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TRACE LEVEL ANALYSIS OF CHROMIUM, MANGANESE, COBALT AND IRON IN HUMAN HAIR OF PEOPLE RESIDING NEAR HEAVY TRAFFIC AREA BY BIOMONITORING

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ABSTRACT

Biomonitoring of Cr, Mn, Co and Fe in hair of 116 subjects of 40-50 years of age living near heavy traffic area and less traffic area in the state of Rajasthan in India was carried out. Out of these 116 subjects, 58 subjects lived near heavy traffic area and remaining 58 subjects lived near less traffic area. Head hair samples from nape region were personally collected using stainless steel scissor. All hair samples were washed with non-ionic detergent & acetone successively to remove external contamination and digested to get a colourless and clear solution followed by analysis using Atomic Absorption Spectrophotometer Perkin Elmer Model 5000 using air acetylene flame for Cr, Mn, Co and Fe concentrations. On appropriate statistical treatment of data, mean Cr and Mn level in hair of subjects living near heavy traffic area were found higher than subjects living near less traffic area. Mean Fe and Co levels in hair of subjects living near heavy traffic area were significantly less than subjects living near less traffic area.

KEY WORDS

Hair, chromium, manganese, cobalt, iron, AAS Biomonitoring.

INTRODUCTION

Metals have played an important role in the history of man. Man has made great strides towards industrial development, technological development and civilization to improve the living conditions and comforts of human life. In doing so man has inadvertently upset the crucial environmental balance of nature. This has led to undue exposure of human beings to the hazards of potential contaminants. Biomonitoring is a new branch of science, in which quantitative measurements of elements and metals are performed using biological tissues. Biological monitoring is direct qualitative and quantitative assessment of exposure of a group of persons or individual to noxious agents present in the environment. Biological monitoring has been found to be a useful means of assessing body burden in humans. The use of bio-indicators such as blood, serum, plasma, hair, nail etc. has been a subject of study by international agency and few researchers[1-3]. Trace elements are determined in man to assess the deficiency or excess levels of elements, which are related to health. A variety of clinical samples are used for the assessment of the extent of deficiency or high level of elements. In assessing the environmental risks to toxic metals, where the exposure is infrequent and highly variable, the

metal contents in biological tissues can provide a better estimate for the long term risk to the general public. In view of the advantages of hair for monitoring body burden, it is convenient to survey exposure levels in exposed and unexposed population groups. Chronic exposure to trace toxic metals had become a cause of various health hazards in male and female subjects such as colon cancer, acute cerebrovascular diseases, allergy, abnormal blood pressure, eczema, itaiitai, kidney damage, respiratory diseases, rheumatic diseases, growth delay and mental abnormalities etc.[4-10]. In addition to lead, cadmium, and arsenic which are already studied by most of the researchers with respect to environmental pollution other essential trace element requires serious concern[11-13]. The Global Environmental Monitoring System (GEMS) has chosen human hair as a biopsy material to estimate metal body burden[14].

In the present study concentration of four trace essential metals chromium (Cr), manganese (Mn), cobalt (Co) and iron (Fe) was determined in hair of subjects residing near Heavy Traffic Areas (HTA) and Less Traffic Areas (LTA) in the Rajasthan state of India. Total 116 subjects of 40 to 50 years of age were selected for study who were workers in locomotive workshops, of 116 subjects 58 resides near HTA and remaining 58 resides near LTA. Hair samples were personally collected, decontaminated and digested before analysis using Atomic Absorption Spectrophotometer. It was goal of this study to determine the concentration of Cr, Mn, Co and Fe in hair of subjects residing near HTA and LTA. It was hypothesized that there might be difference in concentration of Cr, Mn, Co and Fe in hair of subjects residing near HTA as compared to subjects residing near LTA. It was also goal of this study to ascertain the effect of metal pollution due to vehicles using hair of people residing in vicinity of heavy or less traffic area. The main aim of this study was to identify the population at risk to metals in environment due to increasing traffic and vehicular pollution.

EXPERIMENTAL

In the present study workers of locomotive workshop were chosen as subjects which, reside near heavy and less traffic areas of State of Rajasthan in India. Total 116 subjects of 40 to 50 years of age were included in this study, out of these 116 subjects 58 resides near heavy traffic area (HTA) and remaining 58 lived near less traffic area (LTA). Head hair samples were personally collected using a stainless steel scissor from nape region with 1 cm distance form scalp. Approximately 2 gm of head hair samples were taken from each subject, and stored in airtight polythene. Other information of subjects like age, sex, occupation was also obtained from a questionnaire, which was filled while sampling.

Pretreatment of hair samples was done to decontaminate them using non-ionic detergent (Triton X-100), acetone and deionised water and kept for drying at 110^0 C in oven for one hour. Pretreated hair samples were then digested on a hot plate in a fumehood chamber using Nitric Acid and Perchloric Acid in 6:1 ratio, to obtain a colourless clear solution. The acid is now evaporated and residue is then dissolved in 0.1 N Nitric Acid [15-17]. The quantitative analysis of Cr, Mn, Co and Fe was performed with an Atomic Absorption Spectrophotometer (AAS) Perkin Elmer Model-5000 using air acetylene flame. Cathode lamps were used which was set at 283 nm, 229 nm 232 nm and 325 nm separately for Cr, Mn, Co and Fe respectively. The data thus obtained were then analysed to get mean, standard deviation and test of significance using Student 't' test.

RESULTS

Mean and standard deviation of metals under study in hair samples of subjects have been calculated and presented with respect to their residential area. As summarized in Table 1 mean chromium concentration in hair of subjects residing near HTA was 5.792 μg/g (±7.222 μg/g) that was higher than 4.540 μg/g (±4.542 μg/g) of subjects residing near LTA.

Chromium concentration in hair of subjects residing near HTA ranges from 1.99 μg/g to 33.25 μg/g and those residing near LTA ranges from 1.98 μg/g to 12.71 μg/g. The mean concentration of chromium in hair of subjects residing near HTA was though higher than in hair of subjects residing near LTA but this difference was not significant.

Mean manganese concentration in hair of subjects residing near HTA was 5.369 μg/g (±1.833 μg/g) that was higher than 3.717 μg/g (±0.639 μg/g) of subjects residing near LTA. Manganese concentration in hair of subjects residing near HTA ranges from 2.76 μg/g to 7.92 μg/g and those residing near LTA ranges from 2.90μg/g to 4.69 μg/g. The mean concentration of manganese in hair of subjects residing near HTA was significantly higher than in hair of subjects residing near LTA.

Mean iron concentration in hair of subjects residing near HTA was 123.247 μg/g (±53.513 μg/g) that was lower than 154.000 μg/g (±32.090 μg/g) of subjects residing near LTA. Iron concentration in hair of subjects residing near HTA ranges from 42.70 μg/g to 199.23 μg/g and those residing near LTA ranges from 107.14 μg/g to 195.00 μg/g.. The mean concentration of iron in hair of subjects residing near HTA was significantly lower than in hair of subjects residing near LTA.

Mean cobalt concentration in hair of subjects residing near HTA was 0.511 μg/g (±0.217 μg/g) that was lower than 2.180 μg/g (±4.849 μg/g) of subjects residing near LTA. Cobalt concentration in hair of subjects residing near HTA ranges from 0.16 μg/g to 0.81 μg/g and those residing near LTA ranges from 0.29 μg/g to 15.10 μg/g. The mean concentration of cobalt in hair of subjects residing near HTA was significantly higher than in hair of subjects residing near LTA.

DISCUSSION

It can be illustrated from Table 1 that subjects residing near HTA are exposed to metals like chromium and manganese and these metals gets accumulated in the hair. Cr level in hair of subjects residing near HTA was higher but this difference was not significant than in hair of subjects residing near LTA, so there is less risk of exposure to Cr in vicinity of heavy traffic area, but few subjects with skin lesions support the high chromium level in subjects residing near heavy traffic area. Mn level in hair of subjects residing near HTA was significantly higher than subjects residing near LTA, so there is risk of exposure to Mn in vicinity of heavy traffic area. Fe and Co level in hair was found significantly less in subjects residing near HTA as compared to subjects residing near LTA which indicates that subjects residing near HTA area are not exposed to Fe and Co in their environment. When compared to subjects residing near LTA it is found that that subjects residing near HTA are at a risk to deficiency of Fe and Co. Subjects residing near heavy traffic area are at risk to deficiency of iron and cobalt also as evinces from as few subjects were suffering from anemia. This deficiency might be due to interaction of metals like Cr, Mn and others with the biological binding sites of Fe and Co in hair. This supports our earlier report that trace metals interfere with the biological functions of other trace metals[18]. Present work support our earlier work that level of trace element in hair is related to metal pollution caused by heavy traffic[19]. From above discussion it can be concluded that increase in traffic causes metal pollution in the environment which affects the human population near by leading to various diseases.

Table 1

Chromium, Manganese, Iron, Cobalt level in hair of people residing near heavy traffic area and less traffic area.

Metal	Near Heavy Traffic		Near Less Traffic	
	Range (±S.D.) μg/g	Mean (±S.D.) μg/g	Range(±S.D.) μg/g	Mean (±S.D.) μg/g
Chromium	1.99-33.25	5.792 (±7.222)	1.98-12.71	4. 540 (±4.542)
Manganese	2.76-7.92	5.369* (±1.833)	2.90-4.69	3.717 (±0.639)
Iron	42.70-199.23	123.247* (±53.513)	107.14-195.00	154.000 (±32.090)
Cobalt	0.16-0.81	0.511* (±0.217)	0.29-15.10	2.180(±4.849)

* Significant at P<0.05 S.D.= Standard Deviation

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