ORIGINAL ARTICLE

Heavy Metal Contamination of Soil and Health Hazards Among the Residents of Tannery Industrial Area

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ABSTRACT

Background: Heavy metals like chromium compounds can be carcinogenic usually used in the tanning process during leather production. Chromium is an important health risk factor for the tannery workers which may enter the body by inhalation, ingestion and by direct cutaneous contact and cause several health problems of skin and respiratory tract. With the increase of unplanned industries, Bangladesh poses a new challenge to combat health hazards associated with heavy metal toxicity in soil.

Objective: The present study was designed to find out possible toxic effects of heavy metals in soil and health hazards among the people residing at tannery industries area.

Materials and Methods: This is a descriptive cross-sectional study and was carried out in two phases during the period of 1st November 2009 to 30 June 2010. In first phase the soil samples were taken from lagoons of Hazaribagh Thana of Dhaka city for laboratory test of heavy metals. In second phase, a total 190 respondents were interviewed using a semi-structured questionnaire to ascertain the common health problem around the tannery industries.

Results: All the eight soil samples contained Cr, Mn, Ni, Fe, Pb, Cu, where as Cd was nil. Mean distributor of Cr, Mn, Ni, Fe, Pb and Cu was 43.1325, 354.2217, 28.6633, 22420.1867, 97.5833 and 53.4633 ppm respectively. 75.26% respondents stayed in the study area for six to ten years. Most of the respondents (75) were tannery workers. Total 52.85% households had toxicity related sickness in last six months. Among tannery workers most prevalent sickness were conjunctivitis (7.7%) and Dermatitis (6.7%). Regarding occurrence of clinical manifestations similar to Chromium toxicity in relation to staying in the study area, most of the households complained about allergy (39.2%) and abdominal discomfort (24.4%).

Conclusion: Elevated levels of urinary and blood Chromium is associated with high morbidity among the tannery workers. Therefore bio-monitoring of the heavy metals in the exposed workers is considered as a useful tool.

Key Words: Metal Toxicity, Health-Hazards, Tannery, lagoon, carcinogenic

Introduction

Leather production includes many operations with different exposures, which can be harmful and particularly be carcinogenic.[1-3] Some compounds in the tanning process are considered as probably being carcinogenic to humans (some benzene-based dyes and formaldehyde).[4-5] Besides these, scores of other chemicals and organic solvents such as chromate and bichromate salts, aniline, butyl acetate, ethanol, benzene, toluene, sulfuric acid and ammonium hydrogen sulfide are used in the tannery industry. An important health risk factor for the tannery workers is occupational exposure to chromium,

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mainly in the organic Cr (III) form or in the protein bound-form (leather dust). Chromium may enter the body by inhalation, ingestion and by direct cutaneous contact. Professional exposure to Cr (III) increases the risk of dermatitis, ulcers and perforation of the nasal septum and respiratory illnesses as well as increased lung and nasal cancers.[6-12] Cr-specific health hazards like carcinoma of the larynx and lung parenchyma and par nasal sinuses have also been reported.[13-18] Bangladesh is a developing country with a population of about 152.5 million in a total area of 147 570 sq km, making it one of the most heavily populated countries of the world. Dhaka has been the capital city of Bangladesh since it achieved independence in 1971. The overall economy of Bangladesh has registered steady improvement with more than 6% average growth during the last five years. The industrial sector has been an important contributor to the country'sGDP19, its share standing at 28.6% in 2011.

The leather industry sector, which is the fourth largest foreign exchange earner of the country contributing about six per cent of total export earnings, produces 150 metric tons of solid waste every day contaminating the environment and water of the metropolis. With the increase of unplanned and socially and environmentally degraded industries Bangladesh poses a new challenge. Pollution and human-induced hazards are particularly serious in the Dhaka city. Tannery industries of Hazaribaghsituated in a heavily populated residential area. Out of 214 tanneries, 200 are located near the capital's river systems- the Turag to north-west, the Buriganga to the south-west and the Sitalakhya to the south-east, with Turag flowing into the Buriganga. Recently government of Bangladesh has shown much interest in environmental impact created by the industries, now they have planned to shift whole tannery to the Savar area for the safety of its citizen.

Materials and Methods

This is a descriptive cross-sectional study. The study was done in two phases during the period of 1st November 2009 to 30 June 2010. In first phase, the soil samples were taken from up to 10 cm depth of total 3.58 square kilometer area of different places around the tannery industries in Hazaribagh Thana of Dhaka city. Four samples (numbered as 1 to 4) were collected within half kilometer of Lagoon and another four samples (numbered as 5 to 8) were collected after one kilometer of Lagoon. The collected materials were preserved into plastic containers for laboratory test of heavy metals like Chromium, Cadmium, Iron, Lead, Manganese, Nickel & Copper level in the Institute of Bangladesh Council of Science & Industrial Research (BCSIR).

Fig-1: Bangladesh (inset-tannery locations)

In second phase, to ascertain the Common Health Problem around the Tannery Industries. A semi-structured questionnaire were developed. The questions were pre-tested and finalized after necessary correction and relevant data were collected according to stratified cluster sampling procedure. A total 190 houses were randomly numbered and head of the households and his or her family members of respected houses were selected as respondents for the study. First 95 Houses were located in the first four sample size area that is stratum I and another 95 Houses were located in the

second four sample size area that is stratum II. Then data were analyzed by using SPSS program.

Results

Table-I: Distribution of Heavy Metal Concentration in different soil Samples

Id no	Cr	Mn	Ni	Fe	Pb	Cu	Cd
Sample1	91.62	760.41	39.25	34349.53	190.31	69.04	0
Sample 2	76.08	682.88	37.27	34831.57	194.61	69.64	0
Sample 3	121.27	676.67	40.39	33590.69	205.24	101.98	0
Sample 4	86.41	659.92	41.84	32936.51	206.91	77.91	0
Sample 5	5.13	158.35	31.27	7368.02	10.93	29.52	0
Sample 6	1.95	178.05	28.14	7454.5	9.97	26.81	0
Sample 7	8.46	172.05	33.88	7321.42	9.84	26.37	0
Sample 8	2.73	191.77	30.93	7940.94	9.92	30.32	0

Table-II: Distribution of mean Heavy Metal concentration in soil samples

	Chromium ppm	Manganese ppm	Nickel ppm	Iron ppm	Lead ppm	Copper ppm
Mean	43.1325	354.2217	28.6633	22420.1867	97.5833	53.4633
Range	119.32	602.06	26.85	27510.15	197.07	75.61
Minimum	1.95	158.35	14.99	7321.42	9.84	26.37
Maximum	121.27	760.41	41.84	34831.57	206.91	101.98

Table-III: Distribution of length of staying of the respondents in the study area

Length of Stay		ST-I	ST-II	Total
Up to 05 years	Count	6	10	16
	% of Total	3.15%	5.26%	8.42%
Six to ten Years	Count	77	66	143
	% of Total	40.52%	34.73%	75.26%
More than ten years	Count	12	19	31
	% of Total			

Table-IV: Distribution of respondents by Occupation

Tannery worker		Stratum ST-I	Stratum ST-II	Total
Business man	Count	39	35	75
	% of Total	13.7%	12.3%	
Service man	Count	6	6	12
	% of Total	2.1%	2.1%	
Laborer	Count	26	27	53
	% of Total	9.1%	9.5%	
	Count	24	26	50
	% of Total	8.4%	9.5%	

Table-V: Distribution by clinical manifestations similar to Chromium toxicity of Tannery workers and other occupation

		St-I	St-II	Total
Yes	Count	162	273	435
	% Any sickness in last 6 months	37.24%	62.75%	100.0%
	% of Total	19.68%	33.17%	52.85%
No	Count	250	138	388
	% Any sickness in last 6 months	64.43%	35.56%	100.0%
	% of Total	30.37%	16.76%	47.13%

Table-VI: Distribution by clinical manifestations similar to Chromium toxicity of Tannery workers and other occupation

Name of illness	Tannery worker	Other	Total	Remarks
Diarrhoea	8 (2.8%)	29(10.2%)	37	
Dermatitis	19(6.7%)	36(12.6%)	55	*
Conjunctivitis	22(7.7%)	37(13%)	59	*
Skin ulcer	10(3.5%)	27(9.5%)	37	
Abdominal discomfort	16(5.6%)	32(11.2%)	48	*
Lung disease	2(0.7%)	12(4.2%)	14	
Peptic ulcer	3 (1.1%)	7(2.5%)	10	
Scabies	10 (3.5%)	15(5.3%)	25	
Total	90	195	285	

Table-VII: Distribution of the households by occurrence of clinical manifestations similar to Chromium toxicity in relation to staying in the study area

	Length of Stay			
	Up to 05 years	06 to 10 Years	>10 years	Total
Diarrhea	33 (2.7%)	73 (6.1%)	28 (2.3%)	134 (11.1%)
Fever	28 (2.3%)	85 (7.1%)	30 (2.5%)	143 (11.9%)
Lung diseases	4(.3%)	44(3.7%)	39 (3.2%)	87 (7.2%)*
Jaundice	4 (.3%)	11 (.9%)	8 (.7%)	23 (1.9%)*
Dent Diseases	4(.3%)	44(3.7%)	39(3.2%)	54 (4.5%)*
Allergy	104(8.6%)	245(20.4%)	123(10.2%)	472(39.2%)*
Abdominal Discomfort	85(7.1%)	97(8.1%)	75(6.2%)	293(24.4%)*
Nasal Ulcer	0	15(1.2%)	39(3.2%)	54(4.5%)*
Dermatitis	52(4.3%)	144(12%)	55(4.6%)	251(20.9%)*
Scabies	28(2.3%)	115(9.6%)	29(2.9%)	172(14.3%)*
Edema of face	1(.1%)	8(.7%)	26(2.2%)	35(2.9%)*
Skin Ulcer	71(5.9%)	95(7.9%)	52(4.3%)	218(18.1%)*
Loss of smell	12(1%)	120(10%)	73(6.1%)	205(17%)*

Discussion

The results obtained for this study to examine the status of metals in tannery industries effluents and their contamination in associated soil. Generally concentrations of heavy metals in environment occur due to continuous disposal of untreated industrial effluents generated during operational phase of industries. Among various industries, tannery industries is major producer of heavy metals like chromium, iron, manganese, copper, lead, cadmium and nickel etc. Hence, all the collected samples were analyzed for chromium (VI), iron, manganese, copper, lead, cadmium and nickel. Of the total analyzed samples, six metals were detected in each sample, except Cadmium which was not detected in all the studied samples of soils. The average values of chromium recorded in soil samples are 93.84 ppm and 30.99 ppm respectively. Stratum I samples contain maximum concentration of Chromium followed by Stratum II. This may be due to the fact as the water flows downstream, the dilution effect increases, as a result chromium and other heavy metal concentration gradually decreases away from main ditch ie lagoon. The effluent from tannery industries before being discharged into the Burigangariver, collected into lagoon by the side of the river Buriganga flood protection barrage, from this ditch the water containing effluents slowly discharged into the river through sluice gate. So heavy near ditch are very high. Chromium was reported in tannery waste contaminated soil of Vellore district of Tamil Nadu, ranged from 154.5 to 568.0 μg/l, respectively.[20] The effluent released on land particularly at high concentration (100%) increased chromium content in soil. Both trivalent and hexavalent chromium ions are toxic to plant life. To find out the relationship of length of stay of in the area with the occurrence of clinical manifestation which may be related to heavy metal mainly chromium toxicity, it has been found that the occurrence of abdominal discomfort, skin ulcer, scabies, dermatitis dental disease including erosion/discoloration diarrhea, loss of smell and allergy were significantly high among the people of stratum-I, which were gradually reduced in stratum-II. People who were staying 6-10 years duration suffered more. The relationship of occurrence of disease with length of occupation of the workers have also been found in many studies.[21,22]

Conclusion

The high morbidity among the tannery workers may be due to elevated levels of urinary and blood chromium levels resulting from increased soil levels of chromium and other heavy metals at the work place. The study recommends that the bio-monitoring of the heavy metals mainly chromium levels in the biological fluids can serve as a useful tool for mitigating the health hazards and risk factors in the exposed workers.

Conflict of interest: None

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