2.19 $p_{1-3}<0.01$ $p_{2-3}<0.01$
Serum iron, mcmol·l	21.45±1.94	24.33±2.01	15.52±1.69	20.58± 1.98	9.95±1.70 $p_{1-3}<0.01$ $p_{2-3}<0.05$	11.55±1.95 $p_{1-3}<0.01$ $p_{2-3}<0.01$
Iron binding capacity of serum, mcmol·l	50.89±5.03	48.9±3.59	55.23±3.86	54.36±3.56	71.31±5.32 $p_{1-3}<0.05$ $p_{2-3}<0.05$	77.46±5.65 $p_{1-3}<0.01$ $p_{2-3}<0.01$
Serum ferritin, ng·ml	56.14±8.90	51.11±4.12	45.54±6.12	43.65±5.42	22.68±5.21 $p_{1-3}<0.05$ $p_{2-3}<0.05$	15.86±3.93 $p_{1-3}<0.01$ $p_{2-3}<0.01$

Note: p –significant difference between respective groups.