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Use of Biomonitoring in Health Risk Assessment of Workers to Heavy Metals in Industrial Environment

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Abstract

The problem of occupational and work exposure to trace and toxic metals existed at the beginning of industrialization which even persists today. Biomonitoring is the analytical science with multidisciplinary applications that guides industrialist in assessment, management and prevention of trace and toxic metal exposure to workers at workplace. In the present research work, 40 workers were included for the study as subjects out of which, 20 were exposed and 20 were included as controls. Head hair samples were collected from all the subjects and were pretreated for decontamination by washing then digested to get colorless solution prior to analysis for lead (Pb) and cadmium (Cd) with an Atomic Absorption Spectrophotometer.

Keywords

Biomonitoring, Health Risk Assessment, Heavy Metals, Industrial Environment

1. Introduction

The industrial revolution, having been welcomed first in the European countries, followed by America, was to soon prevail in the remaining part of the world. The sudden increase in the GDP and the GNP, particularly in the 'developed' Europe and America, became the desired goal for the 'developing' rest who started competing with one another for achieving the said highly desired goal of (economic) growth and the derived prosperity there from. Besides this, the process of increased industrialization also led to emergence of industrial townships and a mammoth rush of rural population to the urban centers (cities) in search of employment where the industries were coming up, resulting ultimately to urban over-crowding with all the accompanying problems of urbanization [1].

The problem of occupational exposure at the workplace is not new for us. From ancient times when industry was not organized, the workers were in very bad conditions of working and living. Industrial areas were always dirty and unsuitable to health. The problem remains the same at the present time when industries are organized. However, if we study a system properly to analyze harmful effects, we can put a voice in front of population and government to take necessary steps.

In present research work biomonitoring of head hair samples of 20 workers of metal finishing industries, lead cadmium battery industries, electroplating industries and mining industries was performed for determination of lead and cadmium concentration. For the purpose of comparison biomonitoring of head hair samples of 20 control subjects who were not occupationally exposed to metals in these industries was also performed. A recommended questionnaire was also filled along with the sampling of hair samples to get information regarding eating habits, lifestyle disease status and medical history. Analysis of concentrations of lead and cadmium in hair sample was performed after the pretreatment and digestion of samples using Atomic Absorption Spectrophotometer ECIL Model-AAS 4129.

1.1. Biomonitoring

Biomonitoring plays an extremely important role in determining metal exposure at the workplace. It is a multidisciplinary integration of sciences viz. forensics science, environmental science, chemical science, medical science and archaeology in order to utilize natural potential of biological tissues to reflect the metal body burden [2-8]. Literature available on studies in biomonitoring in India informs that there is a lack of availability of reliable and authentic data, and it has been a major bottle neck in achieving the full benefits of safe work environment.

Heavy metals play a significant role in the human body, but their accumulation may cause different adverse health effects in the human body [9-12]. The accumulation of excess of trace and toxic metals can be studied using hair follicles; hence, hence to this reason, the Global Environmental Monitoring System has recommended human hairs as a biopsy material to estimate human metal body burden [13].

2. Materials and Method

In the present study a total of 40 workers of metal finishing industries, lead-cadmium battery industries, electroplating industries and mining industries were included as subjects. Workers those are exposed to toxic metals at their workplace were included as exposed subjects and those who are not exposed to toxic metals and working in offices of these industries were included as control subjects in the same numbers. Male workers of 20 to 55 years of age were included in present study. Head hair samples of all the subjects were collected from nape region of scalp with one centimeter distance using a sterilized stainless-steel scissor and stored in a preceded polyethene bag. While sampling a recommended questionnaire was also filled in to obtain information regarding age, general health, working, occupation, occupational area and living habits of workers. Head Hair samples were then washed with deionized water, Triton-X 100 and acetone and dried at 100O C and digested on hot plate using a digestion mixture of HNO3 and Perchloric acid in 6:1 ratio to get a clear and colorless solution [14-15]. The solution was evaporated to get a white residue which is dissolved in 0.1 N HNO3 solution [16-17]. The analysis of Pb and Cd was performed with an AAS- ECIL Model-AAS4129. The data obtained were tested for significance using statistical software Microcell Origin 6.0.

3. Results and Discussion

Mean and standard deviation (SD) of Pb and Cd in human hair samples have been calculated and presented in Table1. Mean Pb concentration in hair of subjects occupationally exposed to toxic metals was 32.23 mg/g (±7.69 mg/g) that was higher than 24.20 mg/g (±9.14 mg/g) of controls. Pb concentration in hair of subjects occupational exposed to toxic metals are in range of 16.50 mg/g-44.45 mg/g and those of controls are in ranges of 12.30 mg/g - 44.01 mg/g.

Mean Cd concentration in hair samples of occupationally exposed subjects was 2.03 mg/g (±0.42mg/g) that was significantly higher than 1.14 mg/g (±0.48 mg/g) of controls. Cd concentration in hair samples of subjects occupationally exposed to toxic metals is in the range of 1.01 mg/g -2.67 mg/g and those of controls are in ranges of 0.36 mg/g - 1.87 mg/g.

Table 1. Mean Concentrations of lead, cadmium in head hair of controls and exposed subjects in workplace.

	Control		Exposed	
	Range (µg/g)	Mean (S.D.)	Range (µg/g)	Mean (S.D.)
Pb	12.30-44.01	24.20 (9.14)	16.50-44.45	32.23 (7.69)
Cd	0.36-1.87	1.14 (0.47)	1.01-2.67	2.0321 (0.42)

Table 2. Test of significance for lead concentration in head hair of control and exposed.

Subjects	Mean	Variance
Control	24.20	83.59
Exposed	32.23	59.13

At the 0.05 level, the two means are significantly different.

Table 3. Test of significance for Cd concentration in head hair of control and exposed.

Subjects	Mean	Variance
Control	1.14	0.23
Exposed	2.03	0.18

At the 0.05 level, the two means are significantly different.

Above results clearly describe that workers are exposed to Pb and Cd at their workplace and Pb and Cd are accumulated in hairs of workers. This result supports our earlier finding which was supported by other workers [18-19]. These toxic metals change the natural ratio of elements in the body. These toxic metals can damage human tissues and organs even at low concentrations and can lead to several types of risks to human health [20-22]. The risks could be acute, sub-acute or chronic. Acute and sub-acute risks can be caused by ingestion, inhalation or through topical absorption. Chronic causes cancer, damage of genetic materials, neurochemical disorder, respiratory disorder and other severe abnormalities [23-28].

4. Conclusion

We can at this point briefly state the conclusion of the present study in general terms by reporting that the hypotheses we had started with were substantiated on the strength of factual empirical primary data, and so they can now be raised to the level of generalizations. Indian industries still need to construct considerable improvement from the environmental point of vision. Most of the industrial Research & Development is largely disturbed with cost efficiency rather than eco-effective technique. Though there have been a few mutual works between academic industries and industries, still there is a large opportunity for increased collaboration. There is instantaneous need for knowledge transfer from labs of academic institutes to industrial and manufacturing plants for significant application of scientific research.

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