Monitoring of the trophological status of children for early detection of alimentary dependent diseases

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Abstract. Food deficits are now a serious problem because they often lead to the development of health disorders and the formation of chronic pathology. The article presents the results of nutritional status assessment including the study of actual nutrition, health, physical development and availability of a number of macro and micronutrients in 493 children aged 3 to 11 years. Early formation of excess body weight and obesity and their relationship with the development of chronic diseases, decrease of physical performance has been proved. Biochemical markers for cardiovascular disease risk in these age groups have been found. The combination of micronutrients deficiency such as calcium, iron, zinc adversely affects the level of health and development of children, which determines the need to introduce a set of preventive measures.

1 Introduction

In recent years, the Russian Federation has seen positive changes in demographic indicators in the form of a decrease in infant mortality and an increase in fertility. At the same time, the incidence of chronic non-communicable diseases remains high. Causally significant role of malnutrition, decrease of physical activity, excess weight in their occurrence [1-3] has been proved. Food deficits including vitamin and mineral deficiencies lead to a slowdown in the intellectual and physical development of the younger generation. Irrational nutrition and significant intensity of the educational process contribute to the formation of functional disorders in the state of health and chronic alimentary dependent diseases. Such negative influences are prolonged and can affect human health years later.

Alimentary dependent diseases occupy one of the first places in the children morbidity pattern. The most frequently recorded pathologies are those of gastrointestinal tract, endocrine system, musculoskeletal system. Obesity and excess body weight were found in 8-23%, growth lag and underweight - in 15-17% [4-9]. Food deficits - and first of all lack of vitamins and microelements - present the most serious problem in children's nutritionology. Insufficient supply of essential food substances leads to reduced resistance and development of serious health abnormalities. Having high rates of growth and metabolism, 3-11 years old children are a risk group for macro and micronelementosis development and require an individual approach to preventive measures [10-13].

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The purpose of the study was to assess the actual nutrition, health and well-being of a number of essential nutrients for children of preschool and primary school age.

2 Materials and methods

We studied the nutritive status and the provision of essential nutrients of 493 children aged 3-11 years. The examined children were divided into two groups: group I were children 3-6 years of age (n=307), average age - 4.7 ± 0.1 years; group II - children 7-11 years of age (n=186), average age - 8.7 ± 0.1 years.

The studies carried out included collection of complaints, examination of anamnestical data, objective examination, physical development evaluation. A frequency method was applied to study actual nutrition. Physical development of the children examined was assessed according to WHO international standards (ANTHRO 3.2.2 and ANTHRO PLUS 1.0.4).

The laboratory complex included the determination of indicators of protein, lipid and carbohydrate metabolism.

Trophological status was assessed on calcium, phosphorus, and iron metabolism indicators. By the method of spectral analysis with inductive-coupled plasma, the analysis of daily mineral excretion was carried out. The use of the high-efficiency liquid chromatography method allowed to determine the content of individual essential and substituted amino acids in blood serum.

Statistical processing of the study results was carried out using the application programs STATISTICA 10.0., Epi info 7.2.2.2., the values of the arithmetic mean (M), standard deviation (s), standard error of the mean (m), median (m), 95% confidence interval (95% CI), relative risk (RR) were calculated. The chi-square ($\chi 2$) test with Yates's correction and the two-sample t-criterion were applied to compare qualitative and quantitative features in two independent groups, Pearson's linear correlation coefficient - to determine correlation relationships.

3 Results and Discussion

Actual nutrition was studied in 84 children of two age groups using the frequency method. When surveyed, parents noted a good appetite in less than half of the children studied (47.5% and 46.8%), appetition - in 36.8% and 38.2%, decreased - in 14.7% and 13.4% respectively. Children 3-11 years of age gave preference to bakery and confectionery products, pasta dishes, instant products, but often refused to eat dishes of vegetables, dairy, fish, meat, first courses and porridge.

We have proven that the diets of the examined children are not balanced in the most important groups of products. The diet of preschoolers and schoolchildren should have daily presence of dairy and meat products, vegetables, fruits, cereals. However, milk was consumed every day by only 52.9% of preschoolers and 43.9% of primary schoolers, fermented milk products - by 37.3% and 9.1%, respectively. Dairy products containing 600 mg of calcium per 500 ml meet only 50 -80% of the daily requirement, so insufficient dairy consumption primarily affected calcium availability for examined children. The calcium level in serum in children of two age groups corresponded to reference values (2.471±0.011mmol/L and 2.456±0.017 mmol/L), but its excretion was reduced in 55.6% and 65.6% of those surveyed. A reliable increase in osteocalcin levels in children 7-11 years of age (66.140±3.416 ng/ml and 77.044±4.020 ng/ml, p=0.0465) is noteworthy, it indicates the activity of osteogenesis processes that pose a bone mineralization disturbance threat during its rapid growth in conditions of calcium deficiency. Evidence has also been obtained that insufficient calcium

provision increases the risk of musculoskeletal pathology formation by 8 times (OR = 8.40; 95% CI [2.10-33.48]; $\chi 2 = 10.09$; p=0.0015).

According to our data, another identified nutritional adequacy violation was infrequent consumption of fruits and vegetables by children. They were present in the daily diet in only half of 3-6 years old children (50.8% -53.9%), 7-11 years old children received vegetables daily at 46.9%, and fruit - even less often (21.2%).

As a food source of many important micronutrients (magnesium, iron, zinc, copper, manganese selenium, etc.), cereals were received by 64.7% of preschoolers and only 15.1% of primary schoolchildren. The study of minerals urinary excretion revealed a decrease in excretion of magnesium (26.3% and 31.3%), copper (5.9% and 3.1%), zinc (100%). At the same time, selenium excretion in all examined children corresponded to the lower limit of the norm: 0.344±0.042 μg/L in group I and 0.326±0.029 μg/L in group II.

It was found that children consumed meat, fish or poultry less than the physiological standard: these products were presented in the daily diet at 61.7% and 36.4% (p=0.0014). Insufficient food intake of full-fledged animal protein - which is the main source of essential amino acids and heme iron - is a risk factor for impairment elaboration of physical development, immunological resistance, iron deficiency conditions, synthesis of hormones and biologically-active substances.

Decrease in ferritin level characterizing iron tissue reserves was determined in 88.2% of group I children and 75.0% of group II children. One third of preschoolers (31.6%) and one fifth of primary schoolchildren (21.9%) showed latent iron deficiency, 1.8% and 3.5%, and consequently mild degree of iron deficiency anemia.

The data obtained from the free amino acids analysis in blood serum are noteworthy. The total number of essential amino acids in the examined children corresponded to the normative values (484.50±16.46 μmol/L and 571.86±20.05 μmol/L, in group I and II). Active synthesis of proteins and lipids during the first growth spurt may be explained by the concentration increase of threonine to 144.91±6.54 μmol/L and methionine - to 27.801±2.318 μmol/L in preschoolers. Dietary imbalance and insufficient consumption of foods containing full-fledged animal protein have led to a decline in tryptophan, phenylalanine, leucine and lysine concentration.

We determined the influence of certain amino acids on the physical development of children. Tryptophan (r=0.49; p=0.0148), leucine (r=0.43; p=0.0367), phenylalanine (r=0.41; p=0.0486) had the greatest impact on child growth. Growth lagging was accompanied by a decrease in methionine content to 23.034±1.761 μmol/L.

Instant products high in animal fats, simple carbohydrates, salts were present in the diet in half of children (45.5%) more than once a month.

In biochemical blood analysis of the examined children, the indicators of total protein, albumins, transferrin corresponded to the age norm. At the same time, there was a reliable decrease in total protein in 3-7 years old children with growth lag (63.283±1.443 g/l, p=0.0451).

Among preschoolers and primary schoolchildren surveyed, the optimal level of total cholesterol was determined in 70.4% and 68.8%, respectively. Increases in total cholesterol above 5.18 mmol/L were observed in 4.8% and 3.8% of group I and II children. Low-density lipoprotein cholesterol levels below 2.85 mmol/L were identified in 66.7% of group I children and 81.6% of group II children. A reliable increase in atherogenicity coefficient (1.548±0.118 and 1.807±0.097, p=0.0133) was found in primary schoolchildren with excess weight. Overall, markers allowing to predict the risk of cardiovascular diseases development were identified in 5.3% and 7.1% of children of two age groups.

At normal serum glucose concentration, 100% of children had a positive correlation between glucose level and body weight index (r=0.35, p=0.0650).

The health status of the children examined was characterized by an increase in the number of chronic diseases at school age (from 40.8% to 18.2%, p = 0.0095). Diseases of

musculoskeletal, nervous and digestive systems took the first three places in the morbidity structure. We also noted a high prevalence of alimentary dependent diseases. Diseases of the endocrine system, musculoskeletal system, gastrointestinal tract, anemia accounted for 53.8% in the structure of the total morbidity in 3-6 years old children and 69.2% in 7-11 years old children (p=0.0000).

Normal physical development of a child is one of the main indicators of adequate nutritional status. Physical development monitoring of children of two age groups revealed significant deviations. In terms of growth, most of those surveyed had no differences from the median of the standard population. Children with accelerated growth accounted for 4.5% and 5.4% in the study groups. Two children of group I lagged behind (Table 1).

Table 1. Indicators of the Z-score index in the children examined, abs. number (%)

Z-score	group I (n=307)	group II (n=186)	P
Body weight relative to age			
< -2	6 (2.0)	5 (2.7)	0.6125
-2 - +2	287 (93.4)	157 (84.4)	**0.0012**
>+2	14 (4.6)	24 (12.9)	**0.0008**
Z-score average value	0.126±0.060	0.448±0.108	**0.0048**
Body weight index relative to age			
< -2	2 (0.6)	6 (3.2)	**0.0249**
-2 - +2	287 (93.5)	156 (83.9)	**0.0006**
>+2	18 (5.9)	24 (12.9)	**0.0070**
Z-score average value	0.173±0.064	0.440±0.105	**0.0217**

With age, the number of children with normal body weight reliably decreased (p=0.0012) and increased - with obesity (p=0.0008). The obesity risk group was identified, with 13.4% of 3-6 year olds and 16.7% of overweight 7-11 year olds (SDS from +1 to +2). Children with obesity appeared to be reliably more in the study group II (12.9%, p=0.0070).

We also noted changes in physical performance when assessing the right hand dynamometry in 117 primary schoolchildren. Muscle strength corresponded to age at 67.5%, muscle strength decrease was reported in 28.2% of children. The average muscle strength in boys was 10.418±0.503 kg, in girls - 8.695±0.438 kg (p=0.0150). The change in physical performance indicators in primary schoolchildren can be explained by a decrease in their motor activity due to a large number of additional sedentary occupations (21.1% - in preschoolers, 39.0% - in primary schoolchildren, p = 0.0000).

Body weight deficit was reliably more frequent in group I children with chronic diseases of gastrointestinal tract (p=0.0031). Excess body weight is more often found in diseases of the musculoskeletal system (p=0.0000). It has been proven that in 7-11 year olds with excess weight and obesity the risk of chronic pathology formation was 7 times higher (OR = 7.25; 95% CI [3.21-16.39]; $\chi 2 = 24.73$; p=0.0000).

4 Conclusions

1. Negative influence on the physical development and health of 3-11 years old children has a combined deficit of the most important macro and micronutrients (protein, calcium, iron, zinc) developing with irrational nutrition.

2. Analysis of physical development indicators revealed significant impairments in the form of excess weight and obesity in 18.0% of 3-6 year olds and 29.6% of 7-11 year olds.

2. Trophological status monitoring allows timely identification of a group of children threatened by the alimentary dependent diseases development with further development and implementation of preventive and curative measures.

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