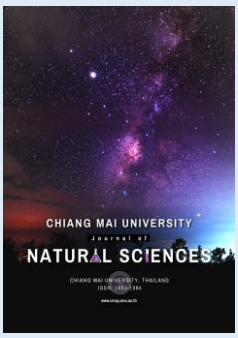

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Research article

Respiratory Health Implications among Wet-Blue Leather Tannery Workers of Kasur

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Abstract Work-related respiratory diseases have imperative role in the globular burden of occupational lung diseases throughout the world. These respiratory disorders can be caused by environmental hazards in the workplace and account for 10-20% of all chronic lung diseases. It is surprising that in Pakistan, scarce data is available on the pulmonary health of tannery workers. Therefore, this study aimed to determine the respiratory-specific health status of wet-blue leather tannery workers in Kasur city, Pakistan. A sample of 227 tannery workers engaged in four different tanneries was selected as a sample of convenience. A control group of 112 participants independent from exposure was also selected from the local community. Respiratory health was determined through an adopted symptom-based questionnaire and pulmonary function tests (PFTs). These tests were carried out by using a portable spirometer, during September-December 2019. A multiple Linear regression analysis was performed to analyze the amount of variance in PFTs by demographics and respiratory symptoms. Among tannery workers, the complaints of respiratory symptoms were 27.8% as compared to 21.4% of the control group. While based on the PFTs, total cases of impaired-pulmonary function among tannery workers were 34.3% as compared to 19.7% of the control. A statistically significant relationship was found between age, job duration, education, respiratory symptoms, and pulmonary function parameters. This study will contribute to generate baseline data of respiratory health status of the tannery workers. Further studies are recommended to find an association between occupational factors and workplace-related respiratory problems to reduce the burden of occupational diseases.

Keywords: Occupational diseases, Lung diseases, Respiratory function tests, Spirometry, Workplace

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INTRODUCTION

Work-related respiratory diseases make major contributions to the globular burden of occupational lung diseases throughout the world. It accounts for 10-20% of all chronic lung diseases (Dalju et al., 2019). The structural attributes of the lungs i.e. high vascularity, thin epithelium of alveoli, and the large surface area of the lung make it prone to the cruelty of environmental pollutants, especially in the workplace. The exposure to the workplace environment takes years; therefore, workplace-related diseases are mostly preventable (Chandrasekaran et al., 2014).

Tanning operations during leather manufacturing are constant hazards to the workers (Issever et al., 2007). Wet-blue leather produces through a chrome tanning procedure (Abbas et al., 2017). Approximately 90% of raw hides are being treated by this method (Thanikaivelan et al., 2004). Such chromium exposure has a potential effect to reduce spirometric measurements among workers (Rasoul et al., 2017). Similarly, buffing as well as loading hides in rotating- drums produce chemical and leather dust comprise microfungi, hair fragments, and excrements, etc. These dusts are related to potential hazards and involve in occupational diseases (Issever et al., 2007).

Occupational health is still at the juvenile stage in Pakistan. The tannery workers are constantly facing exposures to carcinogenic chemicals like chromium salt, benzene, formaldehyde, as well as airborne leather dust produced during different activities of tanning procedure. Such exposures are serious health threats to the tannery workers (Jamal et al., 2017). Keeping in view the toxicity of different compounds and vulnerability of the workers to respiratory disorders, the present research was conducted to study respiratory symptoms along with impaired pulmonary functions among tannery workers. Thus we can bring to prominence the decline of pulmonary functions, especially with increasing years of exposure to leather dust.

MATERIALS AND METHODS

Study area

The present study was conducted in the industrial complex of Deen Garh, Kasur city, Pakistan. The study was carried out during September-December 2019. The sample size was calculated using the G Power formula proposed by Faul et al., (2007). A total of 227 tannery workers participated from four different tanneries while 112 individuals of the control group participated from the local community; unexposed to the environment of tannery. The available workers were the only male.

Inclusion criteria

The inclusion criterion for tannery workers and control group was as directly engaged with the wet-blue leather tanning process and independence from direct-exposure, respectively.

Anthropometric measurements

Age (years), height (cm), weight (kg), and body mass index (BMI in kg/m2) were measured from studied population. To measure height, workers asked to straighten their back and head. A spring-weighing scale recorded the weight. All participants were wearing light clothes and without shoes during anthropometric measurements and pulmonary function tests (PFTs). Besides, demographic factors like sex, age, marital status, education, job duration, the use of face mask, smoking status, and ethnicity were also noted.

Symptom-based questionnaire

A symptom-based questionnaire was employed and adopted to record the status of respiratory signs and symptoms (Jamal et al., 2017). These respiratory signs and symptoms were: wheezing, chest tightness, difficulty in breathing, excessive cough, and dyspnea. However, skin allergy i.e. sneezing, nasal discharge, and eye irritation along with atopy: eczema, and urticaria were studied. The diagnosis of bronchial asthma

was based on the information provided by the workers. The questionnaire was filled through face to face interviews.

Pulmonary Function Tests

PFTs were performed by using a portable spirometer (Spirotron MDX, USA). All measurements were taken by the method of the American College of Occupational and Environmental Medicine (Townsend et al., 2000) and (ATS/ERS 2005 guidelines) adopted by Viegas et al., (2013). All workers were sitting in a comfortable position during PFTs. Nose clips were used to avoid any leakage from the nose. Disposable mouth-pieces were used to avoid contamination. Self-demonstration was provided on how to exhale air forcefully during the procedure after taking a deep breath. Workers were asked to repeat the test if not performing appropriately. Three readings were taken and the highest value was selected for the analysis.

Pulmonary function parameters

Three pulmonary function parameters were recorded as forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and the ratio of FEV1/FVC. The values were taken as percentage predicted for FEV1 and FVC.

Impaired pulmonary function

Impaired pulmonary function was determined in terms of the patterns of respiratory abnormalities, i.e. airflow obstruction, restriction, and mixed abnormality (co-existing airway obstruction and restriction). These patterns of abnormalities were based on the prescribed values of pulmonary function parameters (Bellamy et al., 2005). The normal pattern was indicated if the percentage predicted values of FEV1 and FVC > 80% without considering the values of FEV1/FVC. The restrictive pattern had the values of both FEV1 and FVC < 80% but FEV1/FVC > 0.7. The obstructive pattern had values of FEV1 less than 80%, FVC is usually reduced, but to a lesser extent than FEV1 while FEV1/FVC <0.7. Those having percentage predicted values of FEV1 and FVC < 80 % and FEV1/FVC < 0.7 were designated as mixed abnormality pattern.

Data analysis

Data were analyzed statistically using SPSS (version 25). Point biserial correlation was determined between pulmonary function parameters and some demographic factors of dichotomous nature. Spearman's rho correlation was used to measure the strength and direction of association between pulmonary function parameters and some demographic factors acting as ordinal variables. The P-value of up to 0.05 was considered statistically significant. A multiple Linear regression model i.e., $y = av + bw + cx + dy + ez$ was run to predict the variance of pulmonary function parameters by selected independent variables in terms of F and P value.

RESULTS

The demographic characteristics, respiratory symptoms, pulmonary function parameters as well as patterns of respiratory abnormalities of the studied population (n = 339) were analyzed by frequency distribution. Each category was further sub-divided to analyze their percentage frequency.

In demographic features, the gender of the studied population was only male (n = 339). There were no female participants among tannery workers and control group. The age range was recorded in four subgroups of years: < = 25, 26-35, 36-45, and > 45. The maximum tannery workers fell in a subgroup of 26-35 (34.4%) as compared to the participants of the control group fall in a subgroup of > 45 (54.5%). It was observed that most of the tannery workers and participants of the control group were married. The education was observed at three levels: <= 5 years, 6-12 years, and > 12 years. Most of the tannery workers reported <= 5 years of education (67.8%) as compared to >12 (59.8%) in the control group. The job duration was recorded in three subgroups: <= 3 years, 4-10 years, and > 10 years. Most of the tannery workers had job duration <= 3 years (65.6%) than > 10 (49.1%) in the control group. The majority

of the tannery workers reported that they use face mask (53.3%) during the hours of duty. BMI was recorded in two subgroups: < = 25 and > 25. Most of the tannery workers and participants of the control group were fall in the subgroup of > 25. Similarly, the majority of the studied population reported that they never smoked. Finally, the ethnicity of the participants was observed for Urdu, Pashto, Punjabi, and miscellaneous. Most of the tannery workers were Pashto speaking (42.7%) while in the control group, Punjabi speaking (57.1%) were dominant (Table 1).

Table 1. Demographic factors among studied population.

Demographic Factors		Tannery workers (N= 227) n (%)	Control Group (N= 112) n (%)
Sex	Male	227(100)	112(100)
	Female	0 (0.0)	0 (0.0)
Age (year)	<=25	28(12.3)	10 (8.9)
	26-35	78(34.4)	22 (19.6)
	36-45	45 (19.8)	19 (17.0)
	>45	76(33.5)	61(54.5)
Marital Status	Single	23(10.1)	22 (19.6)
	Married	204(89.9)	90 (80.4)
Education (year)	<= 5	154(67.8)	10 (8.9)
	6-12	73(32.2)	35 (31.3)
	>12	0 (0.0)	67 (59.8)
Job duration (year)	<= 3	149 (65.6)	18 (16.1)
	4-10	19 (8.4)	39 (34.8)
	>10	59 (26.0)	55 (49.1)
Use of Face mask	Yes	121(53.3)	0 (0.0)
	No	106 (46.7)	112 (100)
BMI (Kg/m^2)	<=25	64 (28.2)	18 (16.1)
	>25	163(71.8)	94 (83.9)
Smoking Status	Never smoker	209 (92.1)	93 (83.0)
	Ever smoker	18 (7.9)	19 (17.0)
Ethnicity	Urdu	45 (19.8)	10 (8.9)
	Pashto	97 (42.7)	29 (25.9)
	Punjabi	77 (33.9)	64 (57.1)
	Miscellaneous	8 (3.5)	9 (8.0)

The obtained results of the symptom-based questionnaire showed that frequently reported symptom among tannery workers was difficulty in breathing (20.3%) while dyspnea (13.4%) in the control group. The majority of the studied population reported that they never had bronchial asthma, atopy, and skin allergy i.e. sneezing, nasal discharge, and eye irritation (Table 2).

Table 2. Percentage frequency of questionnaire items.

Questionnaire items	Tannery workers (N= 227)		Control group (N= 112)	
	Yes	No	Yes	No
Wheezing	28 (12.3%)	199 (87.7%)	1 (0.9%)	111 (99.1%)
Chest tightness	25 (11%)	202 (89%)	12 (10.8%)	100 (89.2%)
Difficulty in breathing	46 (20.3%)	181 (79.7%)	8 (7.1%)	104 (92.9%)
Excessive cough	19 (8.4%)	208 (91.6%)	5 (4.5%)	107 (95.5%)
Dyspnea	15 (6.6%)	212 (93.4%)	15 (13.4%)	97 (86.6%)
Symptoms related to work	62 (27.3%)	165 (72.7%)	3 (2.7%)	109 (97.3%)
Sneezing, nasal discharge and irritation of eye	101 (44.5%)	126 (55.5%)	5 (4.5%)	107 (95.5%)
Eczema and urticaria	14 (6.2%)	213 (93.8%)	1 (0.9%)	111 (99.1%)
Bronchial Asthma	1 (0.4%)	226 (99.6%)	2 (1.8%)	110 (98.2%)

Note: Data presented as numbers (Percentage)

The mean values of pulmonary function parameters in tannery workers were as FEV1 percentage predicted (89.61 ± 20.96), FVC percentage predicted (88.45 ± 21.34),

and FEV1/FVC (0.87 ± 0.11). Similarly, in the control group, the obtained mean values were FEV1 percentage predicted (96.48 ± 18.97), FVC percentage predicted (92.94 ± 18.72), and FEV1/FVC (0.86 ± 0.09) (Table 3).

Table 3. Pulmonary function parameters of studied population.

Pulmonary function parameters	Tannery workers (N= 227)		Control group (N= 112)	
	n (%)	Mean (SD)	n (%)	Mean (SD)
FEV1 % predicted				
<=40 %	5 (2.2)	89.61	1 (0.9)	96.48
41-80 %	40 (17.6)	(20.96)	10 (8.9)	(18.97)
>80 %	182 (80.2)		101 (90.2)	
FVC % predicted				
<=40%	5 (2.2)	88.45	1 (0.9)	92.94
41-80%	62 (27.3)	(21.34)	16 (14.3)	(18.72)
>80%	160 (70.5)		95 (84.8)	
FEV1/FVC				
<0.70	16 (07)	0.87	5 (4.5)	0.86
>0.70	211 (93)	(0.11)	107 (95.5)	(0.09)

Note: SD= Standard deviation; FEV1= forced expiratory volume in one second; FVC= Forced vital capacity

In patterns of respiratory abnormalities, the mixed pattern was dominant in both tannery workers (18.1%) and the control group (7.1%) (Figure 1). While airflow obstruction was reported at the least both in tannery workers (3.1%) and control group (1.8%).

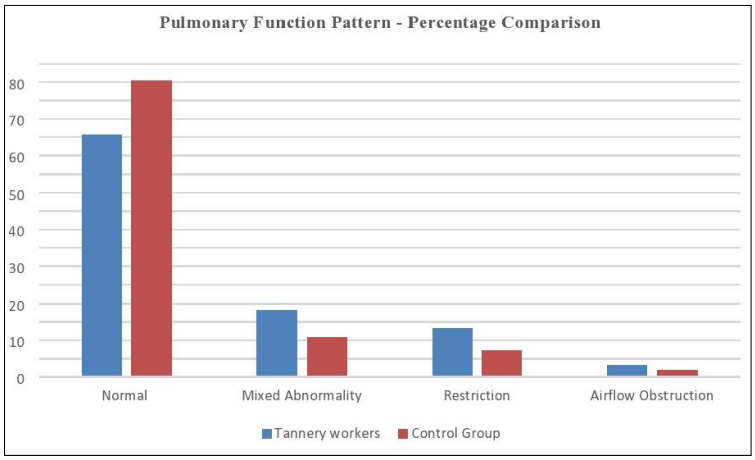

Figure 1. Comparison of Pulmonary function patterns among studied populations.

The results of the point biserial correlation showed that respiratory symptoms were negatively correlated with all pulmonary function parameters (FEV1 percentage predicted, FVC percentage predicted, and FEV1/FVC) at the (0.01) significance level. BMI and smoking status were not significantly correlated with the pulmonary function parameters. However, the use of face mask was positively correlated with FEV1 percentage predicted and FEV1/FVC at the (0.01) significance level. While marital status was negatively correlated only with FEV1/FVC at the (0.05) significance level (Table 4).

Table 4. Point-biserial correlation between demographic factors and pulmonary function parameters (N=227).

Factors	FEV1	FVC	FEV1/FVC	Respiratory symptoms
	Sig. (2-tailed) (Correlation Coefficient)			
Marital status	0.415	0.358	0.016	0.244
	(-0.054)	(-0.061)	(-0.159*)	(0.078)
Use of face mask	0.001	0.076	0.000	0.019
	(0.227**)	(0.118)	(0.246**)	(-0.155*)
BMI	0.934	0.060	0.799	0.119
	(0.006)	(-0.125)	(-0.017)	(0.104)
Smoking status	0.399	0.205	0.649	0.584
	(-0.056)	(-0.084)	(0.030)	(0.037)
Respiratory symptoms	0.000	0.000	0.000	-
	(-0.526**)	(-0.445**)	(-0.501**)	

Note: [1]The values of FEV1 and FVC are in percentage predicted, * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

The results obtained through Spearman's rho correlation showed that age and job duration were negatively correlated with all pulmonary function parameters at the (0.01) and (0.05) significance level. However, education was positively correlated with all pulmonary function parameters at the (0.01) and (0.05) significance level. But ethnicity was not significantly correlated with all pulmonary function parameters (Table 5).

Table 5. Spearman rho correlation between demographic factors and pulmonary function parameters (N=227).

Factors	FEV1	FVC	FEV1/FVC	Respiratory symptoms
	Sig. (2-tailed) (Correlation Coefficient)			
Age	0.011	0.000	0.000	0.000
	(-0.169**)	(-0.278**)	(-0.402**)	(0.299**)
Education	0.000	0.012	0.000	0.000
	(0.330**)	(0.167**)	(0.262**)	(-0.300**)
Job duration	0.000	0.000	0.000	0.000
	(-0.515**)	(-0.560**)	(-0.797**)	(0.544**)
Ethnicity	0.716	0.866	0.490	0.705
	(0.024)	(-0.011)	(0.046)	(-0.025)
Respiratory symptoms	0.000	0.000	0.000	-
	(-0.522**)	(-0.474**)	(-0.454**)	

Note: [1]The values of FEV1 and FVC are in percentage predicted, * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

A multiple linear regression was administered to predict FVC percentage predicted, FEV1 percentage predicted, and FEV1/FVC based on respiratory symptoms, age group, duration of job, education and use of face mask (Table 6). In case of FVC percentage predicted a significant regression equation was found ($F(5, 221) = 19.35$, $P < 0.000$), with an R2 of 0.305.Assessing only the p-values suggests that the respiratory symptoms and duration of job were equally statistically significant. In fact, age group ($P = 0.076$), use of face mask ($P = 0.708$) and education ($P = 0.708$) did not reach statistical significance in the multiple regression model. The multiple regression model was as follows: Y = 113.96 -11.97 (respiratory symptoms) + 2.41 (age group) - 10.49 (duration of job) + 1.026 (education) -0.943 (use of face mask).

In case of FEV1 percentage predicted a significant regression equation was found ($F (5, 221) = 28.11$, $P < 0.000$), with an R2 of 0.389. Assessing only the *P*-values suggests that the respiratory symptoms, age group, duration of job, education were

equally statistically significant. In fact, use of face mask did not reach statistical significance
(P = 0.209) in the multiple regression model. The equation of multiple regression model was as follows: Y = 103.562-15.659 (respiratory symptoms) + 3.135 (age group) - 8.780 (duration of job) + 5.278 (education) + 2.916 (use of face mask).

Similarly, in case of FEV1/FVC a significant regression equation was found (F (5, 221) = 80.28, P < 0.000), with an R2 of 0.645. Assessing only the p-values suggests that the respiratory symptoms and duration of job are equally statistically significant. In fact, age group (P = 0.223), use of face mask (P = 0.129) and education (P = 0.336) does not reach statistical significance in the multiple regression model. The multiple regression model was as follows: Y = 1.040- 0.026 (respiratory symptoms) - 0.006 (age group) - 0.092 (duration of job) + 0.010 (education) +0.015 (Use of face mask).

Table 6. Multiple Linear regression between pulmonary function parameters, respiratory symptoms and demographic factors (Tannery workers N=227).

Model	Unstandardized Coefficients		Standardized Coefficients			Model summary		ANOVA*		
	B	Std. Error	Beta	T	Sig.	R	R Square	df	F	Sig.
FVC % predicted*										
(Constant)	113.960	7.271	-	15.672	0.000	0.552	0.305	5, 221	19.355	0.000†
Respiratory symptoms	-11.970	3.201	-0.252	-3.740	0.000					
Age	2.411	1.350	0.119	1.786	0.076					
Job duration	-10.491	1.877	-0.427	-5.590	0.000					
Education	1.026	2.739	0.022	0.374	0.708					
Use of face mask	-0.943	2.512	-0.022	-0.376	0.708					
FEV1 % predicted*										
(Constant)	103.562	6.696	-	15.467	0.000	0.623	0.389	5, 221	28.110	0.000†
Respiratory symptoms	-15.659	2.947	-0.355	-5.313	0.000					
Age	3.135	1.243	0.158	2.521	0.012					
Job duration	-8.780	1.728	-0.364	-5.081	0.000					
Education	5.278	2.523	0.118	2.092	0.038					
Use of face mask	2.916	2.313	0.070	1.261	0.209					
FEV1/FVC*										
(Constant)	1.040	0.029	-	36.501	0.000	0.803	0.645	5, 221	80.285	0.000†
Respiratory symptoms	-0.026	0.013	-0.101	-2.104	0.037					
Age	-0.006	0.005	-0.058	-1.222	0.223					
Job duration	-0.092	0.007	-0.682	-12.488	0.000					
Education	0.010	0.011	0.041	0.964	0.336					
Use of face mask	0.015	0.010	0.064	1.522	0.129					

Note: FVC % pred, percentage predicted of forced vital capacity; FEV1 % pred, percentage predicted of forced expiratory volume in one second; ANOVA, analysis of variance. * Dependent variables (Y): FVC % predicted: FEV1 % predicted; FEV1/FVC. † Predictors/ Independent variables: (constant), respiratory symptoms (v), age (w), job duration(x), education (y), use of face mask (z).

DISCUSSION

In the present study, the impaired pulmonary function and respiratory symptoms of wet-blue leather tannery workers were studied. The prevalence of respiratory symptoms recorded through questionnaire in the tannery workers and the control group was 27.8% and 21.4% respectively. The difference might be since the tannery workers were more likely to be exposed to many workplace hazards, including chemical, physical, and biological hazards from raw hides that might aggravate respiratory symptoms (Issever et al., 2007). Similar results were reported in Ethiopia (Dalju et al., 2019) where, prevalence rate among exposed tannery workers was 27.1% and 8.3% in unexposed control group. However, results are higher when compared with 16% (Issever et al., 2007) and 16.7% (Rastogi et al., 2008) investigated among tannery workers. The low prevalence rate could be due to better health of the workers, illness reporting approach and occupational conditions. Moreover, differences in prevalence

rate between tannery and non-tannery workers were also reported in Kenya (Were et al., 2014), Egypt (Afify et al., 2013) and India (Chandrasekaran et al., 2014).

In connection with the above, the present result showed a less prevalence of asthma among tannery workers as compared to other researches. A varying prevalence of asthma in workers was reported in different researches. In Istanbul, Turkey, asthma reported among tannery workers were 03% (Issever et al., 2007). In Kanpur, India; it was reported 05% (Thanikaivelan et al., 2004). In Karachi, Pakistan, asthma reported among tannery workers was 10% (Shahzad et al., 2006). However, in present research, bronchial asthma was reported by single tannery worker. The wide difference might be due to different diagnostic criteria, lifestyle, the status of the working environment, and genetic factors.

The tannery workers showed decreased values of pulmonary function parameters (except FEV1/FVC) than the control group. The plausible suggestions for these differences could be the workplace environmental hazards and unused protective equipment by the workers. While in control group such kind of exposure of the workplace was absent. Similar findings were reported among tannery workers in Vellore district, India (Chandrasekaran et al., 2014) and Karachi, Pakistan (Jamal et al., 2017). They concluded that lung function measurements were reduced among tannery workers as compared to the control group.

In tannery workers, impaired pulmonary function recorded as: restriction (13.20%), airflow obstruction (3.10%), and mixed pattern (18.10%) of respiratory abnormalities. However, obstructive pattern among workers was emphasized and frequently reported by other researchers as 14.70% (Rastogi et al., 2008), and 40.27 % (Issever et al., 2007). while in current research it was 3.1 % in tannery workers. The reason for this dissimilarity could be the safest environment in the workplace as well as the better health status of the workers. Similarly, the results of restriction and mixed patterns of the current research were in line with other published data (Chandrasekaran et al., 2014).

In tannery workers, First, age group had shown relationship with FEV1 percentage predicted (r = -0.169, P = 0.011), FVC percentage predicted (r = -0.278, P = 0.000), FEV1/FVC (r = -0.402 P = 0.000), and respiratory symptoms(r = -0.299, P = 0.000). Such statistical significance was also endorsed among tannery workers of Karachi (Jamal et al., 2017) where, age group of > 30 year was associated with respiratory symptoms OR 1.39 (95% CI: 0.33-5.89). Similar findings were corroborated by other researchers among tannery and non-tannery workers (Shahzad et al., 2006; Gao et al., 2018; Gholami et al., 2020). However, discrepancies in results are found when compared with the tannery workers of Ethiopia (age group >35 years OR 1) (Dalju et al., 2019) and Istanbul (P = 0.28) (Ozdilli et al., 2007). It is evident from other researches that the respiratory symptoms increase as the age increases. The performance of the lungs declines with the age factor due to weak muscle strength. Consequently, the lungs become vulnerable to respiratory diseases (Sharma and Goodwin, 2006; Gray et al., 2013).

Second, in the current study education was found to have association with FEV1 percentage predicted (r = 0.330, P = 0.000), FVC percentage predicted (r = 0.167, P = 0.012), FEV1/FVC (r = 0.262, P = 0.000) and respiratory symptoms (r = -0.300, P = 0.000). Similar results were reported among tannery workers of Karachi (Shahzad et al., 2006) where illiterate tannery workers were more likely to have asthma than literate AOR 2.13 (95% CI: 1.17-3.88).

Third, job duration had an association with pulmonary function parameters and respiratory symptoms at the (P = 0.000) significance level. The increased job duration enhances the exposure level at the workplace; ultimately making the lungs prone to impairment. Likewise, the prevalence of respiratory and lung diseases in tannery workers of Karachi (Jamal et al., 2017) reported that job duration of > 4 years is statistically significant with all respiratory symptoms OR 2.89 (95% CI: 0.58-14.30), hence endorse the current results. Such relationship was also proved from other researchers at the same and different workplaces (Issever et al., 2007; Chandrasekaran et al., 2014; Tageldin et al., 2017; Dalju et al., 2019; Yasmeen et al., 2020).

Fourth, the use of face mask was associated with FEV1 percentage predicted (r = 0.227, P = 0.001), FEV1/FVC (r = 0.246, P = 0.000), and respiratory symptoms

(r = -0.155, *P* = 0.019). Different results were reported in different researches. Few results are in line with present research (Offeddua et al., 2016; Dalju et al., 2019). While others reported that there was no association between the use of face mask and respiratory symptoms (Jamal et al., 2017). The contradictory results could be linked with the fact that quality of the face mask is an effective barrier to airborne infections (Sim et al., 2014).

Lastly, BMI, marital status, smoking and ethnicity did not show a significant correlation with respiratory symptoms and pulmonary function parameters. The reasons might be due to ethnic differences that affect the pulmonary functions (Hanizdo et al., 2000; Yap et al., 2001; Fulambarkar et al., 2004; Perez-Padilla et al., 2006). Moreover, variations in age, race and geographical regions may lead possible variations in relationship between BMI and pulmonary functions (Wang et al., 2017). Many researches are in line with our findings. BMI was not associated significantly with the pulmonary function parameters, reported among workers of Iran (Gholami et al., 2020). A study conducted in Istanbul reported that smoking status was not statistically significant for all respiratory symptoms among tannery workers (Issever et al., 2007; Ozdilli et al., 2007).

Furthermore, a multiple linear regression model revealed that respiratory symptoms and duration of job were statistical significant throughout the model for FVC percentage predicted, FEV1 percentage predicted and FEV1/FVC. These results are in partial agreement with the findings (Yasmeen et al., 2020) where, respiratory symptoms after controlling other independent variables, remained significant at the level of 0.000 for FVC percentage predicted and FEV1/FVC. Similar findings in Iran (Gholami et al., 2020) were reported that after controlling smoking, BMI and dust exposure; age and job duration remained statistically significant for both FVC and FEV1/FVC, throughout the linear multiple regression model.

CONCLUSION

In conclusion, the current study suggests that age, education along with the exposure at the workplace may cause increase in impaired pulmonary function, and respiratory symptoms among tannery workers as compared to the control group. To prevent pulmonary function impairments, the periodic medical examinations of the workers, including pulmonary function tests are recommended. Such kind of screening will be helpful in early recognizing respiratory obstructions and consequently the removal of sensitive workers from the workplace before developing chronic respiratory obstruction. We should carry out further research among tannery workers with a large population size from copious tanneries for better understanding related to respiratory-related health problems of the workers.

LIMITATIONS OF THE STUDY

Following limitations may lead to bias results. First, results obtained from the respiratory questionnaire were based on participants' self-reports. Second, samples were collected from fewer numbers of tanneries and non-response occurred, which may lead to bias. Third, sex influences the pulmonary functions, but female population is missing in current study. Finally, age and educational status is not match-controlled between tannery workers and control group, hence statistical power may reduce.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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