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Short communication

Reference values of hair toxic trace elements content in occupationally non-exposed Russian population

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ABSTRACT

A total of 5908 occupationally non-exposed adults (4384 women and 1524 men) living in Moscow and Moscow region were involved in the current investigation. Hair Al, As, Be, Bi, Cd, Hg, Li, Ni, Pb, Sn, and Sr content was estimated by inductively-coupled plasma mass spectrometry using NexION 300D. Men are characterized by significantly higher hair Al, As, Cd, Hg, Li, and Pb content. At the same time, hair levels of Bi, Ni, Sn, and Sr were significantly higher in women. Consequently, the reference ranges were estimated for male, female, and general cohort as coverage intervals in accordance with IUPAC recommendations.

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1. Introduction

Heavy metal exposure has been shown to be associated with a number of diseases (Järup, 2003) and its monitoring is an essential part of environmental and health care (Wolterbeek, 2002). Hair has been widely used as a bioindicator of human exposure to heavy metals (Bencko, 1995). It has been shown that hair may successfully reflect environmental and occupational exposure to lead (Sen, 1996), mercury (Kruzikova et al., 2009), aluminium (Yokel, 1982) and combination of multiple metals (Wang et al., 2009). At the same time, a number of side factors like demography, lifestyle and geography (Christensen, 1995) may affect hair trace element content. Despite the presence of a number of studies indicating reference ranges of hair metal content, the existing data are inconsistent (Mikulewicz et al., 2013). Therefore, the primary aim of the current study is estimation of reference ranges of hair toxic trace elements content in adult Russian population.

2. Materials and methods

A total of 5908 occupationally non-exposed adults (4384 women and 1524 men) aged from 20 to 60 years and living in Moscow and Moscow region were involved in current investigation. The investigation has been carried out in accordance with the principles of the Declaration of Helsinki for studies involving humans and was approved by the Local Ethics Committee. All examinees gave their informed consent prior to the inclusion in the study.

The participants were selected for the study with the use of the following exclusion criteria: (i) occupational exposure to toxic metals; (ii) smoking (both present and former smokers); (iii) acute inflammatory diseases; (iv) endocrine disorders; (v) metallic implants; (vi) pregnancy and lactation; (vii) vegetarian diet, (viii) alcohol abuse.

Proximal parts of occipital scalp hair (0.1 g) were collected. Briefly, hair samples were washed with acetone and then rinsed thrice with deionized water (Zhao et al., 2012). After washing hair samples were dried at 60 °C on air with subsequent microwave degradation. Briefly, 0.05 g of hair samples were introduced into Teflon tubes and added with concentrated HNO_3. Digestion was performed in a Berghof speedwave four system during 20 min at 170–180 °C. The obtained solutions were added with distilled deionized water to a final volume of 15 ml. Hair toxic trace element content (Al, As, Be, Bi, Cd, Hg, Li, Ni, Pb, Sn, Sr) was estimated by inductively-coupled plasma mass spectrometry with NexION 300D (PerkinElmer Inc., Shelton, CT 06484, USA) using Dynamic Reaction Cell technology removing the majority of interferences with minimal loss of analyte sensitivity and equipped with ESI SC-2 DX4 autosampler (Elemental Scientific Inc., Omaha, NE 68122, USA).

Manufacturer's specifications were used for ICP-MS system preparation. Calibration was performed using standards containing 0.5, 5, 10, and 50 μg/l ultra-trace elements prepared from Universal Data Acquisition Standards Kit (PerkinElmer Inc., Shelton, CT 06484, USA) by dilution with distilled deionized water acidified with 1% HNO_3. An internal online

Table 1 – Descriptive statistics of age and hair toxic trace elements content in adult men and women.

Parameter	Men ($n = 1524$)					Women ($n = 4384$)					General sample ($n = 5908$)				
	Median	P_5	P_{95}	Mean	SD	Median	P_5	P_{95}	Mean	SD	Median	P_5	P_{95}	Mean	SD
Age, years	37.026	22.575	56.306	37.914	10.306	36.314	22.969	55.894	37.560	10.198	36.506	22.844	56.008	37.651	8.646
Al, μg/g	5.704	1.926	21.436	7.876	8.439	4.876	1.742	16.020	6.609	8.694	6.936	1.785	16.958	6.936	0.110
As, μg/g	0.046	0.019	0.213	0.074	0.149	0.021	0.006	0.097	0.035	0.091	0.045	0.007	0.135	0.045	0.026
Be, μg/g	0.002	0.000	0.014	0.003	0.008	0.002	0.000	0.010	0.003	0.030	0.003	0.000	0.011	0.003	1.931
Bi, μg/g	0.036	0.007	0.342	0.187	1.917	0.043	0.007	0.735	0.251	1.937	0.234	0.007	0.674	0.234	0.309
Cd, μg/g	0.015	0.004	0.168	0.063	0.594	0.011	0.003	0.070	0.024	0.074	0.034	0.003	0.090	0.034	1.003
Hg, μg/g	0.566	0.076	2.744	0.891	1.086	0.498	0.112	2.002	0.734	0.969	0.775	0.106	2.212	0.775	0.115
Li, μg/g	0.013	0.005	0.070	0.026	0.167	0.010	0.005	0.063	0.023	0.091	0.024	0.005	0.065	0.024	1.057
Ni, μg/g	0.198	0.078	0.809	0.303	0.504	0.265	0.091	1.167	0.451	1.188	0.413	0.087	1.057	0.413	14.943
Pb, μg/g	0.501	0.121	4.689	2.528	29.289	0.295	0.083	1.462	0.532	1.408	1.046	0.088	2.142	1.046	2.568
Sn, μg/g	0.088	0.028	0.402	0.212	2.938	0.133	0.025	2.760	0.647	2.416	0.535	0.026	2.151	0.535	18.468
Sr, μg/g	1.119	0.313	6.624	2.102	4.097	3.990	0.683	25.370	8.696	21.157	6.935	0.455	20.319	6.935	8.646

P_5, P_{95} – 5 and 95 percentile boundaries; SD – standard deviation.