SHORT COMMUNICATION

Respiratory and physical ailments correlated with occupational exposure among welders in Pakistan

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Abstract

Disruption of normal respiratory function is associated with occupational disorders. Exposure to welding fumes on long term basis affects the lung function of the workers and prompts allergic responses. Therefore, the aim of the study was to manifest the association of exposure to welding fumes and respiratory complications with reference to the undermining of normal lung function and respiratory symptoms. A cross sectional study was conducted in different areas of Lahore in 2016. A comparison was made among welders on the basis of lung function and other physical ailments. Questionnaire survey was performed along with the computation of lung function by using spirometer. Data was statistically analyzed by using analysis of variance (ANOVA). The study confirmed a statistically highly significant decline in FVC, FEV1, FEF 25-75%, PEFR and FEV1/FVC ratio among different types of welders. The current study expressed that occupational exposure to welding fumes can considerably distress the lung function. The application of preventive measures is required to solve the health related questions for welders.

Keywords: Lung function, Gas tungsten arc, Oxy-fuel, Shielded metal arc, Skin burns.

Introduction

Welding is connected with respiratory indications and utilitarian unsettling influences, i.e., failure to inspire deeply and exhalation disablement (airway obstruction). Welders most commonly have respiratory disability and chronic bronchitis.[1] The genuine and impending danger of welding relates to numerous variables like type of welding performed, material of anode material to be welded, presence of metal coatings, current and voltage utilized and quality of ventilation.[2] The most common types of welding are shielded-manual metal arc (MMA), gas metal arc (GMA), flux-cored arc (FCA), gas tungsten arc, and submerged arc welding.[3] Metal fume fever, siderosis, lobar pneumonia, lung disease and asthma are all reported as negative results of welding.[4] The most repeated manifestations found among welders was obstructive lung disease when compared with controls.[5] Respiratory symptoms and functional disturbances are found to be associated with welding.[1] Poisonous gases and fume particles created in the welding process enter the respiratory tract.[6] Occupational health risks related to electric arc welding includes electrocution, fire accidents, burns, musculoskeletal problems, cut and injuries.[7] Welders are part of a heterogeneous workforce employed in a variety of workplace settings; these may include well-ventilated indoor and open-air sites or confined poorly ventilated spaces (e.g., ship hulls, pipelines, building crawl spaces). Because of this, a wide range of exposure concentrations have been measured in workplaces where welding occurs.[8] The objectives of this study were to assess the risk of health hazards on human subjects during their occupational exposure to welding fumes and gases and suggestions to minimize the adverse effects by adopting remedial measures.

Methods and Results

The current descriptive analytical study was outlined as a cross sectional study in order to compare the COPD (chronic obstructive pulmonary disease) and other respiratory ailments in welders associated with three different types of welding i.e. Gas tungsten arc welding (GTAW), Shielded metal arc welding (SMAW) and Oxy-fuel welding (OFW). The duration of the research study was 6 months i.e., from January to August 2016. The monitoring locations were spotted by random sampling from different areas of Lahore particularly known as main points of such type of work i.e. Badami Bagh, Misri Shah & Shahdara. There were 120 subjects on the sampling frame who took part in this study including experimental subjects (n=90) as well as control subjects (n=30). Full-time employees having minimum experience of 5 years at the same place were included. Part-time workers, smokers and those having previous medical history were excluded. A walk through survey of various welding shops in the vicinity of Lahore was

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Table-1: Demographic characteristics of OFW, SMAW, GTAW and Controls.

Demographics	Controls Mean±SD n=30	OFW Mean±SD n=30	SMAW Mean±SD n=30	GTAW Mean±SD n=30
Mean Age (years)	32.15±8.25	33.13±11.13	31.83±12.72	31.63±8.43
Mean Height (m)	1.668±0.0343	1.7023±0.0607	1.688±0.0627	1.6967±0.0479
Mean Weight (kg)	77.25±6.03	72.13±11.88	70.93±12.88	75.27±12.53
Mean BMI (kg/m^2)	27.797±2.391	25.001±4.551	23.443±4.408	26.226±4.722
Years in current Employment (Mean)	-	13.52±11.27	11.87±8.66	14.83±10.58
Exposure status (Hours per day) (Mean)	-	9.267±2.625	9.733±1.780	8.800±1.710

OFW= Oxy-fuel welding, SMAW= Shielded metal arc welding, GTAW= Gas tungsten arc welding.

Table-2: Observed Lung function parameters of Experimental and Control groups.

Parameters	Controls Mean±SD	OFW Mean±SD	SMAW Mean±SD	GTAW Mean±SD	ANOVA Group wise Comparison
FVC (L)	2.299±0.804	1.507±0.304	1.487± 0.251	1.467±0.212	***
FEV1 (L)	2.017±0.723	0.736±0.152	0.673±0.231	0.735±0.153	***
FEV1/FVC	0.8825±0.066	0.499±0.1056	0.486±0.0719	0.5001±0.078	***
PEF (L/S)	2.186±0.635	2.458±1.079	2.837±0.926	2.291±0.764	***
FEF 25 (L/S)	3.707±0.2001	3.601±1.102	3.677±0.882	2.996±1.170	*
FEF 75 (L/S)	3.778±0.1417	3.339±1.308	3.511±0.904	2.844±1.679	*
FEF 25-75 (L/S)	3.85±0.1013	3.946±1.369	3.832±0.946	3.502±1.418	X

*=p<0.05 (Significant difference), **=p<0.01 (More Significant difference), ***=p<0.001 (Highly Significant difference), X=Insignificant difference of mean value.
OFW: Oxy-fuel welding. SMAW: Shielded metal arc welding. GTAW: Gas tungsten arc welding. FVC: Force Vital Limit. FEV1: Force Expiratory Volume in First Second. PEF: Peak Expiratory Flow. FEF: Force Expiratory Flow.

arranged inclusive of the observations on the types of welding, examination of various areas of welding, the working states of the welders and their work related environment. Control group comprised of those participants who did not have any experience/exposure with welding in their working life and of same age as experimental group. The structured questionnaire was developed according to American Thoracic Society (ATS) criteria by keeping in view the demographic data (age, height, weight, BMI, respiratory illnesses etc) as well as occupational status (exposed status, employment duration in job etc) and the socio-economic status among different study groups. Body Mass Index was calculated by using the formula: BMI = Weight in Kg / [Height in m].[2] The study groups were categorized into two age groups i.e. 16-32 and 32-49. The subjects with previous chronic ailments like cardiovascular, kidney, liver and severe respiratory illnesses were excluded.

Pulmonary function test (PFT) was conducted at various welding shops using a MDX USA Spirometer and as expressed by the American Thoracic Society's technique.[9] The measurement of pulmonary function related parameters including Force Vital limit (FVC), Force Expiratory Volume in First Second (FEV1), FEV1/FVC, Peak Expiratory Flow (PEF), Force Expiratory Flow at 25%, Force Expiratory Flow at 75% and Force Expiratory Flow at 25-75% was done.

The figures amongst the pulmonary function test data of experimental and control groups were accounted as the Means and Standard Deviations. The statistical differences among the groups were analyzed by one-way analysis of variance (ANOVA single element). Results with statistical differences at a significance level of $p < 0.05$ were considered. Furthermore, Correlation was applied and related analysis was utilized to evaluate relationship of the consistent variables in the study population.

The frequency of demographic features of study subjects is specified in Table-1. The mean age in case of Oxy-fuel welders, Shielded metal arc welders, Gas Tungsten arc welders and controls was 33.13±11.13, 31.83±12.72, 31.63±8.43 and 32.15±8.25 years respectively.

Comparison of occupational asthma between the three welding units as GTAW, OFW and SMAW was made with

Table-3: Lung Function Parameters with respect to age in Experimental groups.

Type of Welders	Respiratory Function Parameters	Age Groups (Years) 16-32	33-49
OFW	FVC	1.476±0.3306	1.5258±0.2873
	FEV1	0.762±0.1617	0.7375±0.15
	FEV1/FVC	0.5324±0.1226	0.4866±0.667
	PEF	2.124±0.946	2.058±0.841
SMAW	FVC	1.4816±0.2435	1.5589±0.2589
	FEV1	0.6763±0.2665	0.7078±0.1516
	FEV1/FVC	0.5108±0.0667	0.4529±0.0647
	PEF	2.849±1.024	2.878±0.828
GTAW	FVC	1.4559±0.2237	1.5091±0.2037
	FEV1	0.7512±0.1613	0.7055±0.544
	FEV1/FVC	0.5153±0.0811	0.4642±0.0648
	PEF	2.187±0.767	2.5849±0.772

OFW= Oxy-fuel welding, SMAW= Shielded metal arc welding, GTAW= Gas tungsten arc welding.

controls. The observations of the symptoms related to lung impairment were concluded. Oxy-fuel welders were discerned accompanied by 37% with phlegm production, 47% with shortness of breath and 10% with chest illness, 40% with wheezing and 27% experienced whistling sound of chest. In case of Shielded metal arc welding, 44% had phlegm production, 80% had shortness of breath and 17% had chest illness, 27% had wheezing and 47% experienced whistling sound of chest; whereas in case of Gas tungsten arc welding, 14% had phlegm production, 24% had shortness of breath and 24% had chest illness, 37% had wheezing and 10% experienced whistling sound of chest.

The frequency of lung function parameters of study subjects is shown in Table-2. The lung function parameters show a decrease with age in uncovered gatherings when contrasted with controls. The mean estimations of FVC, FEV1, FEV1/FVC and PEF were typically lesser in the uncovered gathering. Table-3 demonstrates the lung function parameters with respect to age.

In case of SMAW, GTAW and OFW, the percentages of eye burns were found to be 67, 55 and 40 respectively whereas in case of skin burns, the percentages were 41, 33 and 45 in SMAW, GTAW and OFW respectively. Personal Protective Equipments play an important role in protecting the workers from exposure to chemicals, hot surfaces and noise. The current study revealed the percent usage of PPEs in different types of welding units. In case of SMAW, GTAW and OFW the percent usage of PPEs were found to be 51, 53 and 55 respectively.

Discussion

The decline in FEV1, FVC and PEF is correlated with the manual metal arc welding process significantly in contrast to metal inert gas techniques.[10] An obstructive interpretation is predominantly recommended. The fumes of welding hold various components with the laboratory evidence of being air irritants.[11] The predominant type of welding is Shielded metal arc welding in which the workers remain exposed for a long duration. The decline in lung functioning leads to the obstruction in the airways. These outcomes were outlined in the study on welders.[12] An elevation in the occurrence of respiratory symptoms among welders was significantly found in a cross-sectional study aiming to differentiate the rates of respiratory symptoms and asthma as well as chronic obstructive pulmonary disease as diagnosed by the medical personnel in welders and painters.[13]

Conclusion

The results of the current study highlighted the significant decline in Pulmonary Lung Function and definite outcomes related to physiological impairment of the SMAW workers as compared to the GTAW and OFW, because it is being used widely in Pakistan. The reason for such a decline is due to the fact that welding process emits harmful fumes and gases. Longer exposure to such welding gases and fumes causes the lungs impairment. For the prevention of such impairments in welders, it is highly recommended to have a thorough medical observation earlier as well as during employment. The welders must be acquainted with the hazards associated with welding as well as the importance of protective equipments to prevent lungs damage.

Ethical Consideration

The research work was conducted after the ethical approval from the department of Environmental Science, Lahore College for Women University, Lahore, Pakistan.

Acknowledgement

The authors are thankful to the Chairperson, Department of Environmental Science for administrative support during the study and staff of lab of the department.

Conflict of Interest: There is no conflict of interest among the authors.

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