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Application of hair mineral analysis in identification of sources of human exposure to toxic elements in the region of Lodz

Abstract

The aim of the study was to determine the influence of various factors on the elemental composition of investigated hair samples from inhabitants of Lodz region using modern instrumental techniques such as inductively coupled plasma time-of-flight mass spectrometry (ICP-ToF-MS), atomic absorption spectrometry (AAS) and cold vapor atomic absorption spectrometry (CV-AAS).

The research was carried on samples collected from the population of people living in the region of Lodz, who were also asked to complete a detailed questionnaire containing their lifestyle, dietary habits, medications, cigarettes, etc.

Elements selected for the analysis were: mercury (Hg), chromium (Cr), zinc (Zn), cadmium (Cd), magnesium (Mg), copper (Cu), nickel (Ni), lead (Pb), strontium (Sr), calcium (Ca) and iron (Fe). Mercury analysis with the MA-3000 Automatic Mercury Analyzer was performed on hair samples collected from 462 people. Analyzes of the remaining elements were made using AAS and ICP-ToF-MS techniques on 271 hair samples. The researched groups were subdivided into subgroups and analyzed for factors such as gender, age, hair cosmetic treatments (dyeing and brightening), smoking and diet (fish intake). The obtained results were compared with the results of similar studies in Poland and the world.

Statistically significant correlation ($p < 0.05$) was determined between the levels of Hg, Cu, Sr, Pb, Cr and Zn in the hair, in relation to sex; Hg, Ca, Cu, Sr, Zn, Pb, in relation to age; Cu, Sr, Ni, Cr, Pb in relation to cosmetic treatment and Ni and Cu in relation to cigarette smoking. Statistically higher Hg content was also found for the amount of fish consumed during the week.

The results were elaborated using Statistica ver. 10.0. software. Normality of distribution of the experimental results was assessed by Shapiro–Wilk and Lilliefors tests. Differences in the content of individual elements in hair in the studied groups, depending on the factors, were determined by means of statistical tests.

This type of research should be done every few years, because even in one geographic area, levels of various elements may change with the occurrence of various factors, such as the difference in environmental pollution, the increase in car transport, eating more varied meals, changing dietary habits and undergoing various kind of lifestyle. Investigating the impact of various factors on the results of hair analysis can help to estimate appropriate benchmarks or conduct biomonitoring studies on a larger scale. It was found that techniques used during the research can find practical applications in elemental hair analysis when determining levels of toxic elements as well as bioelements.