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An Investigation of Respiratory Symptoms and Spirometry Parameters of Welders in a Steel Industry

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Abstract

Background: Fumes released form welding activities are capable of initiating several acute and chronic respiratory effects.
Objectives: The aim of the present study was to evaluate respiratory symptoms and spirometry parameters in welders of a steel industry.
Methods: This cross-sectional study was conducted in a steel industry and involved 60 welders and 40 non-welders. A questionnaire was used to record participants' details, and to determine pulmonary function values the spirometric test was used. Pearson correlation, paired and independent t test as statistic tests were used for data analysis.
Results: Comparison between pulmonary function values (PFV) showed a significant relationship between forced vital capacity (FVC), forced expiratory volume in one second (FEV_1) and 25% - 75% forced expiratory flow ($FEF_{25-75\%}$) of the two groups. These values in the welder group had a significant reduction and declines were from 6 to 11 mL. Age and work experience showed a significant correlation with PFV in the two groups.
Conclusions: All workers that participated in this study were relatively young and considering them being young and not having long history of work experience, our results revealed that welders had less respiratory capacity and this was related to increasing work experience and age, but inconsistent with smoking habits of the two groups.

Keywords: Welding Workers, Steel Industry, Respiratory Symptoms, Pulmonary Function Test

1. Background

Laborers, who work in welding procedures are generally exposed to air pollutants such as carbon monoxide, ozone, fumes and so on, which are emitted during the welding process and are major risk factors for the respiratory system. Work-related respiratory diseases have been well documented for welders in many studies (1-7). Air pollutants released from welding activities are capable of initiating several acute and chronic respiratory effects. Examples of acute respiratory symptoms are bronchial obstruction, airway irritation, metal fume fever, occupational asthma and hypersensitivity pneumonitis (8, 9). Chronic respiratory disorders that are known as the main risk factor for welders include pneumoconiosis, chronic bronchitis and lung cancer (8). Studies have demonstrated acute respiratory symptoms in welders although some controversial results have been reported specially in case of changes in lung function (10, 11). Similarly, several studies have documented chronic respiratory disorders in welders yet with some contrary results (12, 13). Cross-sectional studies have mentioned combined effects of welding fumes on lung function of welders (14). Fishwick et al. reported an acute decrease in forced expiratory volume in one second (FEV_1) relative to work experience, which was more prevalent among welders in comparison to non-welders (15). Results of a study by Chinn et al. showed an immutable effect for welding on FEV_1 and forced vital capacity (FVC) in a seven-year follow up study of welders, caulker and burners. Also their results showed an interaction between the effects of welding fumes and smoking habits (16). In another study by Beckett et al. no effects of welding fumes on the annual decline of lung function in a three-year follow up study were observed (17). Erkinjuntti-Pekkanen et al. did not find any differences between welder and non-welder groups in case of pulmonary function variables in a two-year follow-up study. Also their results revealed that

smoker welders, who used to work without respiratory protection or local exhaust ventilation system, have an increased risk of accelerated decline in FEV_1 (18). In a study by Meshkinian et al., a significant correlation between exposure to welding fumes and lung disorders was observed (19).

2. Objectives

The purpose of the present survey was to evaluated respiratory symptoms and spirometry parameters in welders in a steel industry in Ahvaz, during year 2015.

3. Methods

This cross-sectional study was performed during year 2015 involving 60 male welders and 40 male non-welders (office workers, drivers and site workers) working at the national steel industrial group company of Ahvaz, Iran. In order to reduce between-group differences, the participating workers were similarly selected in terms of age, work experience and smoking habit. Exclusion criteria in this study were asthma, chronic and acute respiratory symptoms. A questionnaire was used to record participants' details that included demographic data, smoking habit, recent surgery, cardiovascular disease, phlegm, wheeze, recent cough, recent flu, chest tightness, shortness of breath and respiratory protection devices use (2). To determine pulmonary function, all participants were asked to perform lung function tests with a calibrated portable spirometer (Pony FX, MEDOROUX England). Spirometry tests were taken before the work shift started and the workers were not exposed to welding fume on the day of the study. Several test values were measured including forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), FEV_1/FVC ratio and 25% - 75% forced expiratory flow ($FEF_{25-75\%}$). The highest flow rate of the three consequent forced expiratory maneuvers in the standing position was accepted. Before starting the spirometry test for each person, data including age, weight, race, gender and height was recorded in the spirometer data base and results after calculation of predicted values by means of reference equations in the machine were reported. Abnormal ventilatory function was classified based on the proportion that the measured percentage values constituted of those predicted (20). All analyses were performed by the SPSS version 22 software for windows (IBM - SPSS Inc., 1989 - 2013). Descriptive and analytical (Pearson correlation, paired and independent t- test,) statistics were used for the data analysis. Significance was taken at the 5% significance level ($P < 0.05$).

4. Results

Of the 154 male participants (100 welders and 54 non-welders), who were invited to participate in this study, only 100 were eligible to be included in the study. The candidates participated voluntarily after being given essential information about the study aim and scope and were free to leave the study whenever they wanted. Table 1 represents demographic details and smoking habits of 100 workers, who took part in this study.

Performing independent sample t-test for pulmonary function values showed a significant relationship between FVC, FEV_1 and $FEF_{25-75\%}$ of the two groups (welders and non-welders). All these parameters in the welder group had a significant reduction. Only FEV_1/FVC ratio between the two groups showed a difference (Table 2). As presented in Table 3, after comparing welders who were smokers and non-welders who were smokers, no significant difference regarding pulmonary function values was observed. However, in the case of welders and non–welders who were non-smokers, significant results were obtained regarding FEV_1 value and $FEF_{25-75\%}$. By compering smokers and non-smokers in welders' group, all pulmonary function values except $FEF_{25-75\%}$ showed a significant relationship. Similarly, regarding the smokers and non-smokers of the non-welders' group a significant relationship was observed between all variables. Table 4 represents respiratory symptoms in workers (welders' versus non-welders and smokers' vs. non-smokers). In welders the most prevalent symptoms were phlegm and persistent cough with 68.3% and 56.7% prevalence, respectively. In non-welders, the most reported symptoms were rhinorrhea and persistent cough with 35% and 25%, respectively. Similarly, in the smokers group, the most prevalent symptoms were phlegm and persistent cough with 47.3% and 39.4% prevalence, respectively. Finally for the non-smokers group, the most observed symptoms were persistent cough and rhinorrhea with 46.7% and 45.1% prevalence, respectively. To determine the relationship between age and work experience with pulmonary function values, Pearson correlation test was used, the results of which for the welders group showed a significant relationship in the all variables ($P < 0.05$). However, in non-welders group a significant relationship was only observed between age and spirometry values, while there was no significant relationship between work experience and lung variables.

5. Discussion

The results of this study revealed that pulmonary function values had a decline in welders' group in comparison

Table 1. Demographic Details of the Participants

	Number	Age, y	Job Experience, y	Smoking Habits, No. (%)	
		Mean (SD)	Mean (SD)	Smoker	Non-Smoker
Welder	60	36.1 (2.5)	10.87 (2.4)	23 (38.4)	37 (61.6)
Non-welder	40	32 (1.9)	8.33 (2.2)	15 (37.5)	25 (62.5)

Table 2. Comparison Between Pulmonary Function Values in Welders and Non-Welders

Pulmonary Function Values in mL	Welders, n = 60, Mean (SD)	Non-Welders, n = 40, Mean (SD)	P Value
FVC	85.7 (8.7)	91.3 (14.4)	0.018[a]
FEV_1	82.6 (9.9)	91.5 (13.5)	0.000[a]
FEV_1/FVC	98.1 (7.5)	98. 8 (10.7)	0.71
$FEF_{25-75\%}$	82.9 (17.1)	90.9 (17.8)	0.026[a]

[a] P value < 0.05 is considered significant.

Table 3. Comparison Between Smokers and Non-Smokers With Respect to Relevant Pulmonary Values

Pulmonary Function Values, mL					P Value[a]			
	Welders, Mean (SD)		Non-welders, Mean (SD)		Between Groups		Within Groups	
	Smoker, n = 23	Non-Smoker, n = 37	Smoker, n = 15	Non-Smoker, n = 25	Smokers	Non-Smokers	Welder	Non-Welder
FVC	80.5 (8.5)	89 (7.2)	84 (16.9)	91.7 (14.4)	0.61	0.3	0.000	0.001
FEV1	79.3 (7.7)	84.7 (10.7)	86.5 (10.6)	91.7 (13.7)	0.23	0.01	0.04	0.043
FEV1/FVC	101.4 (7.3)	96.1(7)	105.5 (7.7)	98.5 (10.8)	0.46	0.26	0.007	0.023
$FEF_{25-75\%}$	85.7 (17.7)	81.2 (16.8)	100.5 (16.2)	90.4 (17.9)	0.26	0.02	0.33	0.003

[a] P values of less than 0.05 were considered significant; for P Value between groups, data of welder and non-welder groups had been compared, regarding the smoker/non-smoker criteria; for P Value within groups, data of smoker and non-smoker groups had been compared, regarding the welder/non-welder criteria.

Table 4. Respiratory Symptoms in Workers

	Welders, n = 60, No. (%)	Non- welders, n = 40, No. (%)	Smokers, n = 38, No. (%)	Non- Smokers, n = 62, No. (%)
Persistent cough	34 (56.7)	10 (25)	15 (39.4)	29 (46.7)
Phlegm	41 (68.3)	4 (10)	18 (47.3)	27 (43.5)
Wheezing	33 (55)	6 (15)	15 (39.4)	24 (38.7)
whistle	30 (50)	4 (10)	9 (23.6)	25 (40.3)
Shortness of breath	30 (50)	4 (10)	7 (18.4)	27 (43.5)
Cough with phlegm	21 (35)	8 (20)	7 (18.4)	22 (35.4)
Chest tightness	29 (48.3)	3 (7.5)	11 (28.9)	21 (33.8)
Rhinorrhea	20 (33.3)	14 (35)	6 (15.7)	28 (45.1)

to non-welders' group (6 to 11 mL). Similar findings were reported by many studies, which reviewed these factors with several types of study designs such as longitudinal, case-control and cross sectional design (6, 7, 18). Also some studies reported contrary results (16, 21). This difference in results may be caused by the study setting, and the fact that

respiratory diseases generally have multifactor variables. Our results did not show any association between smoking habits and pulmonary function values among welders' versus non-welders. Similar findings were reported by Erhabor et al. (22). However, many studies documented different results (2, 18, 23), which may be because the age of the participants of this study was less than other studies; welders and non-welders were quite younger in the present research (under 40 years old). Welders and non-welders age range was 33 to 38 and 30 to 34 year, respectively. As age and work experience increased in welders group, lung function values were depressed. According to this finding, several studies claimed the same outcomes (3, 16, 24). Several studies mentioned that welding could cause respiratory morbidity such as asthma (25). Exposure to fumes released during the welding process can be the cause of respiratory morbidity. In this study, the prevalence of welding-related respiratory morbidity indicative of asthma, defined as the presence of symptoms of persistent cough, wheezing, phlegm and chest tightness, was high (18.4%). Our findings were supported by several studies (2, 3, 18). Our results revealed that respiratory symptoms amongst the welders' group were much more than in the non-welders group and phlegm, wheezing and cough symptoms were more common symptoms (5, 6, 23). In other studies by El-Zein et al., dry cough, shortness of breath, metallic taste and wheezing were common complaints among welders during the first days of the working week (3).

5.1. Conclusion

Our investigation revealed that respiratory symptoms are more prevalent among welders' versus non-welders and this was related to increasing work experience and age yet inconsistent with smoking habits in the two groups. Although the participants were quite young, yet respiratory symptoms were still observed.

The authors suggest similar studies with measurement of fumes concentration that are released from the welding process in the air of the breathing zone. Also, other performed studies are required to determine efficiency of respiratory protection devices (full mask) used by welders and local ventilation systems in welding work places. These findings will be of use for improvement of workplace regulations, screening criteria and worker training material in the industry.

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