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Original Research

Determination of Total Mercury Concentration in Hair of Lubartów-Area Citizens (Lublin Region, Poland)

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Abstract

The aim of the experiment was to evaluate mercury content in the hair of people in Lubartów and surrounding areas (Lublin region, Poland) depending on their place of residence, lifestyle and diet. Mean mercury content in the hair of tested general population from Lubartów and surroundings, which amounted to 0.10±0.07 μg g^{-1}, was similar to the results achieved by other authors for populations from Zamość and Warsaw regions as well as about three or four times lower as compared to concentrations determined for Lublin region in 1979. It was found that mean mercury concentrations in the hair of people who had a diet rich in fish products was significantly higher as compared to mean values for remaining groups. It was recorded that the hair of smokers contained significantly higher mercury levels than that of other non-smoking respondents (0.14±0.09 μg g^{-1} for smokers, 0.05±0.03 μg g^{-1} and 0.09±0.06 μg g^{-1} for non-smokers). No influence of hair dying on elevating the mercury content was found.

Keywords: mercury, hair, non-flame atomic spectrometry absorption, environment, foodstuff, lifestyle

Introduction

Content of mercury in hair is a widely applied indicator for environmental pollution evaluation and the exposure of humans and animals to toxic element accumulation [1-9]. In such a context, hair is better material than urine or blood, which is more difficult to sample, transport and store. Moreover, mercury concentration in hair is several times higher than that in blood or urine – this concentration in hair and blood ranges from 200:1 to 300:1 [10], which results in the fact that samples need not be so large, thus making the analytical process easier.

Mercury presence in our environment is associated with the development of different industries, pollution of water reservoirs, atmosphere and food as well as agricultural application of preparations containing this element. Contaminated food, then air, water and random contacts with mercury or its compounds plays a major role in this element's exposure.

The aim of the experiment was to evaluate mercury content in hair of the people coming from Lubartów-area residents (Lublin region 51°28'N and 22°36'E) depending on their place of residence, lifestyle and diet. The study will enable us to identify possible threats posed by mercury in the environment of the tested population.

Experimental Procedures

Each tested person (380 people) filled in a questionnaire about residence, hair color, cigarette exposure, amalgame tooth filling and diet.

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Hair samples were taken in December 2003. Hair was cut from several points on each head just at the skin (about 3 cm sections), then cut into 1 cm parts and washed in 0.2% non-ionic detergent solution (Triton X-100) by shaking in flasks with a polished glass stopper. After filtering, samples were thoroughly washed with de-ionized water, then acetone, finally air-dried.

Mercury content in such prepared samples was determined using non-flame atomic spectrometry absorption technique (mercury analyzer AMA 254, Altec, Czech Republic). Application of the method was very precise and convenient and did not require any previous pre-treatment of the analyzed sample [11]. During analysis in the AMA 254, samples were pre-dried in the internal oven of the analyzer and burned in oxygen (99.999% purity). The decomposition products were further carried to an amalgamator for a selective mercury trap. After stabilization of temperature (120°C) within the amalgamator the content of trapped mercury was measured. Thus mercury was released from the amalgamator by a short heat-up and the mercury cloud was transferred by O_2 carrier gas to a double measuring cuvette. Hence the same quantity of mercury was measured twice using different sensitivy, resulting in a dynamic range of 0.05-600 ng Hg in a single measurement. The detection limit was 10^{-5} µg g^{-1}. The original factory calibration was still valid for the calibration of the instrument. The values were controlled regularly by calibration standard mercury solutions – NIST-traceable Hg standard solution (Accu Trace Single Element Standard; AccuStandard Inc., New Haven, CT, USA) [9].

In order to perform the statistical analysis, a representative group of the tested population has been selected on the basis of the surveys filled in so that there was no interaction of factors influencing mercury concentration in the hair of people tested. Comparison of differences between groups was made by applying Duncan's test using SAS software.

Results and Discussion

As can be seen in Table 1, 40.5% of tested population live in rural areas. Respondents were characterized by a fruit-and-vegetable-rich diet eaten regularly several times a week. Moreover, diets contained freshwater fish (17.3% respondents consumed fish once a week, 48.9% once a month) as well as sea fish (28.4% of them ate it once a week, 48.4% once a month), poultry products (22.8% of respondents consumed it once a week, 46.9% once a month) and mushrooms (13.0% once a week, 53.4% once a month). Among all respondents, 14.2% smoked cigarettes, 38.7% were exposed to cigarette smoke, 36.4% had dyed hair and 43.5% amalgame tooth fillings.

Table 1. Characteristics of the study population.

		(%)
Place of residence	country	40.5
	city	59.5
Cigarette fumes exposure	smokers	14.2
	people exposed to cigarette smoke	38.7
	people not exposed to cigarette smoke	47.1
Factors that may have a potential to increase the threat of mercury exposure	hair dye	36.4
	people with amalgam tooth filling	43.5

Table 2. Characteristics of the frequency of general food groups in a diet of tested population.

Food	(%)			
	more often than once a week	once a week	once a month	once a year
Poultry products	8.1	22.8	46.9	22.2
Mushrooms	2.0	13.0	53.4	31.6
Freshwater fish	0.3	17.3	48.9	33.5
Sea fish	0.6	28.4	48.4	22.6
Vegetables	79.5	18.6	1.6	0.3
Fruits	79.2	17.3	3.5	0.0

As we can see in Table 3, mean mercury concentration in the hair of general tested population was 0.10±0.07 μg g^{-1}. The comparison of these data with results achieved about thirty years earlier for other parts of the Lublin region – 0.39 μg g^{-1} and 0.30 μg g^{-1} [12]; for Warsaw citizens – 0.10 μg g^{-1} [10]; for Wrocław citizens – 0.50 μg g^{-1} [13]; for Gdańsk citizens – 0.39 μg g^{-1} [6] as well as Lubycza Królewska citizens (Zamość region) – 0.13 μg g^{-1} [14], can bring us to the conclusion that mean mercury concentration in hair in the described experiment was at the lowest level. The lower concentration of mercury observed in the population of Lublin region as compared to the data achieved in 1979 [12] may be linked to several factors. First, the number of industrial factories emitting mercury compounds to the atmosphere in the region has considerably decreased, and similarly the amount of pesticides used by the agricultural industry has been lower. This situation may be directly connected with the worse economic situation of Polish industry and farmers after the political transformation of 1989. Moreover, the lower concentration of mercury may result from access to the latest technologies in industry which allows us to considerably lower mercury contamination in the environment.

Much higher mercury levels were found in people who were exposed to mercury and its compounds: for Japanese – 1.63 μg g^{-1} [15] and 2.23 μg g^{-1} [16]; Americans – 0.21–1.23 μg g^{-1} [17]; Canadians – 0.40–1.20 μg g^{-1} [16, 18]; Indians – 1.30 μg g^{-1} [16]; Swedes – 0.70 μg g^{-1} [19]; Poles – 0.28 μg g^{-1} [16]; Bangladesh – 0.44 μg g^{-1} [3]; Albanians – 0.71 μg g^{-1} [5] and Brazilians – 1.51–21.00 μg g^{-1} [20].

Mercury levels in hair of citizens selected from general populations by eliminating people potentially exposed to increased mercury concentrations (cigarette smoking, diet enriched in fish poultry and mushroom products, amalgame tooth filling and dying the hair), had 0.05±0.03 μg g^{-1} and 0.09±0.06 μg g^{-1}, respectively (mean value 0.07 μg g^{-1}).

No negative influence of hair dye on mercury concentration was observed (0.07±0.04 μg g^{-1}). It was found that people who smoked cigarettes had significantly higher amounts of mercury in hair (0.14±0.09 μg g^{-1}) than those not exposed to cigarette smoke (0.05±0.03 μg g^{-1} and 0.09±0.06 μg g^{-1}). An earlier study on the influence of smoking revealed that no significant differences between smokers and non-smokers were found in reference to mercury contents in blood and erythrocytes [21-23] as well as in hair [23].

The results revealed that people who had a diet rich in fish were characterized by the increase of mercury content in hair to 0.09±0.06 μg g^{-1} in the case of freshwater fish and up to 0.12±0.07 μg g^{-1} for sea fish (0.11 μg g^{-1}, on average). Earlier studies performed on Japanese [24], Amazon people [20, 25-27], fishermen and their families from Tucurui and Indians from the Parahora reservation (Brazil) [28], children and youth from the Zamość region [12], Canadians [18], as well as Americans [7, 29] also confirmed our observations. Nakagawa [30] stated that higher mercury concentrations among the Japanese were associated with a traditional diet rich in fish. He recorded that young people who preferred a more European lifestyle based mainly on a vegetarian diet were characterized by lower mercury contents in hair as compared to those who consumed traditional food. Higher mercury levels in the hair of Amazon, Tucurui and Parahora people was associated with regular consumption of fish that absorbed methylated mercury compounds from pollution due to gold deposit exploitation [20, 25-28].

Table 3. Mean mercury contents in hair depending on different factors.

	n	Hg μg g^{-1}		
		mean	S.D.	range
General population – mean	380	0.10	0.07	0.01-0.41
City dwellers (non-smokers)*	28	0.09^{BCbcd}	0.06	0.02-0.26
Country dwellers (non-smokers)*	26	0.05^{Cd}	0.03	0.02-0.12
Smokers *	32	0.14^{Aa}	0.09	0.03-0.41
People with dyed hair (non-smokers)*	26	0.07^{BCcd}	0.04	0.02-0.12
Consumers of diet rich in freshwater fish (non-smokers)*	26	0.09^{ABCbc}	0.06	0.03-0.34
Consumers of diet rich in sea fish (non-smokers)*	45	0.12^{ABab}	0.07	0.02-0.33

*Groups made by eliminating objects where interactions between factors increasing mercury content in hair occurred.

ABC – values designated with the same letters within columns do not significantly differ $P<0.01$

abcd – values designated with the same letters within columns do not significantly differ $P<0.05$

Conclusions

The achieved data related to mercury concentration in the hair of Lubartów population (Lublin region) indicate that the environment tested is characterized by low emission of that element. The results of that analysis confirms the influence of a diet rich in fish products on the considerably higher concentration of mercury. Similarly, the concentration of this element is significantly higher for smokers as compared to other tested groups. No relation between hair dying and the level of mercury concentration has been found.

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