

Quantification of Lead and Manganese in Hair samples of Tannery workers near Sheikhpura road Lahore

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Abstract

The present study aimed to quantify the amount of manganese and lead content in the scalp hair samples of workers of selected tannery. The hair samples were collected from 48 respondents working in selected tannery with age ranging from 21-68 years. Samples were washed with organic detergent and digested in acid mixture before performing the analysis. The concentration of manganese and lead was determined by atomic absorption spectrophotometer (AAS). The results revealed that concentration of manganese and lead in hair was 0.22 ± 0.17 ppm and 0.9 ± 0.42235 . There was significant low level of manganese and high level of lead as compared to permissible limit. The Pearson's correlation of manganese and lead concentration with age ($0.2 > 0.05$), ($0.57 > 0.05$), and BMI ($0.08 > 0.05$), ($0.05 = 0.05$) was more than 0.05 thus showing a positive correlation. Weight ($-0.06 > 0.05$) and height ($-0.19 > 0.05$) had a negative correlation with concentration of manganese but had a positive correlation ($0.392 > 0.05$) ($0.397 > 0.05$) with concentration of lead. The low levels of manganese in diet suggest malnutrition in the workers due to consumption of poor food quality while the high level of lead in samples suggests the increased exposure to lead during labor in these workers. This indicated the lack of appropriate safety measures while work in the local tannery industries

Key words: manganese, lead, Atomic Absorption Spectroscopy, hair, height, weight, ppm

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1. Introduction

Manganese is whitish-grey brittle metal that exists in eight oxidation states. Manganese dioxide (MnO_2) is the most stable oxide. Among the organometallic compounds, manganese 2-methylcyclopentadienyl tricarbonyl (MMT) and manganese cyclopentadienyl tricarbonyl (CMT) are the most important. The biological half-life of manganese is about 40 days, but for manganese in the brain it is considerably longer than for the whole body. The bile flow is the most important route of excretion. Thus, it is eliminated almost entirely with the feces and only about 0.1-1.3% of the daily intake is excreted in the urine. [1] Manganese is an essential dietary mineral for mammals; it is a component of metalloenzymes such as superoxide dismutase, arginase and pyruvate carboxylase, and is involved in amino acid, lipid and carbohydrate metabolism [2, 3, 4]. Glycosyltransferases and xylosyltransferases, which are involved in proteoglycan synthesis (e.g. for bone formation), are sensitive to manganese status in animals. [5] On the other hand, lead is a toxic element and is more easily absorbed in the organic form as compared to inorganic lead species [6]. In humans 20-50% of lead is inhaled, 5-15% of ingested inorganic lead is absorbed. In contrast 80% of organic lead is inhaled and ingested organic lead is absorbed

readily [7]. Children are more sensitive to this metal because of their rapid growth rate and metabolism with critical effects in nervous system [8].

Absorption of lead is affected by age, the chemical form of the lead, and minerals in the diet (e.g., iron, calcium, and zinc)[2]. Gastrointestinal absorption of lead is greater in children than in adults. Once absorbed, lead is distributed to blood plasma, the nervous system, and soft tissues. It subsequently is redistributed and accumulates in bone; 75% to 90% of the lead body burden is found in bones and teeth [9]. Once lead enters the body, it moves from the blood to the soft tissues and organs, and eventually reaches the bones and teeth. Lead can be stored in bone for up to 30 years. When these metals enter the body of living organisms even in trace amounts, they may not be metabolized but accumulate and attain levels which may be toxic to the organism [10]. Neither urine nor blood levels provide an indication of other pathways of excretion or of reduction of total body load. The most reliable and cost effective method commercially available, as well as safest, is hair analysis by a quality laboratory. Hair analysis is very well documented and referenced with respect to measuring the body burden of lead[11]. Interest in human hair as a clinical sample has increased in recent years due to certain advantages offered

by human hair over other clinical specimens such as blood or urine samples. Hair offers a good way of discerning long term variations in trace element concentration by providing a better assessment of normal trace element concentrations.[12]

The present study was conducted in order to collect hair samples from the workers of selected tannery and detect the concentrations of manganese and lead in these samples and then make a comparison with the standard value as recommended by ATSDR. The study also aims to address health issues to the workers working in selected tannery due to the exposure of lead present in industry by using a questionnaire to identify health and safety issues.

2. Materials and methods

2.1. Sampling area and Sample collection

The study was performed in tannery industry in order to quantify manganese and lead in hair samples of workers in tannery workers. Fig.1 presents the site of area of study. The hair samples of subjects of variable age range (21-68 yrs) were obtained from the cervix of scalp by using a pair of disinfected stainless steel scissors. These samples of hair (10 mm) were placed in air tight plastic bags at room temperature before being analyzed in the Environmental Sciences Research laboratory at Lahore College for Women University.

2.2. Instrumentation

Flame atomic absorption analysis of manganese (Mn) and lead (Pb) was performed by Atomic Absorption Spectrophotometer (AAS Thermo scientific M series GF95Z Zeeman Furnace).

2.3. Washing of Hair Sample

A pair of sterilized stainless steel scissors was used to obtain 0.5 g of hair from the back of head. As a precaution, the scissors were cleaned with surgical spirit after each hair collection. Hair samples were washed with non-ionic detergent and rinsed with distilled water and then oven dried for four (4) days at 60-70°C and stored in an airtight plastic bag.

2.4. Digestion of hair samples

Standard method was used in laboratory for the digestion of hair samples for the purpose of quantification of lead and manganese. Samples were weighed and then placed in oven. They were dried at 50°C for 24hrs. For FAAS analysis, these samples were digested with 6:1 mixture of concentrated nitric acid and perchloric acid for the digestion of Pb. Samples were then heated on hotplate at 160°C for 1 hr and after cooling they were diluted with 0.1N nitric acid. In order to digest Mn, samples were digested in 12 ml of aqua regia (1/3 HNO₃ and 3/4 HCl). Samples were then heated on hotplate at 160°C for 1 hr. After cooling and filtering, samples were diluted with to a final volume of 100ml of double distilled deionized water. These solutions were stored in a plastic container until analysis using AAS.

2.5. Analytical Procedure:

Hair samples were analyzed on the flame mode of Atomic Absorption Spectroscopy. Three different standards were run at the beginning of the analysis for the instrument calibration and its sensitivity. After such calibration, the

prepared sample was then injected into the instrument through a small capillary. A separate source lamp of manganese (Hallow cathode lamp with the atoms of the element tested) was used for manganese and lead analysis.

2.6. Data Interpretation and analysis:

After completion of the analysis of manganese and lead concentration, values were demonstrated as mean, maximum, minimum, standard deviation and Pearson's correlation. All calculations were done by using SPSS-17 and Microsoft Excel 2010.

3. Results and Discussion

The results demonstrated a significant deficiency of manganese but high level of lead in the hair samples of tannery workers. According to Douglas E. Ryan, Jiri Holzbecher, and D. Craig Stuart (1978), the ideal manganese level in hair sample should be about 0.425 ppm in normal hair samples while World Health Organisation (WHO) states the ideal lead level in normal individuals should be 0.2ppm. The prevailing situation of manganese and lead that appeared in alarmingly low and high concentration in all samples of hair of the tannery industry workers is quite noticeable.

3.1. Descriptive Statistic

Data collected was computed by using SPSS 17. The descriptive analysis of data revealed the mean scores and the standard deviation (S.D.) of the study variables. It also showed the maximum and minimum values of the variables. Results (Table 1) indicated the mean age of participants of the study was 32.60±13.42 yrs, the mean weight was 56.09±9.907kg, mean height was 1.67±0.108m, mean BMI was 20.22±3.949 and the mean concentration ppm of manganese was 0.225±0.1795 ppm and Pb was 0.9±0.42235. The table also showed that the minimum age of participants of this study was 21 years and the maximum age was 68 years, the minimum weight was 36 kg and the maximum weight was 85 kg, the minimum BMI was 13.2 and the maximum BMI was 32.7. Moreover, the minimum concentration (ppm) of manganese and lead was 0.001 and 1.7969 and the maximum concentration (ppm) of manganese and lead was 0.7198 and 0.3434.

3.2. Inferential Statistic:

Inferential analysis of the data collected from the workers of the tannery industry included Pearson's correlation.

3.3. Analysis of relationship

Analysis of relationship within the variables was determined by Pearson's correlation with the level of significance set at a 0.05 level (2-tailed). If the value of significance was 0.05 then the correlation was significant and if the value of significance was >0.05 then there was no significant correlation in the variables. Also, if the Pearson's correlation value was > 0.05 it showed a strong correlation and if <0.05 there was weak correlation. If no sign (+ or -) is present the correlation is positive and if a -ve (negative) sign is present, it is a negative correlation. Results revealed that all the variables (age, weight, and BMI) showed a positive correlation with manganese concentration ppm (Table 2). The Pearson's correlation of

manganese concentration with age (0.2>0.05) and BMI (0.08>0.05) was more than 0.05 thus showing a positive correlation. The table also demonstrated that weight (-0.06 > 0.05) and height (-0.19 > 0.05) had a negative correlation with concentration of manganese. Results showed a significant correlation of lead concentration ppm with age (-0.081), height (-0.122) and BMI (-0.279) (Table 3). All the variables (age, height, and BMI) showed a negative and very low correlation with the lead concentration ppm. The Pearson's correlation of lead concentration with weight (0.124), demonstrated a positive and strong correlation. Thus the data analysis indicated that there was a significant difference between the manganese and lead concentration (ppm) of the selected tannery workers and also that there was a significant relationship of manganese concentration ppm with age, weight and BMI of the workers.

When the percentages of prevalent diseases among tannery industry workers were noted, it was found that 10% had muscle and joint pain, 32% had headache, 18% had high blood pressure, 10% had kidney problems, 8% had anemia and 22% had no disease (Fig. 3).

Manganese deficiency was observed in tannery industry workers due to lack of balanced diet and poor nutrition. Vegetables have largest proportion in the diet of these workers while chicken, meat, rice and fruits are consumed less frequently by them. The deficiency of meat and poultry products and no consumption of pulses in daily diet was the major cause of manganese deficiency in these respondents. The concentration of manganese was below the permissible limit in hair. The reason for this deficiency is lack of balanced diet and poor nutrition. The analysis of manganese in hair may suggest manganese imbalances present in the body that perhaps could be rectified by a diet supplemented with manganese. The poor health conditions of these workers has direct relationship with their socioeconomic status and nutritional deficiencies which can be attributed to the lifestyle of the people because lower income levels equate to poorer food quality and less consumption of healthy foods like fruits, chicken and meat which are the major sources of manganese.

Table 1: Mean and Standard Deviation of the variables

Parameters	N	Maximum	Minimum	Mean	Standard deviation
Age (years)	48	68	21	32.60	13.42
Weight (kg)	48	85	36	56.09	9.907
Height (m)	48	1.87	1.44	1.67	1.108
BMI	48	32.7	13.2	20.22	3.949
Mn Concentration ppm	48	0.7198	0.001	0.2251	0.17959
Pb Concentration Ppm	48	0.3434	1.7969	0.9141	0.42059

Table 2: Analysis of difference between the variables

One-Sample Test	Test Value = 0.425					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper	
Mn Concentration ppm	-7.712	49	.000	-.19989	-.2520	-.1477	

Table 3: Analysis of difference between the variables

One-Sample Test	Test Value = 0.2					95% Confidence Interval of the Difference	
	T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper	
Conc. ppm of Pb	15.368	49	.000	0.91409	0.7946	1.0336	

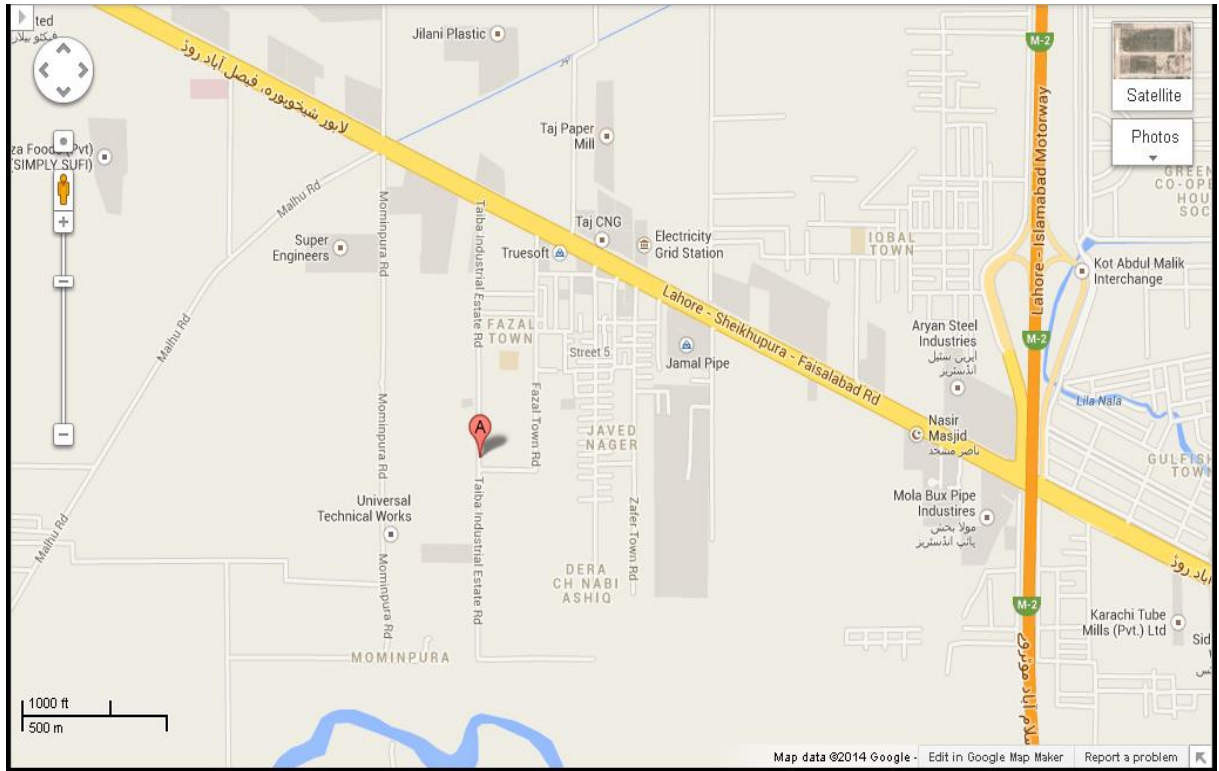


Fig. 1. Location of tannery industry selected for this study.

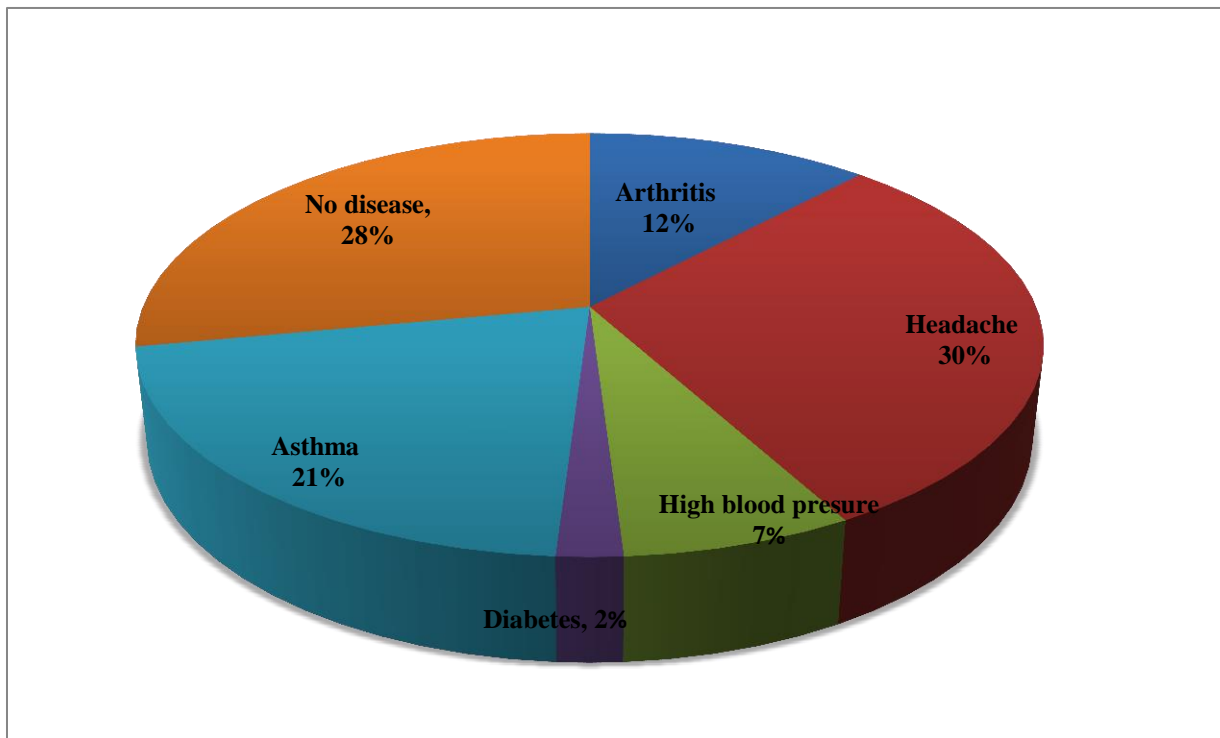


Fig. 2. Percentage of severe diseases in selected tannery workers

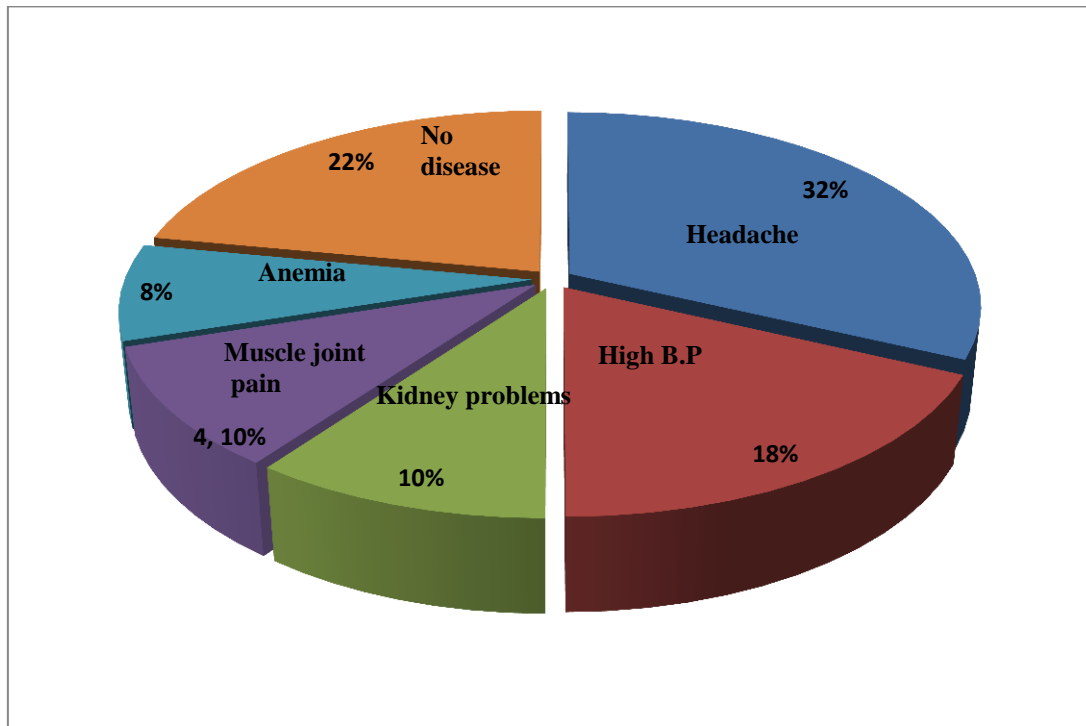


Fig. 3 Percentage of prevalent diseases in tannery industry workers

The analysis of hair samples showed lead content in hair samples (0.9118 ± 0.42235) above the standard value i.e 0.2 ppm. The increased exposure to lead in tanneries causes major health problems. There is a need for appropriate safety measures to minimize the health issues of the workers. Hence, socioeconomic status does play important role in selected tannery workers. There is also a need for introduction of appropriate safety measures for protection of the tannery workers from hazardous metals in the labour market.

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