ASSESSMENT OF TOTAL IRON CONTENT IN SCALP HAIR SAMPLES OF PEOPLE LIVING IN THE VICINITY OF HUDIARA DRAIN, AMRITSAR, PUNJAB

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ABSTRACT

Industrial effluents are a matter of concern. Different industries generate huge amounts of effluents, some of which are treated and rest are thrown in water bodies. Hudiara drain in Amritsar city of Punjab state is known to carry the wastewater of different industries. In this biomonitoring study, the concentration of iron (Fe) was determined using the scalp hair samples of people living in the vicinity of Hudiara drain. For the present study, 35 subjects were chosen from the affected area. Same number of subjects (N = 35) were chosen as controls with respect to age, sex and socioeconomic strata which were not exposed to the effect of Hudiara drain effluents. The present study reveals a significant increase in the total iron content in the scalp hair samples of the exposed group as compared to the control group (p<0.05). Conclusively the people residing in the vicinity of Hudiara drain were advised to take care of the drinking water quality and water purifying measures.

KEYWORDS: Trace metals, Iron, Hudiara drain, Scalp hair, Amritsar.

INTRODUCTION

Industrial effluents have been a concern for all the environmental conservation agencies. Industries including textile, iron and casting, information technology, tannery and beverage are resulting in the production of loads of effluents during various industrial processes.¹ These effluents have been characterized as toxic due to the presence of different sets of chemicals and metals including chromium (Cr), nickel (Ni), iron (Fe), manganese (Mn),
copper (Cu) and lead (Pb). All these metals are known for their toxic effects on both plants and animals. The chemicals and metals leach into the soil and penetrate the soil strata thus polluting the ground water. To assess the health implications of heavy metal exposure, different biomonitoring studies have been carried out.\[2-8\] Various researchers have assessed the concentration of heavy metals in different samples including blood, serum, urine, hair and nails from different models.\[9-11\]

Hair analysis for trace elements is an area of increasing interest in the field of biological and environmental sciences.\[12-18\] An accurate record of trace metals in the human body can be drawn from hair samples. Hair analysis has also been done in patients with different diseases including goiter,\[14\] kidney dialysis patients,\[16\] cystic fibrosis,\[17\] schizophrenia,\[19,20\] mental retardation\[21\] and acute cerebral vascular diseases.\[22\] Hair metal content may vary with the geographical location of the subject. It can change with the proximity of the subject to the effluent site, age and sex. Hair is an excellent indicator of environmental exposure to metals via different media. They reflect the local environmental conditions. Each geographic area also has a typical profile of hair elemental composition of its inhabitants.\[23\] The growth rate of human hair is approximately 1 cm per month.\[24\] Thus metals can provide the metal exposure history of a subject. Metals have also been studied as the behavior deciders. Metals including lead and manganese have been found to be involved behind violent behavior. Researchers have examined the relationship between potentially toxic metals and aberrant behavior including violent activity through hair analysis for trace elements. High levels of manganese were found in prison versus control groups and significantly elevated manganese levels were found in the hair of violent versus nonviolent subjects.\[18\]

+2 and +3 are the most common oxidation states of iron. Like other group 8 elements, iron also exists in a wide range of oxidation states of −2 to +6. Hemoglobin and myoglobin are the two most common oxygen transport proteins. Iron plays an important role in forming complexes with molecular oxygen present in these respiratory pigments. Iron is also present at the active sites of many important redoxenzymes dealing with cellular respiration in plants and animals. After uptake by thecells, iron storage is regulated. Free iron ions do not exist as such in the cells. Large amounts of ingested iron can cause excessive levels of iron in the blood. High blood levels of free ferrous iron react with peroxides to produce free radicals which are highly reactive and can damage DNA,\[25,26\] proteins, lipids, and other cellular components. Free radicals inturn result in oxidative stress.\[27\]
Thus, in the light of the above mentioned facts, the present study was designed to evaluate the presence of iron concentration in the scalp hair samples of the people living in the vicinity of Hudiara drain which is carrying mixed effluents from different industries including paper industry and textile industry.

**MATERIAL AND METHODS**

**Subject selection**

In the present study, 35 people (Mean age: 40.6 ± 1.53 years) living in the vicinity of Hudiara drain were selected as subjects who were exposed to heavy metals through the polluted water of the drain. An equal number (N = 35; Mean age: 34.70 ± 2.17 years) of subjects matched with the exposed subjects with respect to age, sex, socio-economic status and occupation were selected as controls. The control subjects were having no exposure to the polluted water of the Hudiara drain as they selected from an area which was geographically more than 10 kilometers away from that drain. Thus, a total of 70 subjects were chosen for the present study.

**Scalp hair sampling and questionnaire**

Scalp hair samples were personally collected from the subjects using a stainless steel scissor from nape region with 1 cm distance from scalp. Approximately 2.5gm of head hair samples were taken from each subject and stored in airtight polythenes. Every polythene bag was given an ID as per the sample of the subjects with date of collection. Every sample was pretreated within 2 days of the collection. Information of subjects including age, sex and occupation was collected on a questionnaire developed for the time of sampling.

**Hair treatment and Fe estimation**

Pretreatment of hair samples was done to decontaminate them using non-ionic detergent (Triton X-100), acetone and deionized water and kept for drying at 50°C in oven for one hour. Pretreated hair samples were then digested on a hot plate using Nitric Acid and Perchloric Acid (6:1 ratio) to obtain a colourless clear solution. The acid was now evaporated. Residue was then dissolved in 0.1N Nitric Acid. The quantitative analysis of Fe was performed using an Atomic Absorption Spectrophotometer.

**RESULTS**

In the present study 35 subjects were chosen who were residing along the Hudiara drain and were exposed to the hazardous waste chemicals present in the water.
Along with 35 exposed subjects, unequal numbers of subjects were chosen as controls. All the subjects (N=70) were assessed for the iron concentration in the scalp hair samples. The results showed a significant difference between the iron concentration in the hair samples of exposed and control subjects (Mann Whitney; W = 1826; p < 0.001). Figure 1 shows the relative iron concentration in the scalp hair samples of exposed subjects as compared to the control subjects. It is very clear from figure 1 that the exposed subjects were having a significantly higher concentration of iron in scalp hair samples as compared to the controls.

![Figure 1: Relative total Fe concentration values among exposed and control subjects (N = 35)](image)

The mean concentration of iron in the scalp hair samples was found to be 0.5 ppm in the exposed subjects as compared to 0.2 ppm in the case of controls (Figure2). Similarly Ilyas et al.\textsuperscript{[28]} has detected significantly higher concentrations of iron in the scalp hair samples of angina patients as compared to the controls. On the same line Pasha et al.\textsuperscript{[29]} has detected higher iron levels in the scalp hair samples of patients of gastrointestinal cancer as compared to the controls. In an another study, Pasha et al.\textsuperscript{[30]} found the iron concentration to be 96.38 micrograms per gram in benign tumor patients as compared to 81.68 micrograms per gram in the case of controls subjects. Similarly, Chatterjee et al.\textsuperscript{[31]} found and increase in the iron concentrations along with the varied types of cuticular damage in the case of radiographers.
A significantly higher scalp hair iron concentrations were found by Tanburo et al.\cite{32} in the patients of multiple sclerosis. On the contrary, Ozmen et al.\cite{33} found a significantly lower iron concentration in scalp hair samples among the children with growth retardation. Similarly, Pradeep et al.\cite{34} found low iron values in the scalp hair samples among patients having neurological disorders.

The effect of age as confounder has also been evaluated on the Fe concentration in the scalp hair samples in both the exposed and the control groups. Age is known to have its impact on the metal accumulation in the different biological samples including hair. To find out the correlation among scalp hair Fe concentration and age, regression analysis was done. Figure 3 shows the regression graph (N = 35; \(R^2 = 0.1527\)) and figure 5 shows the matrix plot for
exposed subjects. Both these figures indicate the significant correlation among Fe concentration and age. Similarly, figure 4 and 6 indicate an increase in the Fe concentration among control population with age. Thus, an increased Fe retention by hair was found among the individuals of higher age.

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CONCLUSION
Wastewaters from different industries are known to be hazardous for animals including humans. Hudiara drain caters the waste waters from different industries. Iron overload in human body is considered a problem. The present study confirms the presence of significantly higher Fe concentrations in scalp hair samples among the people living in the vicinity of Hudiara drain as compared to the controls. Conclusively, the people living near Hudiara drain should take all the precautions for minimizing the exposure to the waste waters.
and leachates. Water purifying systems are recommended in that particular area. Further studies are needed to find out the impact of effluents from Hudiara drain on the health of people living in the nearby areas.

REFERENCES


19. Luo S. [A control study of some hair trace elements content of schizophrenics before and after treatment]. Zhonghua Shen Jing Jing Shen Ke Za Zhi, 1991; 24: 214-7, 252.


