Biological Monitoring of Lead and Cadmium in Blood, Hair and Nail of Autoworkers

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Abstract—*Samples of blood, hair and nail were collected from occupationally exposed subjects working in auto workshops in Rohtak city. Office workers were taken as control subjects. The concentrations of heavy metals Lead and Cadmium were determined in the samples by using atomic absorption spectrophotometer (AAS). The blood Lead levels of autoworkers were found significantly higher than that of control subjects and ranged between 13.80 – 65.51 µg/dl, whereas, no significant change was found in blood cadmium level of autoworkers in comparison to control group. Both heavy metals lead and cadmium were found significantly higher in hair samples and ranged between 12.98 – 124.13 and 0.31 – 1.96 µg/g of hair respectively. A significant positive correlation was found between blood lead and hair lead content of autoworkers. Nails were found to accumulate less metal in comparison to blood and hair. The present study revealed high concentration of these metals in the analysed samples indicating the presence of these metals in their workplace environment. Therefore there is an instant need for public awareness about the hazards regarding their occupation, so that the necessary precautions/safety measures be taken by the occupational workers.*

1. INTRODUCTION

All working environment have a certain degree of work related hazards and each work place environment is unique in nature and degree of hazards it poses to the workers. There is continuous interaction between man and chemical agents present in the workplace environment. Chemicals come out in the work environment from different uses in the form of dust or spray and may get into the body of worker mainly either through dermal contact or inhalation. Heavy metal pollution in the workplace environment is a worldwide problem. Lead is a potential neurotoxin and its exposure may lead to anaemia by inhibition of haeme synthesis, kidney damage, cerebral oedema, gastro-intestinal, respiratory disorders and nephropathy [1-3]. Cadmium is very toxic metal and its ingestion or inhalation may cause nausea, emphysema, chronic renal disease, cancer of prostrate and possibly of lung [4]. Blood metal levels reflect transient levels whereas hair metal level show long term retention which may be accounted for long period of exposure [5-7]. Nails also indicate metal body burden [8]. Examining toxic metal body burden in hair and nail samples are of biological and environmental importance. Various studies reported that hair, nail and teeth tissues can be used effectively to monitor highest priority toxic trace metals

[9, 10]. Both hair and nail are easy to sample as compared to any other tissue and can be stored without much technical hassle. Earlier studies have also reported high metal concentrations in these tissues [11, 12]. The auto workers selected for present study were in direct contact with petrol, diesel, grease and thinner etc. The aim of study was to determine concentrations of heavy metals (lead and cadmium) in biological samples i.e. blood, hair and nail to evaluate the exposure of these metals in autoworkers.

2. MATERIALS AND METHODS

To examine the exposure of metals in workplace, we analysed Lead and Cadmium concentrations in blood, hair and nail samples. Samples were collected from 80 exposed subjects (autoworkers) and 20 office workers taken as control. Blood samples were collected in heparinised vials. 1ml of blood was taken and digested in tri acid mixture in the ratio of 2:1:0.5 nitric acid, sulphuric acid and perchloric acid respectively .The contents were diluted up to the desired volume with the help of distilled water and estimation of cadmium and lead concentrations was performed with hollow cathode lamps at wavelengths 228.8 and 283.3nm respectively with a slit of 1.3nm by using atomic absorption spectrophotometer (Hitachi-6100). Hair samples were collected from the nape of scalp using a pair of sterilized scissors washed with ethanol [13]. For collection of nail samples, the subjects were asked to wash their hands thoroughly with medicated soap and double distilled water followed by drying with a clean towel or tissue paper to remove any external contamination. Nails were cut from fingers by using stainless steel scissors as used in hair. Hair and nail samples were kept in separate air tight plastic bags and labelled. Hair and nail samples were initially washed with no- ionic detergent, triton X-100, and then by acetone followed by deionized water. Samples were then dried in desiccator at 60ºC. The samples were then digested in tri acid mixture as described earlier for blood and estimation of metal ions was performed with the help of atomic absorption spectrophotometer.

3. RESULTS AND DISCUSSION

Lead was determined in blood as lead in blood is considered to be the best indicator of recent exposure [14]. Determination of Lead levels in blood of autoworkers revealed that concentrations of lead in blood were significantly higher in comparison to control subjects as shown in Fig. 1.
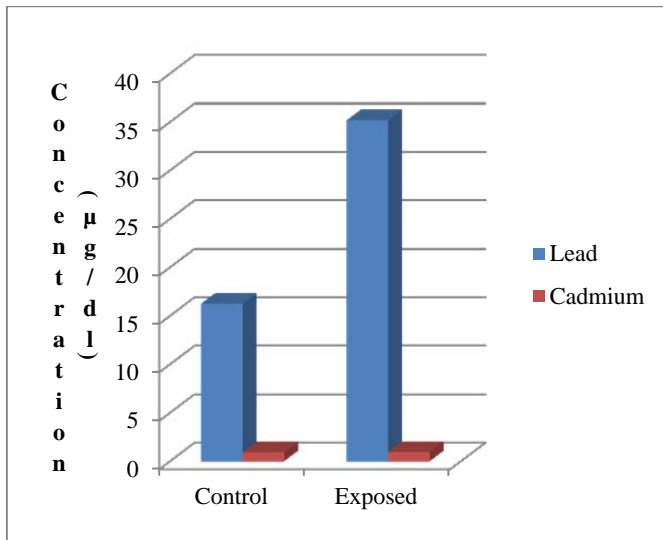

Fig. 1: Mean blood lead and cadmium levels of Autoworkers in comparison to control subjects

The increase in blood lead level was significant at $p < 0.001$. The lead concentrations in blood of exposed subjects ranged between 13.80 to 65.51 µg/dl in comparison to 12.06 to 20.68 µg/dl that of control subjects. High blood lead levels of workers were also reported in ceramic and cement industry [15] and in automotive garage workers [16]. Sources of lead pollution in auto repair shops have in described by earlier study [17]. No significant difference was observed in blood cadmium level of autoworkers as compared to control subjects. The cadmium level in blood of autoworkers and control subjects is ranged between 0.2 to 2.73 and 0.21 to 2.10 µg/dl respectively. Present data showed that the mean blood lead level were higher in comparison to mean cadmium levels in both exposed as well as control group. Low levels of cadmium in blood relative to lead may be because the metal remains in the blood only briefly and at very low levels as suggested by various studies [18, 19] and [20]. As the blood cadmium levels in autoworkers and control subjects were found comparable, it suggests that the workplace environment have major of lead exposure and a low level cadmium exposure. cadmium and copper levels in blood samples of autoworker with high blood lead content were found comparable to control subjects as reported earlier [15, 21]. This indicates that metal body concentration is a function of metal in workplace environment as also supported by other studies [22, 23].
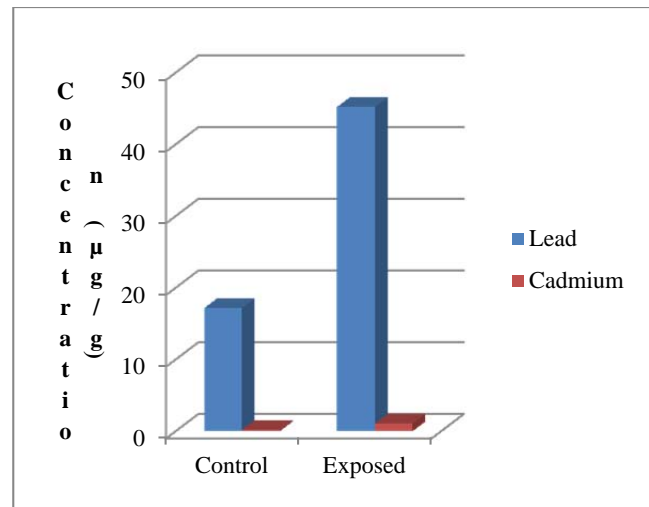

Fig. 2: Mean lead and cadmium levels in hair samples of Autoworkers in comparison to control subjects

Metal content analysis in hair samples has been summarised in Fig. 2. Concentration of both the heavy metals lead and cadmium were significantly high in hair samples of autoworkers than that of control subjects. The lead content of autoworkers and control subjects in hair samples ranged between 12.98 to 124.13 µg/g of hair and 11.48 to 25.48 µg/g of hair respectively. Similarly, cadmium content of exposed and control subjects ranged between 0.31 to 1.96 and 0.14 to 0.36µg/g of hair respectively. In the present study lead content in hair samples was higher in comparison to cadmium content in both exposed as well as control subjects, which is in consistence with the trend shown by lead and cadmium content in blood samples of the same. Also the concentration of both metals was found higher in hair in comparison to blood. This indicates hair is more accumulating tissue. The details of investigation on nail samples is given in Fig. 3.
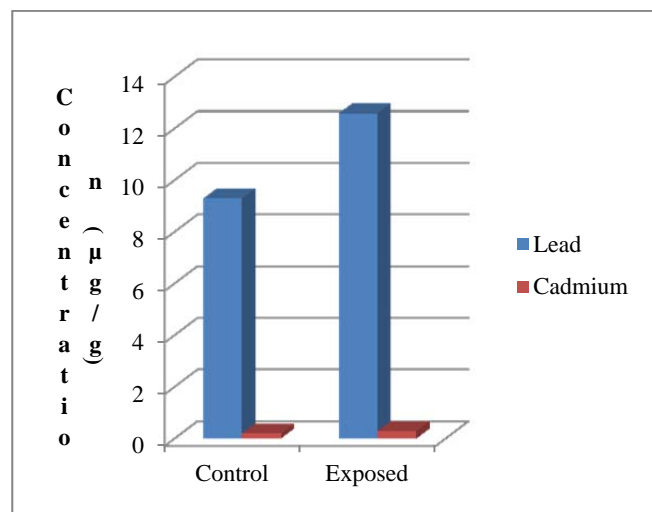

Fig. 3. Mean lead and cadmium levels in nail samples of Autoworkers in comparison to control subjects

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Analysis of metal content revealed that nail accumulates less metal in comparison to hair. Although the mean values of lead and cadmium concentrations in nail samples were higher in comparison to that of control subjects, but the difference was not statistically significant and cadmium concentrations in nail samples were lower than that of lead. Concentration of metals in hair and nail reflects their mean level in the body during long period of exposure as compared to body fluids [24, 25] and [26].
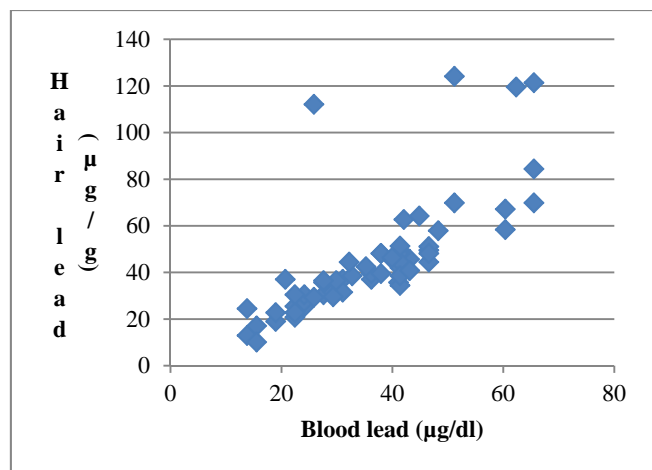

Fig. 4. Correlation between blood lead and hair lead

A significant positive correlation was found between the blood lead and hair lead content of autoworkers as indicated by the discrete diagram (figure4). A correlation coefficient (r) = 0.56 was obtained which is significant at $p<0.01$, indicating that hair is useful monitor to lead and is a more accumulating tissue. The results are in agreement with the earlier studies which reported significant correlation between blood lead and hair led in occupationally exposed workers [15, 27] and also in environmentally exposed adults [28]. Such correlation exists due to longer period of exposure and constant levels of metals in biological fluid/tissue, with intake and excretion in a steady pattern [12].

The present study result concludes that the increase in level of these metals was dependent on the workplace exposure which requires some adequate protective/safety measures for these workers. In this study, occupational exposure to selected toxic heavy metals was investigated and exposure to lead has been identified as a major occupational hazard to autoworkers. Therefore it is suggested that all workers must be protected and following measures are recommended: 1. Wear gloves, masks and protective coat during work. 2. Good ventilation in the work place. 3. Eating and drinking restriction in the work space. 4. Follow good hygiene. 5. Routine health check-up. Moreover, hair is suggested as useful biological indicator and monitoring tool for determination of exposure of heavy metals and nail is less accumulating in comparison to hair.

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