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ORIGINAL ARTICLES

Evaluation of Some Health Hazards Among Egyptian Leather Tannery Workers

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ABSTRACT

There is growing concern over dangerous and harmful aspects of chemicals used in the leather tannery industry and the disposal of waste from the tannery industries. The aim of this study is to assess the health hazards and risks faced by the workers in leather tanning industries in Egypt. So we estimate biochemical, hematological abnormalities and chromium level in the blood of tannery workers. This study conducted on a random sample of 60 male workers from two industries in Old Cairo for leather goods, besides 60 healthy subjects served as a control. The findings revealed a significantly higher prevalence of morbidity (58.3%) in the tanneries workers in comparison to the control group (21.7%). There is significant decrease inwhite blood cells, platelet counts and hemoglobin values,while RBC value showed no significant difference in worker as compared with controls. Also there is no statistical difference in liver enzyme activities, renal functions, total protein level and serum blood glucose between the two studied groups. The tannery workers have significant increased chromium level as compared to control group but still with in a normal range. Conclusion:the study reported that the respiratory, ocular and dermatological were the common morbidity in workers exposed to chromium as evident by significant increased serum chromium level among tannery workers as compared to control group. The differences observed in haematological and biochemical parameters are mostly insignificant. Even when the differences are significant the mean values obtained are well within the normal range. Slight variation may be due to multitude of factors in addition to possible effects of chromium toxicity. So the high morbidity among the tannery workers can be due to elevated levels of blood chromium levels.

Key words: leather tanneries, health risk, morbidity, Chromium.

Introduction

Leather tanning is a process of converting decomposable skin into leather that is usually non decomposable in a short term. This is usually done with tannin - an acidic chemical compound that prevents decomposition. Leather tanning is important for converting hides and skins into usable materials for production of leather based consumer products (Varsha and Apurba 2008).

Since hundreds of years ago, the Egyptian leather has been well known for its unique texture due to Egypt's warm climate. Thus, the leather industry in Egypt has been considered one of the most important industrial sectors in the Egyptian economy representing about5% of the total industrial production of the country. The labor force is made up of about 250,000 workers and has 300 leather tanners. The 300 leather tanners and much of the industry are located in the old Cairo (Marina and Noha 2012).

In Egypt, the raw materials for leather; the hides and skins,are usually by-products of the meat industry and are mainly derived from either urban or rural slaughters of cattle, sheep and goats.In the tanneries of old Cairo, two industries coexist: the production of gelatin and leather, both from the treatment of animal skins.The current tanneries complex suffers from poor sanitation conditions and unreliable access to gas and electricity(Magali 2012)

Most leather is chrome-tanned; nearly 90% of all leather produced is tanned using Cr salts (Stein and Schwedt). Generally 8% of the basic chromium sulphate salt is used for conventional tanning. It binds with the collagenous protein to convert to leather. Occupational exposure to chromium occurs mainly through inhalation and dermal absorption in the working environment,including chromium compound manufacturing,electroplating leather tanning,welding, chrome plating the manufacture of dyes and pigments leather and wood preservation, and treatment of cooling tower water. Smaller amounts are used in drilling mud, textiles, and toner for copying machines (Kornhauser *et al*., 2002).

There is growing concern over dangerous and harmful aspects of chemicals used in the leather tannery industry and the disposal of waste from the tannery industries. The industry is also associated with a number of environmental and human health risks, including cancers among tannery workers (Frank 2009). Dermal

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exposure to chromium may occur during the use of consumer products that contain chromium, such as wood treated with copper dichromate or leather tanned with chromic sulfate (ATSDR 2012). Prolonged exposure to airborne or solid, liquid chromium compounds lead to chronic toxic effects on humans. The diseases are nasal septum perforations, ulceration's of skin surfaces, rhinitis, liver damage, pulmonary congestion, edema, nephritis, intestinal lung and gastric cancers, irritation of gastrointestinal mucosa (Lippman M 1991).

There are only few reports of the health effects of chronic exposure to chromium in leather tanning among developing countries. The purpose of this studyis to assess and document the health hazards and risks faced by in the leather tanning industries in Cairo. So we estimate biochemical, hematological abnormalities and chromium level in the blood of tannery workers.

Materials and Methods

This study conducted on a random sample of 60 male workers from two industries in Old Cairo for leather goods, such as brief cases, wallets, belts, portfolios and ladies handbags; all produced from the full leather. Besides 60 male subjects from the relatives of the studied group belonging to a similar age range and socioeconomic strata, who never had any occupational exposure in any process in the tanneries, served as a control. The workers operate six days a week with one shift starting from 8:30 am till 6 pm with Fridays off.

Blood sampling:

From each subject 10 ml of venous blood were taken through a vein puncture using a dry plastic disposable syringe under complete aseptic condition. 3 ml of blood were taken into a clean tube containing anticoagulant for determination of chromium level in blood. 3 ml of blood was dispensed in a 5 ml sterile glass test tube containing 3.75 mg of dipotassium salt of Ethylenediamine tetra-acetic acid (EDTA) as an anti-coagulant, for the analysis of different haematological parameters.The remaining 4 ml of blood were kept in a tube and allowed to clot then centrifuged at 3000 g for 10 minutes to separate the serum and an aliquot of serum samples (300µl) was stored in a freezer (-20^{o}C) until biochemical analysis.

1. Personal and occupational history:

The personal history includes age, smoking history, and occupational history which include details about jobe.g. working hours, duration and type of exposure (questionnaire for all workers about the specific health and safety risks they face at the workplace). A written consent from each participant was taken before the study.

2. Clinical examination:

A detailed physical examination of the respiratory, cardiovascular, ocular, dermal and gastrointestinal system was conducted at the work place and X ray when needed.

3. Hematological analysis of blood:

Hemogram: including total red blood cell (RBC) count (x10^6 mm^{-3}), hemoglobin content (Hb) (g/dL), total number of leukocytes (x10^3 mm^{-3}) and Platelet count (x10^3 mm^{-3}) were assessed using Coulter counter and examination of Lishman or Wright-stained peripheral blood smears.

4. Biochemical analysis:

1) Liver function tests:

Determination of serum aspartate transaminase (AST) and serum alanine transaminase (ALT) by using kinetic method recommended by the Committee on Enzyme of the Scandinavian Society for Clinical Chemistry and Clinical Physiology (1974), the tests were performed using already commercially available kit from Boehringer-Mannheim Company, Germany.

2) Kidney function tests:

a- Determination of serum creatinine level (mg/dl) according to the Jaffe reaction (Husdan&Rapoport, 1968).

b- Determination of serum urea (mg/dl) level was done by using chemical colorimetric method QuantiChrom^{TM} Urea Assay Kit (DIUR-500). Bioassay Systems' urea assay kit is designed to measure urea directly in biological samples without any pretreatment. The improved Jung method utilizes a chromogenic reagent that forms a colored complex specifically with urea. The intensity of the color, measured at 520 nm, is directly proportional to the urea concentration in the sample (Jung *et al*., 1975).

3) Determination of albumin in the serum using a test reagent kit based on the method of Doumas *et al*., (1971).

4) Determination of total protein in the serum using a test reagent kit based on the method of Josephson *et al*., (1957).

5) Determination of Plasma glucose level was estimated by God-PAP enzymatic colorimetric method (Trinder 1969) using Biomerieux test kit, Cat. No.5 127.

6) Determination of total chromium venous blood samples were collected in heparinized tubes. The samples were transported to the laboratory under chilled conditions. Blood chromium analysis was performed by a direct dilution method. An atomic absorption spectrophotometer (Parkin Elmar model 5000, USA) was used for the estimation of chromium (Schermaier *et al*., 1985).

Statistical Analysis:

Results expressed as range and mean ± SD. Statistical differences between hematological, Biochemical, and chromium level between mean values of tannery workers and control groups were statistically analyzed using the Student's t-test. The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 11 (SPSS Inc., Chicago, USA). Significant differences P value <0.05 considered statistical significant.

*Results***:**

Table 1: Physical characteristics and smoking prevalence amongt he leather tanneries and controls (Mean±SD)

	Tannery workers (n= 60)	Control group (n= 60)
Age (years)	31.1±5.3	32.5±4.8
Height (cm)	169.2±6.8	172.7±4.3
Weight (kg)	79.6±0.9	81.2±0.5
Smoking prevalence (%)	38 (63.3%)	35 (58.3%)
Duration of years of exposure (years)	12.1±0.7	----

Table 2: Physical examination among the leather tanneries and controls

	Tannery workers Number (60)%		Control group Number (60) %	
Ocular	6	10%	3	5%
Dermal	9	15%	23.	3%
Respiratory	14	23.3%	3	5%
Gastrointestinal	6	10%	5	9%
All	35	58.3%	13	21.7%

Table 3: Hematological analysis of blood among the leather tanneries and controls

	Tannery workers	Control group
white blood cells ($x10^3/\mu l$)	7.7±0.7*	9.4±0.6
Red blood cells ($x10^6/\mu l$)	4.5±0.6	5.3±0.4
Platelets ($x10^3/\mu l$)	186.6±5.9*	283±6.0
Hemoglobin (g/dl)	10.4±0.2*	13.5±0.5

Values are expressed as mean ± SD
* indicates significant (P < 0.05)

Table 4: Biochemical analysis of blood of tannery workers and non-workers:

Normal range for age	Tannery workers	Control group
Albumin (3.5 to 5.5 g/dL)	3.8±0.7	5.1±0.3
Alanine aminotransferase (10-40 U/L)	39.7±1.5	36.6±1.7
Aspartate aminotransferase (10-40 U/L)	37.1±3.8	35.9±0.6
Urea (10-20 mg/dL)	18.3 ±1.5	16.2±2.6
Creatinine (0.7-1.2 mg/dL)	1.04 ± 0.11	0.85±0.05
Total protein (6.0 to 8.3 gm/dL)	7.9±0.7	7.8±0.6
Fasting blood sugar (80-120 mg/dL)	96.8±2.7	87.8±2.6
Chromium in blood (Up to 30 ug/L)	13.6±2.4*	4.8±1.06

Values are expressed as mean ± SD
* indicates significant (P < 0.05)

Demographic of the leather tanneriesand control groups are presented in table (1); the mean age, height and body weight of leather tanneries and control group were not significantly different ($p<0.05$).The leather tanneries had a mean exposure of 12.1±0.7 years in the leather tanneries.

Table(2) shows physical examination of both tannery workers and control groups, the overall prevalence of morbidity was found to be significantly higher ($P<0.05$) among the tanneries in contrast to that found in the controls (58.3% vs. 21.7%). In the case of the tannery workers group the incidence of respiratory morbidity is (23.3%) in the form of occupational asthma, chronic bronchitis, allergic bronchitis and sinusitis, followed by dermatological diseases (15%) such as rashes and papules, itching and burning sensation and ocular illnesses (10%) in the form of conjunctivitis that afflicted the tanneries, whereas gastrointestinal tract problems were non-significant different between the tannery workers and the control groups (10%& 9% respectively).

Table (3)shows the comparison of hematological analysis of tannery workers and control group. The red blood cells (RBC) count in leather workers were $4.5\pm0.6x10^6$/µl, white blood cells (WBC)$7.7\pm0.7x10^3$/µl, platelet (PLT) 186.6 ± 5.9 $x10^3$/µl and hemoglobin level (Hb)10.4±0.2g/dl.The count in control group were red blood cells (RBC) $5.3\pm0.4x10^6$/µl, white blood cells (WBC) $9.4\pm0.6x10^3$/µl, platelet (PLT) $283\pm6.0x10^3$/µl and hemoglobin level (Hb) 13.5±0.5g/dl. There is general trend of significant decreased WBC, PLT and Hbvalues in worker as compared with non-worker population ($P<0.05$) but these values were in the normal ranges, while RBC value showed no significant differencein tannery workers as compared with that of control ($P>0.5$).

Table (4) shows the comparison of biochemical analysis of leather tanneries workers and control groups. Almost all the biochemical parameters"albumin, alanine amino transferases, aspart ateamino transferases , renal functions, blood serum glucose and total protein"showed no significant difference both in leather tanneries workers and control group($P>0.5$).

The totalchromium was significantly higher in the blood of leather tanneries workers as compared with the non-workers ($P<0.05$).

Discussion:

An important health risk factor for the tannery workers is occupational exposure to chromium, which is used as a basic tanning pigment. The present work was undertaken in order to provide more information on possible health effects of chromium in tannery workers, one hundred twenty individuals were included in the study, out of which 60 were those who worked in the tanneries and had direct contact with the chemicals used in tanneries, and the other 60 were from the relatives of the studied group, but had no direct exposure or contact.

The result of this study showed that the high morbidity (58.3%) in the tanneries workers in comparison to the control group (21.7%). The increased morbidity in the tannery workers could be attributed to high respiratory illness (23.3%),followed by dermatological diseases (15%) and ocular illnesses (10%) compared with 5%, 3.3% and5% in the control group.These results are in accordance with Subodh *et al* (2008) study which showed the overall prevalence of morbidity was found to be significantly higher ($P< 0.01$) among the tanneries in contrast to that found in the controls (40.1% vs.19.6%). This may be due to elevated levels of blood chromium levels resulting from increased air levels of chromium at the work place.Also Khan *et al*., (2013) reported that all the workers were male with average age of 33 years and 13% had skin rashes, 12% had chronic bronchitis, 8% had gastritis and 3% conjunctivitis. It has been reported in the literature that it is the metabolism distribution and transport of the chromium in the blood that is a causal factor for increased respiratory morbidity (ATSDR, 2012)

Present study showed significant hematological defects in leather tanneries exposed to chromium.The results showed a significant difference between tannery workers and control group as regard white blood cells, platelet counts, and Hb concentration ($P<0.05$) but these level still in the normal ranges, and there is no significant difference inred blood cell count between tannery workers and control group($P>0.5$).These results in accordance with Muhammad *et al* (2006) which showed that in the age group 21-40 years worker population showed 7% and 8% decrease in WBC and platelet count compared to control group. Also they found a significant difference between tannery workers and control group as regard hemoglobin blood level ($P<0.01$).Also Flores-Tena *et al* study in (2001) reported that the haemoglobin contents in *Limnodiluson* decreases significantly when concentration increases above 1 µg/g dry weight.

On the other hand Ramzan *et al*., (2011) found no significant changes were observed in the values of hemoglobin, mean corpuscular volume and mean corpuscular hemoglobin concentration between tannery workers and control individuals. The low values of TEC, PCV and MCH might be a result of chromium exposure in the tannery workers and may act as indicators of chromium toxicity which is related to many haematologic disorders including leukaemias, myelodysplasia and bone marrow depression.

The present study showed that there is no statistical difference in liver enzyme activities (ALT and AST), total protein level and serum blood glucose between the two studied groups ($P>0.5$). This result is accordance with Muhammad *et al*., study (2006) which found insignificant change in the total proteins (mainly Albumin), ALP and ASAT. Chen *et al*. (2001) reported that dietary chromium supplementation did not significantly

influence serum constituents, including insulin, HDL, VLDL, total protein, albumin and gamma globulin. Also Uyanik (2001) had reported that no significant differences were found in total protein, albumin, ALT, and AST between workers and non-workers. On the other hand Khan *et al*., (2013) reported that the workers had hematological, hepatic and renal function impairment because of oxidative stress on body systems. They concluded that about half of the workers had excessive exposure to chromium in the tanneries at Sialkot. They had significantly raised chromium levels in their biological fluids and adverse health effects due to enhanced oxidative stress and inflammatory changes.

Present data showed that a non-significant decrease in the albumin level among tannery workers when compared to non-workers. This result is in accordance with Muhammed *et al* study in 2006 who reported that the factory workers are directly exposed to chromium by physical content and hence show lower albumin content as compared with the control population. Also Uyanik (2001) has reported a non-significant decrease in the albumin in sheep because of dietary chromium. On the other hand Chen *et al*. (2001) have not shown significantly effect on serum constituents, including total protein and albumin after dietary chromium supplementation.

The present study reported that tannery workers have significant increased serum chromium level, when compared to the control group ($P<0.05$) but still in the range of normal levels.The higher biological values of chromium among the tanneries could be explained by atmospheric pollution caused by the liberated leather dust at the work place.This result is in accordance with Kornhauser *et al*., (2002) study that showed the male worker has more tendencies to accumulate chromium in their bodytissue, blood and serum as well. Male workers have higher concentration of chromium in their serum,because almost 95% male works in tanneries and the chromium is accumulating with the passage of time,duration of exposure and concentration of chromium. Khan *et al*., (2013) reported that the tannery workers had significantly ($p < 0.001$) raised median (interquartile range) of blood chromium which is 569 (377-726) nmol/L compared to 318 (245-397) nmol/L in the control group. Sixty-five (54%) workers had blood chromium levels above the upper limit set by Agency for Toxic Substance and Drug Registry.

Conclusions:

An important health risk factor for the tannery workers is occupational exposure to chromium, which is used as a basic tanning pigment. Our results confirm the previous findings of increased morbidity among tannery workers in the form of respiratory diseases, dermal and ocular. The serum chromium level was increased in tannery workers exposed to chromium compounds as compared to control group.

The differences observed in haematological and biochemical parameters were mostly insignificant. Even when the differences are significant the mean values obtained are well within the normal range. Slight variation may be due to multitude of factors in addition to possible effects of chromium toxicity.So the high morbidity among the tannery workers can be due to elevated levels of blood chromium levels.

Recommendations:

Based on the findings of the study the following recommendations are being suggested:

a) The study recommends that the bio-monitoring of the chromium levels in the biological fluids can serve as a useful tool for qualifying the health hazards and risk factors in the tannery workers

b) There is need for providing awareness and training programs on sustainable leather production.

c) There is need for the industry to identify and promote actions that are aimed at reducing the amount and/or toxicity of chemicals. This will need prudent chemical management practices in the leather-tannery industry to help minimize the quantities and risks of the chemicals being used.

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