Indicators of Trace-Element Status of Children Living in Rural Areas

F. G. Sitdikov, N. V. Svyatova, and E. S. Egerev

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 151, No. 7, pp. 15-17, July, 2011
Original article submitted March 23, 2010

The content of essential and toxic elements, except beryllium and mercury, in the hair of examined children (girls aged 7-9 years) is within the biologically acceptable levels set by WHO. The data on the content of essential trace elements suggest that urgent measures aimed at normalization of the elemental status of children are required.

Key Words: *children; hair; trace elements; environmental conditions*

Elemental composition of hair is a good indicator of habitat condition. The content of chemical elements in hair of children widely varies depending on geographical location, distance from industrial plants, the level and nature of industrial pollutant emissions [1,3].

Here we studied microelement status of girls aged 7-9 years living in rural areas of the Republic of Tatarstan.

MATERIALS AND METHODS

The studies were conducted in Bolshe-Elginskaya secondary school, Rybno-Slobodskoy municipal district of the Republic of Tatarstan. Qualitatively homogeneous group was formed of girls 7 to 9 years of age (1st and 2nd group of health). Children were selected by questionnaire developed by the Institute of Developmental Physiology, Russian Academy of Education [2]. Detection of 25 chemical elements in the hair of children was carried out by methods of inductively coupled plasma atomic emission spectrometry/mass spectrometry at the Center for Biotic Medicine (Moscow). The quantitative content of trace elements in hair was assessed by the comparison with biologically acceptable level according to WHO [4,7]. The content of chemical elements in soil and drinking water from centralized water supply system of this settlement was determined at the Laboratory of Environmental Analytical Measurements and Environmental Monitoring, Institute of Ecology and Subsurface Use, Academy of Sciences of the Republic of Tatarstan.

Statistical processing of the results was carried out with Microsoft Excel. Spearman correlation analysis was used to study the relationships between the variables.

RESULTS

According to our findings, the content of aluminum, arsenic, boron, lithium, cadmium, nickel, lead, tin, and vanadium in hair of girls was within the biologically acceptable levels set by WHO (Table 1) [4,7]. Beryllium content was below the biologically acceptable level in 100% of examined girls (Table 1). The physiological role of beryllium is poorly understood. This chemical element is highly toxic, but can participate in the regulation of phosphorus and calcium metabolism and the maintenance of the immune status [5].

In our studies, elevated levels of mercury were found in 86% girls (Table 1). Residents of rural areas are at risk for mercury poisoning, because this element is present in the media for the germination of seeds, fungicides, pesticides, and herbicides. Children accumulate mercury more rapidly than adults [4]. Al-

Department of Anatomy, Physiology and Human Health of the Tatar State Humanitarian Pedagogical University, Kazan, Russia. ***Address for correspondence:*** jalchik2010@mail.ru. N. V. Svyatova

0007-4888/11/1521-0012

TABLE 1. Contents of Chemical Elements in the Hair of 7-9-Year-Old Girls Living in Rural Areas of the Republic of Tatarstan

Trace element	Biologically acceptable level, μg/g*		Minimum value, μg/g	Maximum value, μg/g	Average content of microelements in girls, μg/g
	lower limit	upper limit			
Conditionally essential and toxic					
Aluminum (Al)	1	20	7.06	21.55	14.01286±1.30100
Arsenic (As)	0.005	0.1	0.042	0.06	0.0460±0.0017
Boron (B)	0.1	3.5	0.233	1.28	0.606286±0.089600
Beryllium (Be)	0.005	0.01	0.003	0.003	0.0030±0.0001
Lithium (Li)	0.01	0.25	0.018	0.076	0.042143±0.004600
Cadmium (Cd)	0.05	0.25	0.029	0.16	0.066429±0.011900
Nickel (Ni)	0.1	2	0.147	0.855	0.4890±0.0669
Lead (Pb)	0.1	5	0.55	3.17	1.667143±0.230300
Tin (Sn)	0.05	1.5	0.039	0.337	0.170143±0.022700
Vanadium (V)	0.005	0.5	0.053	0.085	0.071±0.003
Mercury (Hg)	0.05	0.2	0.136	0.895	0.413429±0.06200
Vital					
Iodine (I)	0.27**	4.2**	0.658	20.97	4.690286±1.912000
Potassium (K)	150**	663**	74.93	1323.96	522.5029±130.4690
Phosphorus (P)	75	200	129.35	219.21	158.0286±7.4150
Magnesium (Mg)	19**	163**	33.08	332.32	132.8071±25.6530
Manganese (Mn)	0.1	2	0.414	2.13	1.082286±0.153800
Sodium (Na)	18**	1720**	108.8	1896.48	626.2886±157.3460
Selenium (Se)	0.5	1.5	0.214	0.476	0.404714±0.032900
Silicon (Si)	5	35	14.79	19.48	16.47286±0.40930
Zinc (Zn)	100	250	72.32	169.43	133.8571±9.2299
Calcium (Ca)	200**	2000**	459.62	2177.2	1235.947±152.243
Cobalt (Co)	0.05	0.5	0.02	0.065	0.03300±0.00522
Chrome (Cr)	0.1	2	0.306	0.469	0.369286±0.015800
Copper (Cu)	7.5	80	7.99	10.62	9.322857±0.22300
Iron (Fe)	5	25	19.54	43.05	35.22143±2.08800

Note: * According to WHO data [4,7]; **A. V. Skalny [6].

though the physiological role of mercury is not clear, it is possible that this element plays a significant role in the human body [6].

In the hair of girls of primary school age, decreased content of selenium was found (Table 1). This trace element enters the human body from the soil with crop and livestock products, which determines the dependence of supply with the trace element from geochemical conditions [4,6]. The concentration cobalt was also reduced; physiologically active form of this element is vitamin B12 (Table 1).

The iron content in the hair of 7-9-year-old girls was elevated (Table 1). The deposition of iron in the body may be due to excessive (uncontrolled) use of iron-containing drugs, but often it is due to metabolic disorders [4,6].

Analysis of correlation of chemical element content in the hair of girls with those in water and soil revealed a weak correlation for mercury (r=0.18), moderate relationships for cadmium (r=0.35), potassium (r=0.39), sodium (r=0.35), magnesium (r=0.44), manganese (r=0.49), zinc (r=0.44), cobalt

(r=0.46), and chromium (r=0.45), significant positive moderate correlation for aluminum (r=0.52), nickel (r=0.58), lead (r=0.55, and calcium (r=0.58), and a strong positive relationship with copper (r=0.68) and iron (r=0.85).

These features of the trace element in the hair of girls of primary school age living in Bolshaya Elga village, Rybno-Slobodskoy municipal district of the Republic of Tatarstan, characterize the trace elements supply from the environmental objects, including food produced locally. This may indirectly indicate the formation of biogeochemical provinces in the study area. Unidirectional nature of changes in trace element status in children living in these areas can serve as an evidence of this assumption.

This work was supported by the Russian Humanitarian Research Foundation (grant No. 09-06-29606 a/B).

REFERENCES

1. A. P. Avtsyn, A. A. Zhavoronkov, M. A. Rish, and L. S. Strochkova, *Trace Element Diseases in Man: Etiology, Classification, Organopathology* [in Rusian], Moscow (1991).
2. M. M. Bezrukikh and V. D. Sonkina, *Health Saving Technologies in Secondary Schools: Analysis Methodology, Forms, Methods, Experience of Application (Methodological Recommendations)* [in Russian], Moscow (2002).
3. A. N. Mikhailov and N. P. Setko, *Vestn. Orenburgsk. Gos. Univer*., No. 4, 112-114 (2010).
4. V. G. Rebrov and O. A. Gromova, *Vitamins, Major and Trace Elements. Educational Programs of Regional Service Center, UNESCO Institute of Trace Elements* [in Russian], Moscow (2008).
5. A. V. Skalny, *Chemical elements in human physiology and ecology* [in Russian], Moscow (2004).
6. A. V. Skalny, *Trace Minerals for Your Health* [in Russian], Moscow (2004).
7. H. P. Bertram, *Spurenelemente: Analytik, Okotoxikologische und Medizinisch-klinische Bedeutung* [in German]. Munchen; Wien; Baltimore (1992).