ОРИГИНАЛЬНАЯ СТАТЬЯ

REGIONAL APPROACH TO PROVIDING WFP UN SERVICES: COMPARISON OF MULTIELEMENT HAIR DATA OF SCHOOLCHILDREN FROM TAJIKISTAN, AZERBAIJAN, KAZAKHSTAN, TURKMENISTAN, BANGLADESH, MACEDONIA, CROATIA, AND RUSSIAN FEDERATION

A.R. Grabeklis [1,2]****, K.A. Abazov*** [1]***, A.A. Skalny*** [1]***, Yu.N. Lobanova*** [1]

[1] RUDN University, Miklukho-Maklay str., 10/2, Moscow 117198, Russia
[2] Yaroslavl State University, Sovetskaya str., 14, Yaroslavl 150000, Russia

ABSTRACT. The technology (methodology) of non-invasive screening of human elemental status was tested under real conditions of Tajikistan child population in scope of assessment of dietary provision of schoolchildren with chemical elements – micronutrients, and of load with heavy metals. The project was implemented within the framework of regional activity of the World Food Programme (WFP). There were totally examined 588 schoolchildren of 1–4 classes of average educational institutions aged 7–10 years (301 girls, 287 boys), residing in the territory of the Republic of Tajikistan in Sughd and Khatlon regions, including those involved and not involved in WFP programme of organized school nutrition with hot meals provision fortified with vitamins and trace elements. The study included collection of hair samples and determination of 25 main physiologically significant macro and trace elements in them by the ICP-MS method. The obtained results confirmed known patterns of gender difference in hair mineral content with lower levels of most elements in girls, hair except magnesium. Also, the results revealed extremely low levels of copper and iodine in hair of Tajik schoolchildren: Cu 7.94 and 8.14 µg/g, I 0.094 and 0.071 µg/g respectively in boys and girls in average. Occurrence of copper deficiency as estimated by hair level of the element was 73.2% cases in schools involved in WFP programme and more than 90% cases in schools not involved in WFP programme. Iodine deficiency was registered in 84.4% and 84.2% children, respectively. Comparison of trace element patterns with corresponding data obtained earlier from children of the same age and sex living in other countries (Azerbaijan, Kazakhstan, Turkmenistan, Bangladesh, Macedonia, Croatia, and two regions of Russia) also showed a very decreased Cu, I levels in Tajik schoolchildren, suggesting that a lack of supply with these elements can be a cause of anemia and goiter widespread in this territory.

KEYWORDS: trace elements, macro elements, hair analysis, schoolchildren, Tajikistan, World Food Programme.

INTRODUCTION

Nutrition, being one of the most important components of human life, ensures optimal growth and development of the body, complete reproductive capacity, wide adaptation possibilities, as well as the duration of the active health and life. Malnutrition can cause a variety of diseases of internal organs, complicate existing pathological process influence the course and outcome of disease [Scrimshaw et al., 1968; Martinchik et al., 2002; Guideline, 2017].

One of the priority health problems is to preserve and strengthening of health of children, as adult health is largely determined by what they had health outcomes in childhood. Nutrition is a leading factor in determining the health of the child, as well as providing its normal growth and development, active vitality, promotes disease prevention [Skalnaya, Notova, 2004; Shevchenko, Klimatskaya, 2007; Guideline, 2017; Hennig et al., 2018].

Mineral substances along with proteins, fats, carbohydrates and vitamins are vital components of human food and necessary for building a chemical structures of living tissue and implementation of the most important biochemical and physiological processes which underlying of vital activity of the organism [Oberleas et al., 2008]. Currently obtained nu-

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* Corresponding author:
Andrei R. Grabeklis
E-mail: andrewgrabeklis@gmail.com

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merous scientific data supporting a link between inadequate security of the human body a variety of macro and trace elements and the emergence of various diseases, the nature of their course, clinical prognosis [Negretti de Braetter, 1999; Golubkina et al., 2002; Oberleas et al., 2008; Skalnaya, Skalny, 2018].

Inadequate intake of micronutrients is massive and constantly acting factor having a negative impact on the health, growth and physical development of children and adolescents. It is obvious that the problem of school-age children provision with macro and trace elements takes place; therefore, it is necessary to improve preventive approaches on elimination of essential micronutrient deficiency. In this scope, a study of the element status of younger schoolchildren in the Republic of Tajikistan was carried out in order to improve school nutrition. The project is implemented within the framework of regional activity of the World Food Programme.

The World Food Programme (WFP) is the food-assistance branch of the United Nations and the world's largest humanitarian organization addressing hunger and promoting food security. It is a member of the United Nations Development Group and part of its Executive Committee. According to the WFP, it provides food assistance to an average of 80 million people in 76 countries each year. WFP food aid is also directed to fight micronutrient deficiencies, reduce child mortality, improve maternal health, combat disease, help promote environmental and economic stability and agricultural production. The aim of WFP activity in Tajikistan was to improve the efficiency of activities conducted in the framework of the national school feeding program for improving quality of life, physical and mental development, academic achievements and strengthening children's health by reduction of alimentary dependent conditions and diseases. And the particular task of our study was to test under real conditions the technology (methodology) of non-invasive screening assessment of dietary provision of schoolchildren with chemical elements – micronutrients, and of load with heavy metals – antagonists of micronutrients.

MATERIALS AND METHODS

During performance of the work there were totally examined 588 children (301 girls, 287 boys), residing in the territory of the Republic of Tajikistan in Sughd and Khatlon regions. And of particular interest there was a subgroup of schoolchildren (96 girls, 96 boys) from the Ayni and Panjakent districts of the Sughd region, which are typical of Tajikistan mountainous areas with preferably rural population, living in relatively small settlements. These areas are partly covered by the WFP program, so that there are different types of schools in the same territory, including those not involved in the WFP program (type I) and those fully involved in the WFP program and the national pilot project on school nutrition improvement (type II). The former have no organized school nutrition, the latter have organized hot meals provision fortified with vitamins and trace elements.

All examined peoples were schoolchildren of 1–4 classes of average educational institutions aged 7–10 years. The study included the collection of anthropometric data and investigation of hair samples on the content of macro and trace elements.

In the submitted hair samples was performed determination of the Al, As, B, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, I, K, Li, Mg, Mn, Na, Ni, P, Pb, Se, Si , Sn, V, Zn content. Detection was performed by mass spectrometry with inductively coupled argon plasma (ICP-MS).

Samples were exposed to sample preparation according to the guidelines «Method of determination of trace elements in biosubstrates by mass spectrometry with inductively coupled plasma (ICP-MS)», Federal Hygiene and Epidemiology Centre of Russia approved 26.03.2003 and methodology guidelines 4.1.1482-03, 4.1.1483-03 «Determination of the chemical elements in biological fluids and preparations by atomic emission spectrometry with inductively coupled plasma and mass spectrometry with inductively coupled plasma», approved by the Russian Ministry of Health in 2003.

Analytical studies were performed at the testing laboratory of NGO «Center for Biotic Medicine», accredited by the Federal Agency for Technical Regulation and Metrology of Russia (accreditation certificate POCC.RU.0001.22ПЯ.05) on the quadrupole mass spectrometer NexION 300D (Perkin Elmer, USA). Quality control of the analyzes was performed using a certified reference material GBW09101b Human Hair (Shanghai Institute of Nuclear Research, Academia Sinica, PR China).

The results of the chemical elements determination were compared with the reference limits developed in the NGO «Center for Biotic Medicine» and comparable with other sources [Bertram, 1992; Caroli et al., 1992 et al.]. The reference limits are based on the definition of a biologically acceptable level in accordance with guidelines of the «Screening methods for identifying high-risk groups among workers exposed to toxic chemical elements» [Lyubchenko et al., 1989], as well as conditional biologically acceptable levels [Skalny et al., 2009]. Conditional biologically acceptable levels represent empirically established levels of the chemical elements in hair, at which marked specific changes in health status and human morbidity are detected on the basis of long-term clinical observation. In practice, a conventional biologically acceptable level corresponds to the top or bottom limit of the physiological element content. The used values shown in Table 1 and are in accordance with the medical technology «Identification and correction of disturbances of mineral metabolism of the human body», registered in the Federal Service for the Supervision of Public Health and Social Development of Russia (registration certificate №FS-2007/128).

Mathematical processing and statistical analysis of the obtained data was performed using Microsoft Excel XP (Microsoft Corp., USA) software application package and an integrated package of statistical software STATISTICA 8.0 (StatSoft Inc., USA). Assessment of data normality was performed using Shapiro-Wilk test and demonstrated the absence of Gaussian distribution of the data for most elements. Therefore, the median and the 25, 75 quartiles (Me (q25–q75)) were used in this work for data description. Nonparametric Mann–Whitney U test was used for paired group comparison. The level of significance was set as $p < 0.05$ for all analyses.

Table 1. ***Applied normal ranges of chemical element contents in human hair (μg/g)***

Element	Boys, 7–11 y/o		Girls, 7–11 y/o	
	From	To	From	To
Al	0	25	0	25
As	0	1	0	1
B	0	5	0	5
Be	0	0.005	0	0.005
Ca	200	2000	200	2000
Cd	0	0.25	0	0.25
Co	0.004	0.3	0.004	0.3
Cr	0.04	1	0.04	1
Cu	9	40	9	40
Fe	7	40	7	40
Hg	0	1	0	1
I	0.15	10	0.15	10
K	40	2000	40	2000
Li	0	0.1	0	0.1
Mg	15	200	20	200
Mn	0.15	2	0.25	2
Na	50	2000	50	2000
Ni	0	2	0	2
P	120	200	120	200
Pb	0	5	0	5
Se	0.25	2	0.25	2
Si	11	70	11	70
Sn	0	3	0	3
V	0.005	0.1	0.005	0.1
Zn	125	400	125	400

RESULTS AND DISCUSSION

Table 2 demonstrates obtained data on macro and trace elements content in hair samples of the examined schoolchildren.

At present it is known that the presence of significant differences in element status between male and female subjects that are maximal in reproductive age [Skalnaya et al., 2016]. Men are characterized by significantly higher hair potassium, sodium, and certain heavy metals, whereas the level of calcium and magnesium is significantly lower than in women [Skalny et al., 2009].

The above mentioned patterns were also detected in the current investigation. Particularly, girls in all areas of Tajikistan were characterized by significantly lower medians of hair potassium, sodium, iron, chromium, cobalt, iodine, manganese, boron, lithium, vanadium, lead, cadmium, and beryllium, whereas the level of magnesium was higher in comparison to boys from the respective group (Table 2).

Table 2. ***Content of chemical elements in hair of schoolchildren living in Tajikistan (μg/g)***

Element	Boys			Girls		
	All schools (n = 287)	Sughd region		All schools (n = 301)	Sughd region	
		Type I schools (n = 51)	Type II schools (n = 45)		Type I schools (n = 44)	Type II schools (n = 52)
Al	18.9 (10.2–36.1)	26.6 (16–38.4)	37.9 (27.7–49.4)	10.4 (5.6–20.6)	14.8 (10–29.6)	21.6 (11.7–33.5)
As	0.077 (0.054–0.110)	0.104 (0.083–0.124)	0.111 (0.086–0.136)	0.057 (0.043–0.079)	0.084 (0.074–0.096)	0.070 (0.056–0.087)
B	0.714 (0.474–1.109)	1.051 (0.676–1.485)	0.744 (0.548–1.128)	0.482 (0.331–0.685)	0.753 (0.49–1.077)	0.404 (0.303–0.595)
Be	0.0013 (0.0008–0.0025)	0.0021 (0.0014–0.0027)	0.0028 (0.0022–0.0036)	0.0008 (0.0004–0.0016)	0.0013 (0.0007–0.0022)	0.0015 (0.0008–0.0025)
Ca	489 (399–579)	430 (351–518)	540 (468–622)	583 (437–765)	400 (334–456)	579 (480–715)
Cd	0.0211 (0.0123–0.0338)	0.0232 (0.0136–0.0355)	0.0194 (0.0115–0.0336)	0.0092 (0.0064–0.0152)	0.0096 (0.0075–0.0151)	0.0103 (0.007–0.0146)
Co	0.0205 (0.0139–0.0351)	0.0242 (0.0175–0.0346)	0.0394 (0.0282–0.0463)	0.0146 (0.0089–0.0262)	0.0139 (0.0098–0.0263)	0.0228 (0.0111–0.0307)
Cr	0.146 (0.101–0.194)	0.134 (0.098–0.171)	0.182 (0.159–0.222)	0.094 (0.065–0.136)	0.095 (0.067–0.136)	0.117 (0.084–0.154)
Cu	7.94 (7.17–9.15)	7.7 (7.1–8.54)	9.29 (7.96–9.97)	8.14 (7.41–9.16)	7.62 (6.95–8.35)	8.7 (7.91–9.74)
Fe	29.1 (17.5–48.6)	31.6 (23.5–46.9)	67.7 (40.3–78)	17.6 (10.5–31.1)	21.3 (16–34.2)	40.5 (23.5–58.3)
Hg	0.035 (0.018–0.094)	0.162 (0.092–0.275)	0.051 (0.033–0.077)	0.030 (0.017–0.071)	0.193 (0.104–0.242)	0.034 (0.026–0.053)
I	0.094 (0.061–0.199)	0.122 (0.083–0.356)	0.171 (0.090–0.376)	0.071 (0.045–0.120)	0.098 (0.054–0.160)	0.102 (0.069–0.202)
K	406 (175–949)	579 (243–1363)	655 (357–1072)	226 (75–468)	304 (189–822)	371 (229–620)
Li	0.0420 (0.0267–0.0756)	0.0515 (0.0389–0.0783)	0.073 (0.0478–0.0933)	0.0291 (0.0185–0.0461)	0.0352 (0.0249–0.0487)	0.0416 (0.0297–0.0549)
Mg	57.9 (43.9–76.2)	58.6 (48.4–72.4)	72.2 (61.6–84)	82.1 (55.7–122.3)	67.5 (50.7–84.5)	91.4 (69–119.6)
Mn	0.855 (0.490–1.371)	0.947 (0.767–1.583)	1.631 (1.15–2.109)	0.435 (0.277–0.766)	0.493 (0.366–0.825)	0.757 (0.431–1.045)
Na	486 (234–1544)	590 (248–1444)	1397 (510–2278)	318 (169–725)	313 (216–670)	512 (270–865)
Ni	0.138 (0.107–0.188)	0.146 (0.111–0.214)	0.182 (0.146–0.223)	0.126 (0.095–0.177)	0.151 (0.091–0.185)	0.133 (0.099–0.182)
P	169 (157–188)	170 (157–187)	163 (153–176)	171 (157–192)	171 (158–187)	163 (154–181)
Pb	0.787 (0.503–1.375)	0.802 (0.485–1.092)	0.759 (0.499–1.793)	0.307 (0.199–0.524)	0.313 (0.235–0.567)	0.296 (0.211–0.424)
Se	0.397 (0.345–0.442)	0.371 (0.347–0.407)	0.434 (0.396–0.479)	0.374 (0.332–0.424)	0.359 (0.328–0.383)	0.44 (0.419–0.474)
Si	18.2 (12.4–28.1)	14.6 (12.3–32.4)	17 (13.1–22.2)	15.7 (11.5–27.0)	13.8 (11.1–24.2)	15.3 (12–19.9)
Sn	0.0452 (0.0304–0.0664)	0.0469 (0.0334–0.07)	0.0446 (0.0343–0.0666)	0.0296 (0.018–0.0487)	0.0377 (0.0209–0.0626)	0.0326 (0.0206–0.0475)
V	0.0530 (0.0303–0.1017)	0.0627 (0.0417–0.09)	0.1218 (0.0879–0.1588)	0.0301 (0.0176–0.0645)	0.0395 (0.0248–0.0621)	0.0689 (0.0385–0.0987)
Zn	181 (164–203)	175 (163–197)	205 (182–222)	190 (163–220)	183 (155–223)	222 (204–243)

Table 3. ***Contents of chemical elements in hair of schoolchildren aged 7-11 years living in various countries (µg/g)***

Element	Azerbaijan *n* = 31	Kazakhstan *n* = 836	Turkmenistan *n* = 35	Bangladesh *n* = 27	Macedonia *n* = 264	Croatia *n* = 48	Russia (Dagestan) *n* = 25	Russia (Ryazan region) *n* = 37
Al	10.4 (6.6–12.7)	12.4 (7.4–19)	13.8 (9.6–19.3)	27.6 (9.8–52.9)	11.8 (6.8–22.8)	10.4 (6.6–12.7)	10.9 (7–13.2)	13.8 (6.6–28.4)
As	0.053 (0.022–0.082)	0.081 (0.047–0.13)	0.077 (0.035–0.114)	0.152 (0.118–0.349)	0.067 (0.043–0.117)	0.053 (0.022–0.082)	0.074 (0.043–0.138)	0.072 (0.05–0.109)
B	2.07 (0.86–3.4)	1.82 (1.02–2.88)	1.67 (1.19–3.56)	1.13 (0.94–1.53)	2.35 (1.34–3.6)	2.07 (0.86–3.4)	1.69 (0.97–2.79)	1.72 (0.8–2.71)
Be	0.0018 (0.0015–0.0069)	0.0015 (0.0009–0.0037)	0.0015 (0.0009–0.0015)	0.002 (0.0018–0.0036)	0.0015 (0.0015–0.0074)	0.0018 (0.0015–0.0069)	0.0035 (0.0015–0.0085)	0.0015 (0.0015–0.0055)
Ca	467 (337–679)	358 (253–535)	789 (425–1414)	569 (505–675)	355 (245–610)	467 (337–679)	362 (261–528)	459 (244–551)
Cd	0.032 (0.011–0.058)	0.063 (0.033–0.13)	0.033 (0.017–0.06)	0.013 (0.006–0.023)	0.05 (0.02–0.096)	0.032 (0.011–0.058)	0.043 (0.024–0.069)	0.069 (0.025–0.141)
Co	0.023 (0.012–0.05)	0.018 (0.012–0.027)	0.023 (0.013–0.04)	0.029 (0.021–0.039)	0.016 (0.01–0.03)	0.023 (0.012–0.05)	0.014 (0.01–0.027)	0.015 (0.008–0.024)
Cr	0.378 (0.273–0.56)	0.335 (0.121–0.605)	0.266 (0.074–0.652)	0.156 (0.079–0.239)	0.431 (0.299–0.681)	0.378 (0.273–0.56)	0.494 (0.241–0.857)	0.573 (0.288–0.931)
Cu	10.7 (9.2–13.1)	9.5 (8.3–10.9)	9.8 (8.4–12)	6.1 (5.6–6.9)	10.1 (8.7–11.6)	10.7 (9.2–13.1)	11 (9.8–12)	11.2 (9.3–13.9)
Fe	14.7 (10.4–25.1)	22.8 (16.2–32.1)	21.4 (12.8–31.1)	26.7 (16–124.2)	15.7 (11.3–27.3)	14.7 (10.4–25.1)	21.3 (16.6–29.7)	23.1 (11.9–38.3)
Hg	0.294 (0.106–1.009)	0.145 (0.069–0.297)	0.05 (0.03–0.109)	0.508 (0.487–0.917)	0.101 (0.05–0.218)	0.294 (0.106–1.009)	0.11 (0.075–0.175)	0.296 (0.125–0.518)
I	0.454 (0.15–0.902)	0.886 (0.465–1.871)	1.386 (1.075–3.884)	0.386 (0.234–0.688)	0.483 (0.15–0.993)	0.454 (0.15–0.902)	1.011 (0.319–2.478)	1.574 (0.572–3.562)
K	265 (110–652)	422 (162–929)	242 (93–750)	144 (100–197)	328 (100–915)	265 (110–652)	271 (114–1232)	631 (227–1026)
Li	0.034 (0.015–0.052)	0.03 (0.019–0.051)	0.047 (0.03–0.072)	0.014 (0.004–0.032)	0.028 (0.017–0.054)	0.034 (0.015–0.052)	0.045 (0.03–0.06)	0.045 (0.025–0.084)
Mg	78.5 (34.8–174.8)	36.8 (23.6–65.9)	98.4 (63.2–162.7)	59 (44.6–79.2)	33.7 (20.9–72.6)	78.5 (34.8–174.8)	35.4 (20.7–49.6)	41.7 (24.3–59.4)
Mn	0.345 (0.202–0.629)	0.852 (0.513–1.408)	0.6 (0.411–1.401)	2.318 (1.102–5.325)	0.466 (0.266–1.069)	0.345 (0.202–0.629)	0.613 (0.328–1.181)	0.708 (0.409–1.166)
Na	437 (182–1256)	481 (212–1020)	289 (163–601)	221 (119–382)	323 (118–1162)	437 (182–1256)	325 (175–1428)	639 (208–1125)
Ni	0.289 (0.163–0.633)	0.246 (0.161–0.396)	0.32 (0.204–0.564)	0.218 (0.157–0.299)	0.263 (0.165–0.592)	0.289 (0.163–0.633)	0.311 (0.174–0.558)	0.336 (0.18–0.468)
P	142 (126–178)	145 (127–166)	154 (144–182)	178 (160–200)	145 (127–171)	142 (126–178)	142 (129–165)	147 (130–208)
Pb	0.7 (0.41–1.8)	1.72 (0.82–3.36)	1.32 (0.75–2.54)	0.72 (0.43–1.17)	1.49 (0.79–2.91)	0.7 (0.41–1.8)	0.85 (0.47–2.01)	2.54 (0.86–4.75)
Se	0.333 (0.229–0.532)	0.388 (0.283–0.471)	0.418 (0.343–0.515)	0.258 (0.203–0.334)	0.368 (0.233–0.531)	0.333 (0.229–0.532)	0.424 (0.311–0.573)	0.357 (0.253–0.417)
Si	22.1 (17–35.6)	24.5 (17.3–38.9)	30.5 (19.4–45.2)	30.7 (15.3–40.2)	27.3 (18.6–42.7)	22.1 (17–35.6)	25.8 (17.9–43.3)	32.3 (19.7–46.2)
Sn	0.138 (0.074–0.266)	0.158 (0.103–0.269)	0.189 (0.122–0.294)	0.037 (0.015–0.066)	0.144 (0.077–0.256)	0.138 (0.074–0.266)	0.228 (0.115–0.443)	0.203 (0.125–0.392)
V	0.093 (0.057–0.159)	0.076 (0.042–0.13)	0.071 (0.032–0.127)	0.058 (0.03–0.109)	0.088 (0.05–0.153)	0.093 (0.057–0.159)	0.058 (0.048–0.185)	0.131 (0.056–0.177)
Zn	177 (149–202)	121 (81–164)	173 (107–264)	188 (177–211)	153 (117–188)	177 (149–202)	138 (87–186)	134 (91–192)

At the same time, both girls and boys in Tajikistan demonstrated in their hair mineral patterns extremely low levels of copper and iodine. Thus, in the Sughd region the occurrence of copper deficiency, when hair level of the element is below the bottom limit of the physiological content (Table 1), was 73.2% cases in type II schools and more than 90% cases in type I schools. Iodine deficiency was registered in 84.4% and 84.2% children, respectively.

To make sure that the higher risk of the above mentioned trace element deficiencies is a particular problem of child nutrition in the studied regions of the Republic of Tajikistan, we compared their trace element patterns with the data on the elemental composition of hair samples obtained earlier from children of the same age (7-10 years old) and sex (the boys:girls ratio in the groups was about 1:1) living in other countries and stored in a database of the testing laboratory of NGO «Center for Biotic Medicine», namely from Azerbaijan, Kazakhstan, Turkmenistan, Bangladesh, Macedonia, Croatia, and two regions of Russia: Dagestan and Ryazan region (Table 3).

As shown in Table 3, among 8 areas of the world where children's hair have been analyzed, the level of copper in hair of primary school children from Tajikistan (mostly girls) is minimal, except for the children from Bangladesh, a poorest country of the world (6.1 µg/g). This is especially pronounced in children from schools that do not provide meals fortified with micronutrients (7.6 µg/g in girls and 7.7 µg/g in boys). It is important to note that Tajik schoolchildren from the Ayni and Panjakent districts, eating fortified food, on the copper content in hair are close to their peers from Turkmenistan and Kazakhstan: 8.7 µg/g in girls and 9.3 µg/g in boys from the studied territory vs. 9.8 µg/g and 9.5 µg/g, respectively, in the compared areas.

Tajikistan is characterized by high prevalence of iron deficient anemia among population [Statistical Agency, 2013]. However, iron levels in hair of observed children are within the normal range and mostly even higher than in the other countries of comparison. In this context is seems noteworthy that the low levels of copper in hair and blood is described in the scientific literature for the different types of iron-deficiency anemia [Hågå, 1981; Leming, 1998; Chan, Mike, 2014], hypothyroidism [Dumitriu et al, 1988.; Blasig et al., 2016], hyperthyroidism [Akçay et al, 1994; Baltaci et al., 2013], alopecia [Ozturk et al, 2014; Skalnaya, Skalny, 2018], atherosclerosis, aneurysms, some neuropsychiatric disorders in children [Oberleas et al., 2008] and genetic pathologies with deficiency and impaired metabolism of copper (Menkes disease, Wilson disease) [de Bie et al., 2007; Finner, 2013; Ferenci, 2017].

Recently evidence are obtained that the level of iodine in hair reflects the individual provision of iodine [Momcilovic et al., 2014]. The observed Tajik children in comparison with children from other regions of the world are appeared to have very low level of iodine in hair (in average 0.09 µg/g in boys and 0.07 µg/g in girls). Even in children from Bangladesh (continental part) the median value of iodine content is 0.39 µg/g, whereas in Azerbaijan and Croatia it is 0.45 µg/g, in Macedonia – 0.48 µg/g, in Kazakhstan – 0.89 µg/g, in Dagestan – 1.01 µg/g, in Turkmenistan – 1.39 µg/g, in the Ryazan region of Russia – 1.57 µg/g.

It is known that iodine metabolism in humans is closely connected to the metabolism of selenium and cobalt [Kubasova, Kubasov, 2008]. Supplementation of selenium with the diet, on the basis of published data [Golubkina et al., 2002; O'Kane et al., 2018] could increase absorption and its inclusion in the metabolic processes of the thyroid gland. By the level of selenium in hair, which reflects well the selenium status of the organism, the schoolchildren from Tajikistan look better than their peers from Bangladesh and Macedonia, are comparable with the children from Azerbaijan, Kazakhstan, Croatia, Dagestan and the Ryazan region, just being significantly behind schoolchildren from Turkmenistan in this index. The content of cobalt in hair of children from Tajikistan as related to other regions of the world is seems also comparable enough (in average 0.021 µg/g in boys and 0.015 µg/g in girls versus 0.014–0.018 µg/g in all children on average in Kazakhstan, Macedonia, and the two regions of Russia, 0.023 µg/g in Croatia, Turkmenistan, and 0.029 µg/g in Bangladesh). Recently we also showed that elevated levels of cobalt in hair of children is associated to significant improvement in their health status and functional performance [Detkov et al., 2013]; the administration of additional amounts of cobalt increases erythropoietin levels and helps eliminate anemia.

CONCLUSION

Hair analysis is a noninvasive screening method of prenosological hygienic diagnostics. In the conducted study using this method evidence is obtained that the elemental composition of hair reflects the environmental and nutritional peculiarities of schoolchildren's life. Thus, by an example of this study it may be concluded that multielement hair analysis is an effective and adequate method for noninvasive screening assessment of provision of the population by chemical elements-micronutrients and of the load by toxicants that can be widely applied for WFP in various regions of the world.

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РЕГИОНАЛЬНЫЙ ПОДХОД К ОБЕСПЕЧЕНИЮ ВПП ООН: СРАВНЕНИЕ ДАННЫХ ЭЛЕМЕНТНОГО АНАЛИЗА ВОЛОС ШКОЛЬНИКОВ ИЗ ТАДЖИКИСТАНА, АЗЕРБАЙДЖАНА, КАЗАХСТАНА, ТУРКМЕНИСТАНА, БАНГЛАДЕШ, МАКЕДОНИИ, ХОРВАТИИ И РОССИЙСКОЙ ФЕДЕРАЦИИ

А.Р. Грабеклис [1,2], К.А. Абазов [1], А.А. Скальный [1], Ю.Н. Лобанова [1]

[1] Российский университет дружбы народов, Москва, Россия
[2] Ярославский государственный университет им. П. Г. Демидова, Ярославль, Россия

РЕЗЮМЕ. Испытана технология (методология) неинвазивного скрининга элементного статуса человека в реальных условиях на примере детского населения Таджикистана в контексте оценки алиментарной обеспеченности школьников химическими элементами – микронутриентами и нагрузки тяжелыми металлами. Проект был реализован в рамках региональной деятельности Всемирной продовольственной программы (ВПП) ООН. Всего обследовано 588 школьников 1–4 классов средних школ в возрасте 7–10 лет (301 девочка, 287 мальчиков), проживающих на территории Республики Таджикистан в Согдийской и Хатлонской областях, в том числе включенных и не включенных в программу ВПП по внедрению организованного школьного питания с использованием горячих блюд, обогащенных витаминами и микроэлементами. Исследование включало сбор образцов волос и определение 25 основных физиологически значимых макро- и микроэлементов в них методом ИСП-МС. Полученные результаты подтвердили известные закономерности половых различий в минеральном составе волос с более низкими уровнями большинства элементов у девочек, за исключением магния. Кроме того, результаты показали чрезвычайно низкие уровни меди и йода в волосах таджикских школьников: Cu – 7,94 и 8,14 мкг/г, I – 0,094 и 0,071 мкг/г соответственно у мальчиков и девочек в среднем по республике. Встречаемость дефицита меди, оцененного по уровню элемента в волосах, составила 73,2% случаев в школах, участвующих в программе ВПП, и более 90% случаев в школах, не участвующих в программе ВПП. Дефицит йода зарегистрирован у 84,4% и 84,2% детей соответственно. Сравнение элементных профилей с аналогичными данными, полученными ранее у детей того же возраста и пола, проживающих в других странах (Азербайджан, Казахстан, Туркменистан, Бангладеш, Македония, Хорватия и два региона России) также подтвердило очень низкий уровень Cu и I у таджикских школьников, что дает основание полагать, что в нехватке этих элементов кроется причина широкой распространенности анемии и зоба на этой территории.

КЛЮЧЕВЫЕ СЛОВА: микроэлементы, макроэлементы, анализ волос, школьники, Таджикистан, Всемирная продовольственная программа.

ИНФОРМАЦИЯ

Конференции, симпозиумы и семинары по проблемам элементологии в 2018 г.

Июль, 2018

Biometals 2018
11th International Biometals Symposium

Ottawa, Canada, 15-19 July, 2018

Main topics:

- Metals in biological systems.

Language of the conference: English.

Organizer: International Biometals Society.

Contacts: astintzi@uottawa.ca.

General information: http://www.biometals.org/meetings.html.

Сентябрь, 2018

5th Congress of 'Russian Society for trace Elements in Medicine' – RUSTEM
Moscow, 20-22 September, 2018

Language of the conference: Russian/English
Important deadlines: abstract June 31, 2018
General information: People's Friendship University of Russia, 117198, Moscow, Miklukho-Maklaya st., 6;
E-mail: teu.moscow@gmail.com

Октябрь, 2018

7th International Selenium Conference (Se2018)
Selenium in Biology, Chemistry and Medicine
Otsu, Shiga, Japan, 1-5 October, 2018

Language of the conference: English.

Important deadlines: abstract July 15, 2018.
End of early registration: August 31, 2018.

General information: http://selenium2018.strikingly.com/, E-mail: se2018@gst.ritsumei.ac.jp

Октябрь, 2018

Cancer, Inorganic Elements & Vitamins
Lyon, France, 11-12 October, 2018

Language of the conference: English.

Important deadlines: Abstract July 15, 2018.
End of early registration: August 31, 2018.

General information: http://selenium2018.strikingly.com/, E-mail: se2018@gst.ritsumei.ac.jp
Organizer: Trace Element - Institute For UNESCO (Lyon, France).

Language: English.
Important deadline: Abstract June 29, 2018.
General information (in French): www.trace-element.org; E-mail: sferete@gmail.com.

TEU promotes research and capacity-building in the multidisciplinary area of "trace elements" and thus aims to enhance the sharing and transfer of knowledge in scientific fields. The Institute focuses on a broad spectrum of scientific endeavours that includes areas such as water, the environment, basic sciences and health. The main objective of the Institute is to coordinate scientific projects in basic and applied research on trace elements from an interdisciplinary point of view. TEU has established a network of satellite centres, which facilitates international scientific collaboration in line with UNESCO's objectives in that field. Fields of competence: Chemistry, biochemistry, pharmacology, genetics, epidemiology, therapeutics, nutrition, agronomy, environment (soil and water) and veterinary sciences. The aim of Institute is coordination of UNESCO's scientific projects in basic and applied research on trace elements from an interdisciplinary point of view; promote the development and transfer of scientific knowledge between the different regions of the world.

A WHO-FAO-IAEA committee was suggested the creation of an institute dedicated to the study of trace elements in1973. In 1992 the Institute was found under the auspices of Federico Mayor, Director-General of UNESCO. Trace element institute for

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The Russian Society of Trace Elements in Medicine (RUSTEM) was founded in April 2001 in Moscow. The goal of the Society is to unite efforts of public associations directed to improvement of human health protection in Russia and CIS; assistance to professional and humanitarian contacts between specialists, working in medical elementology and adjacent fields; realization of creative potential of Society members in medicine theory and practice; protection of professional, civil, social, author's and adjacent rights of the members; assistance to ecological problems solution, environmental protection, correct use of natural resources; studying of environmental influence on the human health; professional and scientific relations with Russian and foreign medical societies, specialists and organizations of other medical specialities.

Институт микроэлементов Юнеско (далее Институт) занимается развитием потенциала и сопровождением исследований в мультидисциплинарной области «Микроэлементы», его целью является увеличение взаимодействия в области обмена и распространения знаний в данной научной области. Внимание Института сфокусировано на широком спектре областей науки, таких как гидросфера, окружающая среда, фундаментальные науки и здоровье. Основной целью Института является координация научных проектов фундаментальных и прикладных исследований, касающихся микроэлементов, с междисциплинарной точки зрения. Институтом микроэлементов ЮНЕСКО основана сеть вспомогательных центров, которые способствуют научному сотрудничеству в соответствии с целями ЮНЕСКО в данной области. Сферы полномочий: химия, биохимия, фармакология, генетика, эпидемиология, терапия, питание, агрономия, окружающая среда (почва и вода) и ветеринария. Цель деятельности Института – координация научных проектов ЮНЕСКО в области фундаментальных и прикладных исследований микроэлементов с междисциплинарной точки зрения, обеспечение развития и обмена научными знаниями между различными регионами мира.

Комитетом ВОЗ-ФАО-МАГАТЭ в 1973 г. предложено создать институт, посвященный изучению микроэлементов. Институт был учрежден в 1992 г. под эгидой Генерального директора ЮНЕСКО Федерико Майора. С октября 2011 г. Институт микроэлементов ЮНЕСКО располагается в Лионе (Франция).

РУКОВОДСТВО

Президент: доктор Мюриэл Бост, Франция;
Вице-президент: профессор Ив Матийон, Франция;
Вице-президент в области спецпроектов: профессор Анатолий Скальный, Россия;
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Казначей: профессор Ив Матийон, Франция.

Российское общество микроэлементов в медицине (РОСМЭМ) было основано в 2001 г. в Москве. Цель Общества – объединение усилий общественных организаций, направленных на решение проблем охраны здоровья человека в России и СНГ; содействие профессиональным и гуманитарным контактам между специалистами, работающими в области медицинской патологии и смежных областях; реализация творческого потенциала членов Общества в теории и на практике в области медицины; защита профессиональных, гражданских, социальных, авторских и смежных прав членов Общества; помощь в решении экологических проблем, защита окружающей среды, правильное использование природных ресурсов; изучение влияния окружающей среды на здоровье человека; формирование профессиональных и научных связей с российскими и зарубежными медицинскими сообществами и специалистами различных направлений.