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## Research Article

# Prevalence of Respiratory Symptoms, Bronchial Asthma and Obstructive Lung Disease among Tannery Workers

## Abstract

**Objectives:** We determined the prevalence of respiratory symptoms, bronchial asthma and obstructive lung disease among selected tannery workers.

**Method:** We conducted a cross-sectional study during 2010-2011 among leather tannery workers in Karachi, Pakistan. The total population of workers in the tannery was 250. A cohort of 160 workers was selected on a convenience sampling basis. Fifty-two controls were selected from the local community. Data was collected through a questionnaire, and lung function tests were carried out by trained professionals to measure FEV<sub>1</sub>, FVC, PEF<sub>r</sub> and the FEV<sub>1</sub>/FVC ratio.

**Results:** Among tannery workers we found whistling symptoms in 20% of the group, awakening from sleep due to a tightness of chest in 23%, difficulty in breathing in 24%, excessive coughing in 25%, and out of breath on a usual walk in 41%. Among controls, awakening from sleep due to tightness of the chest was 4%, excessive coughing was 4% and shortness of breath during a usual walk was 4%. The prevalence of asthma was 7% in the tannery workers and 4% in the controls. We found obstructive lung diseases in 39.4% of the workers as compared to 11.5% among controls. 64% of the asthmatics considered that their asthma was related to work. A statistically significant relationship was found between bronchial asthma, respiratory symptoms and duration of exposure, smoking, ethnicity and nasal and skin manifestations.

**Conclusion:** The study showed a high prevalence of bronchial asthma, respiratory symptoms and obstructive lung disease among tannery workers, and that it was related to duration of exposure, ethnicity, smoking and nasal and skin allergies.

## Introduction

A worker in a factory is exposed to a great variety of hazards that include chemical, physical and biological factors. Housekeeping, ventilation, layout and illumination contribute to the magnitude of these hazards if left unattended. A number of protocols and conventions have been developed to promote better environmental conditions at the work place. This has resulted in the raising of the level of awareness among the managers as well as workers of the industrial units regarding the working conditions. This awareness is more pronounced in the developed world, but developing countries remain far behind. Workers' health depends on the working conditions, work ergonomics, welfare incentives and psychosomatic environment.

Tannery workers are exposed to a number of toxic chemicals which are hazardous for health and might lead to an increase in morbidity and mortality. In addition, working

conditions in general are rather dangerous compared to other occupations. Harmful effects on the body depend upon the severity, duration of exposure and on the general health of the worker. The chemical hazards in tanneries include vegetal tannins, chromium salts, biocides, bleaching agents, hydrogen sulphide and dyes. Infection with anthrax is common [1]. The hazards may cause minor illnesses or they may lead to severe chronic debilitating diseases [1]. Dust produced by various processes are from rotating drums and by buffing and shaving, and this dust can affect the respiratory tract, which may lead to the most common respiratory problem of chronic bronchitis among the tannery workers [1]. Lime and leather dust in the drum section is corrosive and can give rise to irritation of the respiratory tract and may lead to irritant-induced asthma [1]. If accidental contact occurs with the eyes, it may lead to corneal ulceration and resultant complications [1].

The tanned waste contains thiol proteins. The decomposition and degradation of this waste leads to the release of hydrogen

sulphide. This gas is prevalent in tan pits.  $H_2S$  is released into the atmosphere if tan liquor is stirred. In small amounts, it can cause irritation of the eyes, throat, headache and giddiness. In excessive amounts, it can be fatal [1]. Also, basic chromium sulphate  $[Cr (H_2O)_5(OH)SO_4]$  is used as a chelating agent in tanneries. The minimum amount of chromium needed for good staining is three grams of  $Cr_2O_3$  for 100 g of leather. Chromium can affect the body by directly affecting the skin and may lead to ulceration of the hand and feet leading to occupational dermatitis and it may also lead to DNA damage [2-4]. Chromium may cause a local effect on the nose and leads to nasal ulceration and nasal septal perforation [3,5,6].

Due to excessive manual handling of skin and hides, there are chances for developing callosities on pressure points like shoulders and hands. Cases of leukoderma reported among tannery workers could be due to the use of rubber gloves and boot [1]. Workers endure continuous soaking and interaction with chemicals like lime, biocides, bleaching agents and dyes which are sensitizers and irritants and may lead to dermatitis [4,6]. The most widely used tanning agents include plant tannins which are extracted from, for example, hardwood species. These phenols react with hide leather rendering it supple and amenable for further processing [7]. Also, there is a significant risk for tumors among tannery workers [3,6,8-11].

The exposure data for different compounds is not available because there is no such service available in Pakistan. Occupational health is still at an infantile stage in Pakistan. Only export and petrochemical-oriented multinational companies have occupational health and safety departments. In the non-organized sector where millions of workers are involved like in the cottage industry, agriculture and transportation, there is no concept of occupational health and safety. The background of workers including their literacy level, socioeconomic status, age, and ethnicity also plays a significant role in the workers' health. There are 200,000 workers involved in the leather and tannery industry in Pakistan [12]. Keeping in view the toxic nature of chemicals used in the tannery and a general state of health and safety in Pakistan, we decided to carry out a study regarding respiratory symptoms and bronchial asthma prevalence among tannery workers. The information collected here, regarding pulmonary morbidity among tannery workers, will help us in deciding a future course of action.

## Material and Methods

Following is a briefly described process at a typical tannery. Raw skin is manually preserved by sodium chloride, pesticides and insecticides. Preserved skin is soaked in water, biocides and enzymes to restore humidity. Hair and skin appendages are removed by putting hides in drums filled with lime, metam sodium and sodium sulfide. Excessive lime is removed by treating hides with hydrogen peroxides and carbon dioxide. Excessive hairs are removed by adding protease enzymes and natural fat by lipase enzymes. Hide is exposed to acidic conditions by adding formic acid, sulphuric acid, sodiumformate and sodium metabisulphite. All these processes take place in huge wooden rotating drums. Trivalent chromium sulphate is added to the hides and then water content is reduced and

shaving is carried out mechanically. Hide is called "wet blue" at this stage. Then dyeing is carried out. The hide is softened by fat liquoring, made smooth on a setting out machine, excess water is removed by a vacuum dryer, softened using a vibrating metal pin, stretched on a toggling machine and unwanted parts are removed by trimming. Lastly, a protective and decorative coating is carried out by using a spray machine. After finishing, it is measured, sorted and dispatched.

Most of the tannery workers were illiterate and ignorant to the basic principles of safety. The company did not have any list of chemicals used in the tanning process. There were no files of chemical safety data sheets and chemical containers were not marked with names and warning labels. No training in chemical safety for workers was organized in the company. There was no occupational health and safety department. Those who got injured during work were provided medical treatment at a nearby private hospital, and those who needed medical treatment were referred to social security funded health facilities.

## Study population and their interviews

This cross-sectional study was conducted during 2010-2011 at a leather tannery in Korangi Industrial Area, Karachi, Pakistan. The target population was male tannery workers. Only those 160 workers who were involved in the tanning process were selected for study and were interviewed. Fifty-two controls of the same sex and age were selected from the local community. Verbal consent was obtained from the owner of the tannery. Interviews were conducted face to face and spirometry was carried out. A qualified and experienced doctor conducted the interview and pulmonary function tests. The inclusion criterion was that "a worker who was employed permanently or by contract at the tannery". The questionnaire was in English, and it was translated into the local language. The record was kept in the English language. The majority of the workers were speaking Pashto and illiterate. Therefore, we took the help of a translator for the regional language. The questionnaire consisted of basic demography which included name, age, marital status, ethnicity, education, health and safety training, the use of a facemask, salary, smoking, duration of job and its description. We considered a smoker who was currently smoking, an ex-smoker who had stopped smoking and a non-smoker who had never smoked. We took a list of employees from the management and classified them according to the department. The main questionnaire consisted of questions such as: during the last 12 months have you suffered from whistling from the mouth; were awoken from sleep due to a tightness in the chest; difficulty in breathing or excessive cough; shortness of breath during a usual walk; bouts of sneezing, nasal discharge and irritation of the eyes; suffered from skin diseases like eczema and allergic rash; are your symptoms related to work; been diagnosed asthmatic by a qualified physician? The answers were recorded as "Yes/No". Those who mentioned that their symptoms improved on weekends and annual vacations or symptoms are aggravated at work were marked as having symptoms related to their work.

## Lung function measurements

We took height and weight of the workers in cm and in kg respectively, using a standard scale. We used a hand-held Vitalograph micro made in the USA for assessing the lung function. The workers were informed about the procedure, and we demonstrated to them how to breathe out during the test. The test was carried out in a sitting position. All tests were repeated three times and the best value was taken. We carried out tests for forced expiratory volume in 1s (FEV<sub>1</sub>), peak expiratory volume (PEFR), forced vital capacity (FVC) and FEV<sub>1</sub>/FVC ratio. We took the value as % of predictive value of test as per NANEES II Health and Nutrition Survey for Caucasians. Those who were having FEV<sub>1</sub> at 80-100% of the normal predictive value were considered as within normal limit, less than 80% of normal predictive value was considered as low, FEV<sub>1</sub>/FVC ratio less than 0.7 were considered as obstructive lung disease. We considered: "asthma diagnosed by a physician" as criteria for diagnosing asthma.

## Analysis

The results obtained were entered into SPSS IBM version 18 statistical software. The data regarding demographic factors, physician diagnosed asthma respiratory symptoms was analyzed. We determined frequency distribution of age, marital status, ethnicity, level of education, duration of job, salary, HSE training, use of face mask, body mass index, smoking behavior, physician's diagnosed asthma and respiratory symptoms. We calculated number, mean and standard deviation of duration of job, body mass index, FEV<sub>1</sub>, PEFR, FVCL and FEV<sub>1</sub>/FVC ratio. We calculated mean, SD of duration of job, BMI and a pulmonary function test result. We measured number, mean and STD of FEV<sub>1</sub>, PEFR, FEV<sub>1</sub>/FVC ratio with reference to job description of tannery workers and applied the Student's t-test for significance of the relationship among respiratory symptoms, FEV<sub>1</sub>, PEFR and the FEV<sub>1</sub>/FVC ratio. We carried out Univariate analysis to know the relationship between age, marital status, education, duration of job, salary, use of face mask, BMI, smoking, sneezing/nasal discharge and eczema/urticaria with workers diagnosed as asthmatic by physician and respiratory symptoms. We applied the student analysis of variance to know the relationship between those who were diagnosed asthma by physician, and respiratory symptoms with respiratory function test results

## Walk-through survey of the tannery

We carried out a walk-through survey of the factory and observed working conditions, use of personal protective equipment, ventilation, humidity, temperature and dust in the environment.

## Results

During our study on tannery workers, we found that there were poor working conditions and health and safety protection was non-existent. Prevalence of asthma was 7% and obstructive lung diseases was 39.4% among tannery workers.

Frequency distribution of socio-demographic, anthropometric and lifestyle factors (Table 1). According to our finding, the total number of workers participated in the study was 160. The distribution of the tannery workers who participated in this study was that 92(58%) belonged to the 20-30-year age

**Table 1:** Demographics of tannery workers and control.

Variable	Tannery workers, n=160	Non-tannery workers, n=52
	n(%)	n(%)
<b>Age</b>		
<20 yrs	7(4)	0(0)
20-30 yrs	92(58)	17(33)
31-40 yrs	34(21)	21(40)
41-50 yrs	21(13)	7(13)
51-60 yrs	6(4)	5(10)
>60 yrs	0(0)	2(4)
<b>Marital Status</b>		
Single	54(3)	29(56)
Married	106(66)	23(44)
<b>Ethnicity</b>		
Mohajir	12(8)	35(67)
Sindhi	6(4)	1(2)
Baluchi	2(1)	0(0)
Seraiki	8(5)	0(0)
Punjabi	33(21)	11(21)
Pathan	91(57)	5(10)
Misc	8(5)	0(0)
<b>Education</b>		
0-5 yrs	91(57)	11(21)
6-10 yrs	49(31)	9(17)
11-12 yrs	19(12)	10(19)
> 12 yrs	1(1)	22(42)
<b>Duration of Job</b>		
0-3 yrs	46(29)	20(39)
4-10 yrs	69(43)	19(36)
> 10 yrs	45(28)	13(25)
<b>Salary</b>		
< 7000	68(42.5)	0(0)
7-15000	86(53.8)	38(53.8)
>15000	6(3.8)	24(46.2)
<b>HSE Training</b>		
Yes	3(2)	0(0)
No	157(98)	52(0)
<b>Face Mask</b>		
Yes	63(39)	0(0)
No	97(61)	52(100)
<b>Body mass index</b>		
< 25	127(82)	37(71)
> 25	27(18)	15(29)
<b>Smoking</b>		
Non-smoker	107(67)	43(83)
Ex-smokers	12(8)	8(15)
Smokers	41(26)	1(2)

group, 34(21%) 31–40 years, 21(13) 41–50 years, 7(4%) less than 20 years and 6(4%) were between 51–60 years. There was no worker who participated in the study was more than 60 years of age. Marital status: 106(66%) were married 54(33) were unmarried. Ethnicity: 91(57%) belonged to the Pathan ethnic group, 33 (21%) Punjabi group, 8(5%) miscellaneous, 8(5%) Seraiki group, 6(4%) Sindhi group and 2(1%) Baluchi. Thus we found that majority of the workers belong to Pathan group. Education: Those who received 0–5 years of education was 91(57%), 6–10 years 49(31%), 11–12 years 19(12%) and more 12 years 1(1%). We found maximum number of workers were having an education of 0–5 years. Duration of job: 69 (43%) had an exposure of tannery for 4–10 years, 46(29%) less than 3 years, and 45(28%) for more than 10 years. We found that majority of the workers were having exposure to 4–10 years.

Salary: 86(53.8%) had a salary of Rs 7000–15000 per month, 68(43%) less than Rs 7000 per month and 6(3.8%) more than Rs15000 per month. Thus majority of the workers were drawing salary between Rs 7–15000 per month. HSE training: 157(98%) did not received HSE training. Use of face mask: 63(39%) were using face mask, 97(61%) were not using face mask. Thus majority of the workers were not using face mask. BMI: 127(82%) had BMI less than 25 and 27(18%) more than 25. Thus most of the workers were under weight. Smoking: 107(82%) were non-smokers, 41(26%) smokers and 12(8%) were ex-smokers. We found that majority of the workers were non-smokers.

The frequency of a physician's diagnosed asthma and respiratory symptoms was calculated among 160 tannery workers (Table 2). We found that only 11(7%) of tannery workers were diagnosed with asthma by a qualified physician as compared to 149(93%) has no such history. Respiratory symptoms: As far as respiratory symptoms are concerned only 32(20%) had a history of whistling sound on the contrary 128(80%) of the tannery workers had no history of whistling sound. 37(23%) were awoken from sleep due to tightness in the chest whereas 123(77%) had no history of awakening from sleep due to tightness in the chest. 39(24%) accepted that they were having a history of awakening from sleep due to difficulty in breathing, whereas 121(76%) had no such history. 40(25%) were awoken from sleep due to excessive coughing in contrast 120(75%) had no such history. 66(41%) had a shortness of breath during a usual walk whereas 59(59%) had no such history., 52(33%) considered that symptoms were related to work whereas 108(68%) don't think so. 66(41%) had sneezing, nasal discharge and irritation of eyes whereas 94(59%) had no such history. 33(21%) had history of eczema and urticaria on the contrary 127(79%) had no such history.

The number, mean and SD of duration of job, body mass index and function (Table 3). We determined mean and standard deviation of duration of job of 160 subjects. The mean was 7.91 with STD+/- of 6.4. The mean BMI of 154 subjects was 21.2 with STD +/- of 5.1. The pulmonary function test was carried out of 151 subjects. Following was the result for mean and standard deviation. FEV1 mean was 71.6 STD+/-20.3. PEF mean was 72.7 STD+/-29.3. FVCL mean was 73.3 STD+/-15.3. FEV1/FVC ratio mean was 79.8 STD+/-16.5.

Univariate analysis of factors associated with bronchial asthma and respiratory symptoms and OR ratio (Table 4). We carried out Univariate analysis to know the statistically significant relationship between Physician's diagnosed asthma, respiratory symptoms and age, marital status, education, duration of job, salary, use of face mask, body mass index, smoking, sneezing/nasal discharge and eczema/urticaria. We found a statistically significant relationship between an age 31–40 years and respiratory symptoms, whistling OR 1.85(95% CI), tightness of chest OR 1.5(95%CI), difficulty in breathing OR 1.60(95%CI), excessive coughing OR 1.84(95%CI), shortness

**Table 2:** Respiratory and Atopy symptoms.

Variable	Tannery workers n=160	Non-tannery workers n=52
Diagnosed by qualified physician		
Yes	11(7%)	1(2%)
No	149(93%)	51(98%)
Whistling sound		
Yes	32(20%)	0(0%)
No	128(80%)	52(100%)
You awoke from sleep due to tightness in chest		
Yes	37(23%)	2(4%)
No	123(77%)	50(96%)
You awoke from sleep due to difficulty in breathing		
Yes	39(24%)	0(0%)
No	121(76%)	53(100%)
You awoke from sleep due to excessive coughing		
Yes	40(25%)	2(4%)
No	120(75%)	50(96%)
Shortness of breath during a usual walk		
Yes	66(41%)	2(4%)
No	59(59%)	50(96%)
Symptoms are related to work		
Yes	52(33%)	1(100%)
No	108(68%)	0(0%)
Sneezing, nasal discharge and irritation of the eyes		
Yes	66(41%)	2(4%)
No	94(59%)	50(96%)
Eczema and urticaria		
Yes	33(21%)	1(2%)
No	127(79%)	51(98%)

**Table 3:** Number, mean and SD of subjects and control.

	Tannery workers n=160		Non-tannery workers n=52	
	n	mean(SD)	n	mean(SD)
Duration of job	160	7.91(6.4)	45	9.42(9.0)
Body mass index	154	21.2(5.1)	52	23.8(4.2)
FEV1	151	71.6(20.3)	52	77.6(16.6)
PEFR	151	72.7(29.3)	52	98.1(19.1)
FVCL	151	73.3(15.3)	52	71.2(12.9)
FEV1/FVC Ratio	151	79.8(16.5)	52	86.7(13.1)

**Table 4:** Univariate analysis of factors associated with bronchial asthma and respiratory symptoms and Odd Ratio (OR).

Factor	N	Qualified OR(95% CI)	Whistling OR(95% CI)	Tightness OR(95% CI)	Difficulty in breathing OR(95% CI)	Excessive coughing OR (95% CI)	Shortness of breath OR(95%CI)
Age:							
20-30y	92	1.00	1.00	1.00	1.00	1.00	1.00
31-40y	34	0.90 (0.17-4.67)	1.85 (0.72-4.74)	1.59 (0.63-4.01)	1.60 (0.66-3.91)	1.84 (0.76-4.42)	1.52 (0.68-3.36)
>40y	34	1.39 (0.33-5.89)	1.58 (0.60-4.15)	2.11 (0.87-5.14)	1.60 (0.66-3.91)	1.60 (0.66-3.91)	1.52 (0.68-3.36)
Marital status							
Single	54	1.00	1.00	1.00	1.00	1.00	1.00
Married	106	5.52 (0.69-44.3)	0.81 (0.36-1.82)	0.92 (0.43-2.00)	0.76 (0.36-1.61)	0.93 (0.44-1.97)	1.03 (0.53-2.01)
Education							
0-5y	91	1.00	1.00	1.00	1.00	1.00	1.00
>6y	69	0.74 (0.21-2.63)	0.88 (0.40-1.93)	0.87 (0.41-1.84)	0.76 (0.37-1.62)	0.64 (0.30-1.34)	0.95 (0.60-1.80)
Duration of job							
1-3	46	1.00	1.00	1.00	1.00	1.00	1.00
4-10	69	2.89 (0.58-14.3)	2.35 (0.86-6.48)	2.08 (0.83-5.21)	1.68 (0.69-4.11)	2.97 (1.16-7.64)	1.39 (0.65-2.99)
>10	45	0.50 (0.04-5.72)	1.44 (0.46-4.55)	1.03 (0.35-3.02)	1.17 (0.43-3.23)	1.39 (0.65-2.99)	1.14 (0.49-2.65)
Salary							
7-8000	60	1.00	1.00	1.00	1.00	1.00	1.00
<9000	32	1.97 (0.37-10.4)	0.74 (0.24-2.33)	0.84 (0.30-2.33)	0.69 (0.24-2.00)	1.10 (0.40-2.97)	0.52 (0.21-1.28)
<7000	68	1.51 (0.35-6.60)	1.13 (0.48-2.66)	0.85 (0.37-1.93)	1.08 (0.49-3.39)	1.18 (0.53-2.65)	0.80 (0.40-1.61)
Face mass							
Yes	63	0.32 (0.07-1.54)	0.64 (0.28-1.47)	0.68 (0.31-1.47)	0.82 (0.39-1.74)	0.67 (0.32-1.43)	0.65 (0.34-1.24)
No	97	1.00	1.00	1.00	1.00	1.00	1.00
Body mass index							
<25	127	1.00	1.00	1.00	1.00	1.00	1.00
25-	27	0.45 (0.06-3.67)	1.81 (0.71-4.62)	0.68 (0.24-1.93)	1.04 (0.40-2.69)	1.00 (0.39-2.57)	0.90 (0.39-2.09)
Smoking							
Non-smoker	107	1.00	1.00	1.00	1.00	1.00	1.00
Ex-smoker	53	10.74(2.23-51.7)	3.42 (1.54-7.60)	2.38 (1.12-5.06)	2.11 (1.00-4.42)	3.51 (1.67-7.39)	1.61 (0.83-3.14)
Sneezing/nasal discharge							
Yes	66	4.18 (1.07-16.4)	6.14 (2.55-14.82)	3.56 (1.65-7.70)	4.05 (1.88-8.71)	5.04 (2.31-11.0)	2.06 (1.08-3.92)
No	94	1.00	1.00	1.00	1.00	1.00	1.00
Eczema/urticaria							
Yes	33	0.58 (0.17-4.12)	2.52 (1.07-5.98)	1.61 (0.69-3.79)	1.47 (0.63-3.44)	2.86 (1.27-6.46)	1.45 (0.67-3.13)
No	127	1.00	1.00	1.00	1.00	1.00	1.00

of breath on usual exertion OR 1.52(95% CI). Age 20–40 years has no statistically significant relationship with Physician's diagnosed asthma. Age more than 40 years has statistically significant relationship with Physician's diagnosed asthma OR 1.39(95%CI) and shortness of breath OR 1.03(95%CI). Marital status has significant relationship with Physicians' diagnosed asthma OR 5.52 (95%CI) but not with respiratory symptoms. Year of education has no statistically significant relationship with Physician's diagnosed asthma as well as respiratory symptoms. Duration of job 1–3 years has no statistically significant relationship with Physician's diagnosed asthma as well as respiratory symptoms. Duration of job 4–10 years has statistically significant relationship with Physician's diagnosed asthma OR 2.89(95%CI) as well as respiratory symptoms, whistling OR 2.35(95%CI), tightness of the chest OR 2.08(95%CI), difficulty in breathing OR 1.68(95%CI), excessive coughing OR 2.97(95%CI), shortness of breath on usual exertion OR 1.39(95%CI). Duration of job more than 10 years has statistically significant relationship with respiratory symptoms whistling OR 1.44(95%CI), tightness of chest OR 1.03(95%CI), difficulty in breathing OR 1.17(95%CI), excessive coughing OR 2.97(95%CI) , shortness of breath on usual

exertion OR 1.39(95%CI) but no significant relationship with Physician's diagnosed asthma. Salary Rs 7–8000 per month has no statistically significant relationship with Physician's diagnosed asthma and respiratory symptoms. Salary less than Rs 9000/month has statistically significant relationship with Physician's diagnosed asthma OR 1.97(95%CI), and excessive coughing OR 1.10(95%CI). Salary less than Rs 7000/month has statistically significant relationship with Physician's diagnosed asthma OR 1.51(95%CI), wheezing OR 1.13(95%CI), difficulty in breathing 1.08(95%CI), and excessive coughing. Use of face mask has no statistically significant relationship with Physician's diagnosed asthma and respiratory symptoms. Body mass index has no statistically significant relationship with Physician's diagnosed asthma and respiratory symptoms. Smoking, nonsmokers has no statistically significant relationship with Physician's diagnosed asthma and respiratory symptoms. Smokers and ex-smoker had statistically significant relationship with Physicians diagnosed asthma OR 10.74, whistling OR 3.42, tightness of the chest OR 2.38(95%CI), difficulty in breathing OR 2.11(95%CI), excessive coughing OR 3.51(95%CI), shortness of breath on usual walk OR 1.61(95%CI). Sneezing/nasal discharge has statistically

significant relationship with physicians' diagnosed asthma OR 4.18(95%CI), wheezing OR 6.14(95%CI), tightness of the chest OR 3.56(95%CI), difficulty in breathing OR 4.05(95%CI), excessive coughing OR 5.04(95%CI), shortness of breath on usual walk OR 2.06(95%CI). Eczema/urticaria, has no statistically significant relationship with Physician's diagnosed asthma but has statistically significant relationship with whistling OR 2.52(95%CI), tightness of the chest OR 1.61(95%CI), difficulty in breathing OR 1.47(95%CI), excessive coughing OR 2.86(95%CI), and shortness of breath on usual walk OR 1.45 (95% CI).

We applied the student analysis of variance and found a statistically significant relationship between those who were diagnosed with asthma and FEV<sub>1</sub> ( $p = 0.003$ ), PEFR ( $p = 0.018$ ), FEV<sub>1</sub>/FVC ratio ( $p = 0.005$ ), whistling and FEV<sub>1</sub> ( $p = 0.012$ ), FVCL ( $p = 0.017$ ), difficulty in breathing and FEV<sub>1</sub> ( $p = 0.030$ ), excessive coughing and FEV<sub>1</sub> ( $p = 0.037$ ), FVCL ( $p = 0.018$ ). Tannery workers in different jobs had no statistically significant relationship between their department and the results of the pulmonary function test (Table 5).

### Walk-through survey of the factory

We carried out an occupational health and safety walk-through survey of the factory. The tannery sector is a neglected sector regarding health and safety practices. The factory consisted of a multistory building. The drumming section was situated on the ground floor. There was a large amount of noise from drums, an excessively pungent smell of hydrogen and poor housekeeping. Ventilation and light were insufficient. Few workers used facemasks and gloves. None of them used safety boots or goggles. The chemical section was situated on the first floor. There was poor ventilation and exhaust systems and an excessive amount of chemicals was present in the environment. Most of the workers were not using PPE. Chemical drums were

not labeled and Material Safety Datasheets were not available. The knowledge of the workers regarding chemical safety was poor. The spray section was the worst; there was excessive dye present in the environment. We found workers eating food in the spray section. There was no environmental monitoring as well as no biological monitoring of the workers. Overall health and safety conditions were poor.

### Discussion

In the scientific literature there are only few studies about working conditions and occupational health in tanneries regarding the prevalence of respiratory symptoms and pulmonary function tests among tannery workers in Pakistan. Therefore, we carried out this study regarding the prevalence of respiratory symptoms, bronchial asthma and determined lung function.

In tanneries, tons of hazardous chemicals are used in various processes. Some of the chemicals are carcinogens classified by IARC like chromium salts, arsenic compounds, azo dyes and chlorinated hydrocarbons. Some studies show increased lung, prostate, renal, urinary bladder and colorectal tumors in leather tanning workers [8-11].

The tannery workers are exposed to chromium and leather dust through inhalation. Chromium enters the body through the respiratory system and produces its toxic effects like nasal allergy, nasal septal perforation, irritation in the throat, bronchial asthma, alteration in lung function, and tumors in the nose, throat and lung. Other chemicals like organic acids are respiratory irritants and may cause the destruction of the upper and lower respiratory tract. Among tannery workers, we found whistling in 20% of the study group, awakening from sleep due to tightness of chest in 23%, awakening from sleep due to difficulty in breathing in 24%, awakening from sleep due to excessive coughing in 25% and shortness of breath during a usual walk in 41%. Among controls we found awakening from sleep due to tightness of the chest in 4%, awakening from sleep due to excessive coughing in 4% and those with a shortness of breath during a usual walk in 4%. Overall the prevalence rate of respiratory symptoms among the tannery workers was 27% as compared to 2.3% in the controls. This shows that pulmonary symptoms were more common in the exposed subjects as compared to the non-exposed. Studies were carried out on tannery workers in Istanbul, Turkey and Kanpur, India, and they found that 16% [13]. And 16.7% [14], of the workers suffered from pulmonary symptoms, respectively. The low prevalence of pulmonary symptoms could be due to better health and safety conditions.

From the statistical analysis we found that there was a statistically significant relationship between an age of greater than 30 years, duration of work of greater than 4 years, a monthly salary of Pakistani rupees of less than 7000/month, smoking, ex-smoking, sneezing, nasal discharge, irritation of eyes, eczema/urticaria, dyes/stock, buffing/shaving, finish measurement, drumming sections and pulmonary symptoms. Those who were working on rotto machines, spray machines, "wet blue" and in a workshop had a statistically significant

**Table 5:** Bronchial asthma, Respiratory Symptoms vs. Spirometry: Number, Mean(SD) and P value.

Factor	n	FEV1 Mean (SD)	PEFR Mean (SD)	FVC Mean (SD)	FEV1/ FVC RATIO Mean (SD)
Qualified doctor		p=0.003	p=0.018	p=0.064	p=0.005
Yes	11	54.0 (20.1)	52.7 (31.8)	65.1 (15.8)	66.5 (18.0)
No	140	73.0 (19.8)	74.3 (28.6)	74.0 (15.1)	80.9 (15.9)
Whistling		p=0.012	p=0.207	p=0.017	p=0.171
Yes	32	63.6 (21.5)	66.9 (31.3)	67.6 (14.9)	76.3 (19.8)
No	119	73.7 (19.5)	74.3 (28.7)	74.8 (15.1)	80.8 (15.4)
Tightness		p=0.254	p=0.846	p=0.107	p=0.995
Yes	36	68.2 (21.8)	71.9 (29.7)	69.7 (16.9)	79.8 (17.3)
No	115	72.6 (19.8)	73.0 (29.3)	74.4 (14.6)	79.8 (16.2)
Difficulty in breathing		p=0.030	p=0.283	p=0.050	p=0.232
Yes	38	65.4 (21.0)	68.3 (31.0)	69.1 (15.9)	77.1 (18.9)
No	113	73.7 (19.8)	74.2 (28.7)	74.7 (14.9)	80.8 (15.5)
Excessive coughing		p=0.037	p=0.267	p=0.018	p=0.435
Yes	40	65.9 (19.1)	68.3 (31.4)	68.4 (14.3)	78.1 (16.9)
No	111	73.6 (20.5)	74.3 (28.5)	75.1 (15.3)	80.5 (16.3)
Shortness of breath during a usual walk		p=0.147	p=0.080	p=0.511	p=0.127
Yes	66	68.8 (21.7)	68.0 (28.4)	72.4 (16.9)	77.5 (17.1)
No	85	73.7 (19.0)	76.4 (29.6)	74.0 (14.0)	81.6 (15.8)

relationship with awakening from sleep due to tightness of chest and whistling. The Pathan ethnic group had a statistically significant relationship with all pulmonary symptoms, and the Punjabi ethnic group had a significant relationship with whistling, awakening during sleep due to tightness of chest, excessive coughing and being out of breath during a usual walk only. Other ethnic groups did not have any statistically significant relationships with pulmonary symptoms.

We have used “physician diagnosed asthma” as a criterion for the diagnosis of bronchial asthma which has a sensitivity of 99% [15,16]. We found that 7% of the tannery workers were suffering from bronchial asthma as compared to 2% of the controls. It shows that the prevalence of bronchial asthma is more common among tannery workers as compared to controls. The prevalence of bronchial asthma at Istanbul, Turkey tanneries was 3%, [13] and in Kanpur, India tanneries at 5% [14]. The prevalence rate of bronchial asthma in the above-mentioned studies is less than our results. On the contrary, the prevalence rate of bronchial asthma in our study was lower than below mentioned studies. Among tannery workers at Karachi, Pakistan, the prevalence rate was 10% [15]. Adult residents of surrounding tanneries at Velore, India had 20–25% [17]. And at Kanpur India 38% [18]. According to different studies, the following is the prevalence rate of bronchial asthma in the general population of Karachi, Pakistan at 4% [15]. Rural Sind, Pakistan at 5.5%, [19]. Residents of twin cities of Islamabad/Rawalpindi and all provinces of Pakistan at 19.41%, [20]. Rural and urban population of Delhi, India at [7.9–13]. 34%. [21]. The prevalence of bronchial asthma varies among different geographical regions [22]. This could be due to difference in diagnostic criteria as well as lifestyle, genetic, racial, environmental and occupational factors.

We found that bronchial asthma was more common among the dye stock, finish measurements, spray and chemical store workers of the tannery. We observed that there was an excessive leaking of the dye, a lack of adequate arrangement of waste disposal, an excessive amount of chemicals in the dye/stock section and leather dust in the finishing section of the tannery. The prevalence of bronchial asthma depended upon the nature and amount of chemical exposure, local environment and occupational conditions. These conditions varied from one department to other department. Therefore, there was a difference in the prevalence of bronchial asthma in different departments of the tannery. We found a statistically significant relationship between bronchial asthma and dyes/stock, buffing/shaving, finish measurement and drumming section. We did not find a statistically significant relationship between bronchial asthma and eczema/urticaria.

Chromium compounds and phenols are used as tannins. Other chemicals and leather dust irritate the respiratory tract leading to its destruction resulting in airway limitations. Pulmonary function gives a better idea regarding the status of the respiratory system [23]. We found that 39.4% of tannery workers suffered from obstructive lung diseases as compared to 11.5% of the controls, who showed obstructive lung disease more commonly among tannery workers. In the study from

Istanbul, Turkey, 40.27% of the workers [13] and from Kanpur, India, 14.7% of the workers [14], were found suffering from obstructive lung disease. Our results are similar to the study on tannery workers of Istanbul, Turkey, but are more than those at tanneries of Kanpur, India. The prevalence of obstructive lung diseases among tannery workers is more than in the general population in Pakistan that could be due to hexavalent chromium which combines with hemoglobin and reduces oxygen carrying capacity leading to increased respiratory morbidity [14].

We have found increased prevalence of pulmonary obstructive lung disease in tannery workers, which could be due to exposure to toxic chemicals and the absence of safety measures. We found a statistically significant relationship between whistling and FEV<sub>1</sub>, FVCL, wake up from sleep due to excessive coughing and the FEV<sub>1</sub>, PEF, FEV<sub>1</sub>/FVC ratios. We did not find a significant relationship between different departments of the tannery and results from the pulmonary function test.

Smoking is a major risk factor for disease burden. It irritates bronchi, leads to bronchial hyper-responsiveness and sensitizes airways to occupational allergens [24]. It is a significant predictor of wheezing [20,25] and leads to a high prevalence rate of bronchial asthma [26,27]. In our study, we found 33.12% smokers/ex-smokers. In those who were smoking/ex-smoking, 16.98% had asthma as compared to 1.8% in non-smokers. In those who were asthmatics, 82% were smoker/ex-smokers. This suggests that smoking leads to an increased prevalence of bronchial asthma. A study conducted in the UK showed that among young people, those who were currently smoking had a high prevalence of bronchial asthma [28]. Thus validating our results. The increased prevalence of asthma among tannery workers who were smokers is due to increased sensitization of the respiratory tract to the chemicals which are themselves a irritant and thus causes an exaggerated response and increased prevalence of bronchial asthma.

When the tannery workers are exposed to chromium, it may affect the nose and may lead to inflammation, ulceration and perforation of nasal septum. In a study using workers from chromium plating factories, nasal septal perforation and ulceration were found in 30.8% and 38.5% of the workers respectively. 30% of those who were suffering from nasal as well as asthma symptoms thought that their symptoms were related to each other [29]. We found excessive sneezing, nasal discharge and irritation of the eyes in 41% of the workers, 12.12% of them had bronchial asthma as compared to 3.12% of those who did not have these symptoms. 72.72% of the asthmatics had sneezing, nasal discharge and irritation of the eyes as compared to 27.27% of those who did not have these symptoms. This shows that sneezing, nasal discharge and irritation of eyes are important predictors of asthma. A study in Bangladesh found that 33% of asthma patients suffered from rhinitis [30]. The results of our study is validated by following studies which mentioned that allergic rhinitis is a powerful predictor of bronchial asthma [31–34].

Chemicals used in the tannery are irritants and sensitizers. Chromium exposure can lead to dermatitis [14]. Skin sensitization may lead to IgE-mediated asthma [15]. We found that 21% of the workers had eczema/urticarial and out of them, only 6.06% suffered from bronchial asthma. In those who were asthmatics, 18.18% suffered from eczema/urticaria. We did not find a strong relationship between urticaria/eczema and bronchial asthma in our study. A study using school children in Southern Brazil found that 10% of the asthmatic children had eczema [35]. These results are lower than our findings which could be due to due to racial, personal, lifestyle, genetic, occupational and environmental reasons.

We have studied the role of ethnicity in the prevalence of bronchial asthma. Our study population consisted of 56.9% Pathan, 20.6% Punjabi and 2.5% of other ethnic groups. We found that 8.97% of the Pathan ethnic group suffered from bronchial asthma as compared to 3.03% of the Punjabi and 5.5% of other ethnic groups. We focused our attention on the Punjabi and Pathan ethnic groups. We found that 72.72% of the Pathan and 9% of Punjabi ethnic group suffered from bronchial asthma. A national study in England and Wales found that ethnicity has a significant and independent effect on bronchial asthma incidence. They found a prevalence of bronchial asthma in white's of 26.4%, South Asians of 30.4%, Afro-Caribbean's of 35.1% and others of 27.8% [36]. This study validates our results that ethnicity plays a role in prevalence of bronchial asthma.

Personal protective equipment has a definite role in prevention of disease at work. The tannery worker should use appropriate respiratory equipment for prevention of work-related asthma. We found that 39.4% of the workers used a face mask. A study was conducted among tannery workers at Kasur, Pakistan. It was found that only 5.3% of the workers were using a facemask [37]. The prevalence of bronchial asthma was 3.1% among those using a facemask as compared to 9.27% who were not using mask. We found that in our study, in those who were diagnosed with bronchial asthma, 82% were not using facemask. This shows that facemask use can reduce the prevalence of bronchial asthma in tannery workers. There should be awareness program regarding benefits of PPE among workers.

Bronchial responses to occupational and environmental challenges may be early, late or atypical. Bronchial asthma could be due to immunological reasons or irritants. Immunological-induced asthma could be associated with a known IgE or without it and mostly associated with a latent period [38]. Irritant-induced asthma does not involve IgE and usually there is no latent period. It may occur even due to single exposure. We studied the duration of exposure and its relationship with the development of bronchial asthma. Our study population had exposure of less than 4 years in 29%, 4 to 10 years in 43%, and greater than 10 years in 28% of the workers. Those who were diagnosed asthma, 72.72% had exposure of 4-10 years, 18.18% after greater than 4 years and 9% in greater than 10 years. We found that prevalence of bronchial asthma was low in less than 4 years and greater than 10 years of exposure suggesting

that less than 4 years could be due to a latent period and more than 10 years could be due to a healthy workereffect [38]. It has been mentioned in medical research that low molecular weight molecules can lead to bronchial asthma with a latent period that substantiate our findings regarding latent period [39]. The prevalence of bronchial asthma among industrial workers is underreported because those who suffered from bronchial asthma leave the job and may join some other work and this is called the healthy worker effect. We have seen same phenomenon in our study. We found that 4-10 year duration of exposure has a statistically significant relationship with prevalence of bronchial asthma as compared to less than 4 and greater than 10 years of exposure.

We found that in 58.41% of those who had respiratory symptoms and in 64% of those who had bronchial asthma considered that their symptoms were work related. In order to validate this finding, we should have carried out more objective laboratory tests. We have not carried out those tests as it was out of our domain.

## Conclusion

We have carried out this study regarding pulmonary symptoms, bronchial asthma and lung function tests among tannery workers of Karachi, Pakistan. The study showed a high prevalence of respiratory symptoms, bronchial asthma and obstructive lung disease. The prevalence of bronchial asthma was more common among tannery workers than the general population of Sind but was less than general population of other provinces. Obstructive lung disease was more common as compared to in the general population of Sind, Pakistan. There might be occupational as well as non-occupational factors in the causation of respiratory symptoms and bronchial asthma among tannery workers. We should carry out further research among tannery workers with a larger and more diversified sampling from various tanneries in different parts of the country using subjective as well as objective tests to determine the occupational nature of the disease. In order to prevent occupational diseases, there should be a well-developed occupational health service in the country. According to Pasha TS, there is no organized occupational health system, no university education available and occupational safety and health administration is not working properly in the country [40]. Therefore it is suggested that in order to reduce the burden of occupational disease, a plan of occupational health service should be made and implemented.

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