Arab Journal of Sciences & Research publishing
Issue (2), Volume (1)
September 2015
ISSN: 2518 - 5780

المجلة العربية للعلوم و نشر الأبحاث
Arab Journal of Sciences & Research Publishing
AJSRP

# Prevalence of Respiratory Symptoms Among Welders in Steel and Air Conditioning Plant (DAMMAM City)

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**Abstract: Aims:** To determine the prevalence of welding related respiratory symptoms. **Methods:** Cross-sectional study with convenience sampling. The study was conducted among welding workers in air conditioning plant and steel plant in 2014, occupational history questionnaire and respiratory symptoms questionnaire were administered by person-to-person to 110 welders from two plants in DAMMAM city, Saudi Arabia. **Results:** this study involved 110 welders from two plants, 38 welders from AC plants and 72 welders from steel plants. All welders are male and welding type in AC plant are oxyacetylene welding (oxyacetylene welding (OAW)) and the welding type in steel plant are arc welding. 21 (19.1%) welders from AC plant reported shortness of breath compared to 26 (23.6%) welders from steel plant ($X^2$ =2.62, P value =0.03). 16 (42.1%) of welders in AC plant reported cough compared to 24 (33.3%) of welders in steel plant ($X^2$ =1.83, P value = 0.03). 20 (52.6%) of welders in AC plant reported phlegm compared to 27 (37.5%) of welders in steel plant ($X^2$ =2.33, P value=0.02). 40 (36.4%) of welders reported cough ($X^2$ =2.33, P value = 0.04). 47 (42.7%) of welders reported phlegm ($X^2$ =3.07, P value = 0.02). There is no significant associations was founded between (marital status and education level) and respiratory symptoms. Significant association was founded between duration of employment and respiratory symptoms (wheeze (p value=0.03), cough (p value= 0.04), phlegm (p value=0.01). Binary logistic regression was significantly associated between shortness of breath and type of plant (p value=0.01). **Conclusion:** high prevalence of respiratory symptoms related to type of plant, age of welders and duration of employment. Welders should understand the hazards of the materials they are working with. General ventilation, local exhaust ventilation systems, personal protective equipment are recommended.

## Introduction

Welding is an indispensable trade in modern society and has developed rapidly since 1940.[1] Welding is the process of joining metal components by melting the work piece by means of heat or pressure, or both, and adding filler material to form a strong joint.[2] The most common types of welding technology are oxyacetylene welding and arc welding.The oxyacetylene welding use fuel gases and oxygen to weld metals.[3] The arc welding use high heat from an electric arc to melt and fuse the metal at the joint between the two parts.[4]

All welding processes produce fumes and gases. The degree of risk to welder's health from fumes and gases depends on composition, concentration, and the length of exposure. [5] Occupational exposure to

welding fumes and gases is a serious occupational health problem all over the world. It is estimated that 1 million workers worldwide perform some type of welding. [6] Welding of metals may cause substantial exposure to fume particulates and gases. [7] The welding fume generated during the welding process possesses at least 13 metals, including manganese (Mn), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), molybdenum (Mo), nickel (Ni), zinc (Zn), antimony (Sb), and vanadium (V).[8]

The respiratory symptoms due to exposure to welding fumes and gases rang from breathlessness, wheezing, cough, phlegm.[9]

There are several cross-sectional studies on welders reporting respiratory symptoms.[10] Also many researchers have evaluated the effects of welding fumes and gases on respiratory symptoms of welders, but there is disagreement among these studies.[11] The majority of

differences between findings in various studies are frequently due to bias. the most important bias are smoking status of study subjects, history of employment in years and day-time exposure in hours per day, type of welding processes, and usage of protective measures[12]

The objectives of this study were to determine the prevalence of welding related respiratory symptoms and to determine which plants (AC or steel plants) is more worse on respiratory system.

## Methods

The largest Air conditioning plant and steel plant in DAMMAM city was selected for the study. A cross-sectional study with convenience sampling was conducted among welding workers in air conditioning plant and steel plant in 2014 (there is only 38 welders in air conditioning plant and only 72 welders in steel plant). The type of welding in air conditioning plant is oxy acetylene welding and the type of welding in steel plant is arc welding.

The management office of both plants was officially contacted, and their cooperation sought. Verbal consent was obtained from all welders after the aim of the study was explained to them (no need for written consent). All welders were informed that they have right to withdraw from the study at any time without any consequences and assured all data will be confidentiality coded.

The respiratory questionnaire was derived from the standardized questionnaire of the International Union against Tuberculosis and Lung Disease (see attachment).[4] And its divided in two sections; The Socio-demographic characteristics questions section and Respiratory symptoms questions section.

The socio-demographic characteristics questions section include questions on age, marital status, education level, age of worker when he start welding, type of welding and how many years in welding job.

The Respiratory questions section include question on breathlessness, wheezing, cough, phlegm chest illness, past medical illnesses and questions on smoking habits.

**Statistical analysis**

Data were checked and entered into a personal computer using Statistical Package for Social Science (SPSS) version 20.0, Descriptive study, Frequency and distributions were generated for welding related respiratory symptoms. Chi-square ( $\chi^2$ ) analysis was used to test the association between respiratory symptoms and independent variables. Binary logistic regression analysis were used to estimate odds ratios (OR ) with 95% confidence intervals (CIs) for welding characteristics and respiratory symptoms. *P value* < 0.05 was considered as statistically significant.

## Results

Data were obtained for 110 participants, the majority 72 (65.5%) are welders from steel plant and 38 (34.5%) from air conditioner plant (all participants are male – no women in SAUDI ARABIA work in welding field). The age of participants between 21 and 60 years of age. 48 (43.6 %) between 21-30 years of age, 34 (30.9 %) between 31-40 years of age, 28 (25.8%) more than 40 years of age. 78 (70.9 %) of welders are married, 32 (29.1%) are single. 23 (20.9 %) of welders are completed elementary school, 79 (71.8%) are completed secondary school and only 8 (7.3%) of welders are completed university. The age at which welders had started their welding job ranged from 16 to 50 years, 67 (60.9%) of welders do welding job between 1 to 10 years in duration, 31 (28.2%) of welders do welding job between 11 to 20 years and only 12 (10.9%) do welding job more than 30 years. 34 (30.9%) of welders smoke cigarettes, 76 (69.1%) of welders are non-smoker. (see table 1)

**Table 1: Socio-demographic and smoking characteristics (n=110):**

| No. of subject (%) n=110 | |
|---|---|
| **Type of plants** | |
| Air conditioning **plant** | 38 (34.5%) |
| **STEEL** | 72 (65.5%) |
| **Age** | |
| **21-30** | 48 (43.6%) |
| **31-40** | 34 (30.9%) |
| **>40** | 28 (25.8%) |

| No. of subject (%) n=110 | |
|---|---|
| **Marital Status** | |
| **Single** | 32 (29.1%) |
| **Married** | 78 (70.9%) |
| **Education level** | |
| **Elementary or less** | 23 (20.9%) |
| **secondary** | 79 (71.8%) |
| **University** | 8 (7.3%) |
| **Type of welding** | |
| **Oxyacetylene welding** | 38 (34.5%) |
| **Arc welding** | 72 (65.5%) |
| **Duration of employment (years)** | |
| **1-10** | 67 (60.9%) |
| **11-20** | 31 (28.2%) |
| **>20** | 12 (10.9%) |
| **Cigarettes smoking** | |
| **YES** | 34 (30.9%) |
| **NO** | 76 (69.1%) |

Table 2 display Distribution of respiratory symptoms in study population by type of plants. 21 (19.1%) of welders in AC plant and 26 (23.6%) of welders in steel plant complain from shortness of breath, A significant association was found between shortness of breath and plant type ($X^2$ =3.73 , P value =0.03). 16 (42.1%) of welders in AC plant and 24 (33.3%) of welders in steel plant complain from wheeze, Significant association was found between cough and plant type ($X^2$ =0.83 , P value =0.03). 20 (52.6%) of welders in AC plant and 27 (37.5%)of welders in steel plant complain from phlegm and a significant association between phlegm and plant type was founded ($X^2$ =2.33 ,P value = 0.02).

**Table 2 display Distribution of respiratory symptoms in study population by type of plants:**

| Symptoms | AC | steel | Total | Chi2 | P value |
|---|---|---|---|---|---|
| **Shortness of breath** | 21 (19.1%) | 26 (23.6%) | 47 (42.7%) | 2.62 | 0.03 |
| **Wheeze** | 9 (23.7%) | 26 (36.1) | 35 (31.8%) | 1.78 | 0.18 |
| **Cough** | 16 (42.1%) | 24 (33.3%) | 40 (36.4%) | 1.83 | 0.03 |
| **Phlegm** | 20 (52.6%) | 27 (37.5%) | 47 (42.7%) | 2.33 | 0.02 |

Table 3 display Distribution of respiratory symptoms in study population by age. There is significant association between age and respiratory symptoms (cough and phlegm) (P value 0.04 and 0.02 respectively).

**Table 3. Distribution of respiratory symptoms in study population by age:**

| Symptoms | Age | | | Total | Chi2 | P-value |
|---|---|---|---|---|---|---|
| | 21-30 | 31-40 | >40 | | | |
| **Shortness of breath** | 23 (20.9%) | 11 (10%) | 13 (11.8%) | 47 (42.7%) | 2.18 | 0.31 |
| **Wheeze** | 13 (11.8%) | 10 (9.1%) | 12 (10.9%) | 35 (31.8%) | 2.16 | 0.34 |
| **Cough** | 16 (14.5%) | 12 (10.9%) | 12 (10.9%) | 40 (36.4%) | 2.33 | 0.04 |
| **Phlegm** | 16 (14.5%) | 17 (15.5%) | 14 (12.7%) | 47 (42.7%) | 3.07 | 0.02 |

Table 4 display Distribution of respiratory symptoms in study population by marital status. There is no significant association between marital status and respiratory symptoms.

**Table 4. Distribution of respiratory symptoms in study population by marital status:**

| Symptoms | Marital status | | Total | Chi2 | P-value |
|---|---|---|---|---|---|
| | Single | Married | | | |
| **Shortness of breath** | 16 (14.5%) | 31 (28.2%) | 47 (42.7%) | 0.97 | 0.32 |
| **Wheeze** | 13 (11.8%)) | 10 (9.1%) | 12 (10.9%) | 0.23 | 0.63 |
| **Cough** | 2 (1.8%) | 8 (7.3%)) | 10 (9.1%) | 0.44 | 0.51 |
| **Phlegm** | 12 (10.9%) | 28 (25.5%) | 40 (36.4%) | 0.03 | 0.87 |

Table 5 display Distribution of respiratory symptoms in study population by education level. There is no significant association between education level and respiratory symptoms.

**Table 5. Distribution of respiratory symptoms in study population by education level:**

| Symptoms | Education level | | | Total | Chi2 | P-value |
|---|---|---|---|---|---|---|
| | Elementary or less | Secondary | University | | | |
| **Shortness of breath** | 16 (14.5%) | 35 (31.8%) | 2 (1.8%) | 47 (42.7%) | 1.11 | 0.57 |
| **Wheeze** | 7 (6.4%) | 13 (11.8%) | 1 (0.9%) | 21 (19.1%) | 2.49 | 0.29 |
| **Cough** | 3 (2.7%) | 6 (5.5%) | 1 (0.9%)) | 10 (9.1%) | 0.76 | 0.68 |
| **Phlegm** | 9 (8.%) | 27 (24.5%) | 4 (3.6%) | 40 (36.4%) | 0.88 | 0.64 |

Table 6 display Distribution of respiratory symptoms in study population by age starting welding. There is significant association between age starting welding and respiratory symptoms (cough), P value= 0.01)

**Table 6. Distribution of respiratory symptoms in study population by age starting welding:**

| Symptoms | Age starting welding | | | Total | Chi2 | P-value |
|---|---|---|---|---|---|---|
| | ≤20 | 21-30 | >30 | | | |
| **Shortness of breath** | 17 (15.5%) | 25 (22.7%) | 5 (4.5%) | 47 (42.7%) | 0.61 | 0.74 |
| **Wheeze** | 13 (11.8%) | 18 (16.4%) | 4 (3.6%) | 35 (31.8%) | 0.80 | 0.67 |
| **Cough** | 13 (11.8%) | 20 (18.2%) | 7 (6.4%) | 40 (36.4%) | 5.49 | 0.01 |
| **Phlegm** | 12 (10.9%) | 28 (25.5%) | 7 (6.4%) | 47 (42.7%) | 4.72 | 0.95 |

Table 7 display Distribution of respiratory symptoms in study population by type of plants. A significant association was found between plant type and respiratory symptoms (shortness of breath, cough, phlegm), P value 0.03, 0.03 0.02 respectively.

**Table 7. Distribution of respiratory symptoms in study population by type of welding:**

| Symptoms | AC | steel | Total | Chi2 | P value |
|---|---|---|---|---|---|
| **Shortness of breath** | 21 (19.1%) | 26 (23.6%) | 47 (42.7%) | 3.73 | 0.03 |
| **Wheeze** | 9 (23.7%) | 26 (36.1%) | 35 (31.8%) | 1.78 | 0.18 |
| **Cough** | 16 (42.1%) | 24 (33.3%) | 40 (36.4%) | 0.83 | 0.03 |
| **Phlegm** | 20 (52.6%) | 27 (37.5%) | 47 (42.7%) | 2.33 | 0.02 |

Table 8 display Distribution of respiratory symptoms in study population by duration of employment. There is significant association between duration of employment and respiratory symptoms (wheeze, cough, phlegm, p value 0.03, 0.04, 0.01 respectively).

**Table 8. Distribution of respiratory symptoms in study population by duration of employment:**

| Symptoms | duration of employment | | | Total | Chi2 | P-value |
|---|---|---|---|---|---|---|
| | 1-10 | 11-20 | >20 | | | |
| **Shortness of breath** | 29 (26.4%) | 13 (11.8%) | 5 (4.5%) | 47 (42.7%) | 0.22 | 0.99 |
| **Wheeze** | 13 (11.8%) | 8 (7.3%) | 0 (0.0%) | 21 (19.1%) | 3.74 | 0.03 |
| **Cough** | 4 (3.6%) | 6 (5.5%) | 0 (0.0%)) | 10 (9.1%) | 5.94 | 0.04 |
| **Phlegm** | 21 (19.1%) | 15 (13.6%) | 4 (3.6%) | 40 (36.4%) | 2.71 | 0.01 |

Table 9 display Distribution of respiratory symptoms in study population by smoking or not. There is no significant association between smokers welders and respiratory symptoms.

**Table 9 Distribution of respiratory symptoms in study population by smoking or not:**

| Symptoms | Smoking | | Total | Chi2 | P-value |
|---|---|---|---|---|---|
| | YES | NO | | | |
| **Shortness of breath** | 36 (32.7%) | 11 (10%) | 47 (42.7%) | 2.16 | 0.14 |
| **Wheeze** | 14 (12.7%) | 7 (5.4%) | 21 (19.1%) | 0.71 | 0.79 |
| **Cough** | 8 (7.3%) | 2 (1.8%)) | 10 (9.1%) | 0.61 | 0.43 |
| **Phlegm** | 29(26.4%) | 11 (10%) | 40 (36.4%) | 0.34 | 0.56 |

Table 10 gives parameter estimates for the binary logistic regression of shortness of breath on the independent variables. The odds ratio of welders in air conditioning (OR=0.65) , confidence intervals (CI=0.24-0.56) and P value was significant (P value=0.01). Significant association was founded between shortness of breath and welders doing welding job from 11 to 20 years (P value = 0.01) and also significant association was founded between shortness of breath and welders doing welding job more than 20 years (P value=0.01) .There is no significant association with other independent variable for the shortness of breath .

**Table 10: Binary logistic regression of shortness of breath on independent variable:**

| Independent variables | OR | CI | P-value |
|---|---|---|---|
| **Type of plants** | | | |
| **AC plant** | 0.65 | 0.24-0.65 | 0.01 |
| **Age (REF. >40)** | | | 0.38 |
| **21-30** | 0.63 | 0.18-2.12 | 0.45 |
| **31-40** | 1.58 | 0.34-7.25 | 0.55 |
| **Marital status (REF. Married)** | | | |
| **Single** | 0.55 | 0.17-1.80 | 0.32 |
| **Education level (REF. University)** | | | 0.58 |
| **Elementary** | 0.89 | 0.31-2.52 | 0.83 |
| **Secondary** | 0.36 | 0.05-2.62 | 0.31 |
| **Years in welding job (REF. >20)** | | | 0.01 |
| **1-10** | 1.16 | 0.38-3.53 | 0.79 |
| **11-20** | 0.57 | 0.30-0.85 | 0.03 |
| **Smoking (REF. YES)** | 0.37 | 0.14-0.94 | 0.61 |

Table 11 gives parameter estimates for the binary logistic regression of wheeze on the independent variables. Significant association was founded between wheeze and welders doing welding job between 11 to 20 years and more than 20 years (P value = 0.02 and 0.01respectively) .

**Table 11: Binary logistic regression of wheeze on independent variable:**

| Independent variables | OR | CI | P-value |
|---|---|---|---|
| **Type of plants** | | | |
| **AC plant** | 1.78 | 0.68-4.61 | 0.23 |
| **Age (REF. >40)** | | | 0.98 |
| **21-30** | 0.95 | 0.26-3.45 | 0.94 |
| **31-40** | 0.86 | 0.16-4.50 | 0.86 |
| **Marital status (REF. Married)** | | | |
| **Single** | 0.92 | 0.25-3.33 | 0.90 |
| **Education level (REF. University)** | | | 0.72 |
| **Elementary** | 0.74 | 0.25-2.15 | 0.57 |
| **Secondary** | 1.27 | 0.20-7.88 | 0.79 |
| **Years in welding job (REF. >20)** | | | 0.01 |
| **1-10** | 1.71 | 0.53-5.52 | 0.36 |
| **11-20** | 5.57 | 0.37-0.83 | 0.02 |
| **Smoking (REF. YES)** | 1.64 | 0.62-4.32 | 0.31 |

Table 12 gives parameter estimates for the binary logistic regression of cough on the independent variables. There is significant association between type of plant and cough (P value= 0.02). also significant association was founded between cough and age of welders between 21-30 years (P value=0.02) and between 31-40 years (P value=0.03). Significant association was founded between cough and welders doing welding jobs between 11-20 years (P value=0.04) and welders doing welders job more than 20 years (P value=0.01).

**Table 12: binary Logistic regression of cough on independent variables:**

| Independent variables | OR | CI | P-value |
|---|---|---|---|
| **Type of plants** | | | |
| **AC plant** | 0.75 | 0.30-0.71 | 0.02 |
| **Age (REF. >40)** | | | 0.32 |
| **21-30** | 0.86 | 0.22-0.53 | 0.02 |

| Independent variables | OR | CI | P-value |
|---|---|---|---|
| 31-40 | 2.55 | 0.51-0.94 | 0.03 |
| Marital status (REF. Married)<br>Single | 0.34 | 0.09-1.26 | 0.11 |
| Education level (REF. University) | | | 0.50 |
| Elementary | 2.10 | 0.50-7.46 | 0.25 |
| Secondary | 2.51 | 0.36-17.8 | 0.36 |
| Years in welding job (REF. >20) | | | 0.01 |
| 1-10 | 1.17 | 0.34-4.02 | 0.81 |
| 11-20 | 0.51 | 0.08-0.68 | 0.04 |
| Smoking (Reference: YES) | 0.54 | 0.19-1.55 | 0.25 |

Table 13 gives parameter estimates for the binary logistic regression of phlegm on the independent variables. There is significant association between phlegm and age of welders from 21 to 30 (P value= 0.03) and age of welders from 31 to 40 years (P value= 0.04).

**Table 13: Logistic regression of phlegm on independent variables:**

| Independent variables | OR | CI | P-value |
|---|---|---|---|
| Type of plants<br>AC plant | 0.45 | 0.19-1.09 | 0.07 |
| Age (REF. >40) | | | 0.06 |
| 21-30 | 3.8 | 0.29-0.66 | 0.03 |
| 31-40 | 5.26 | 0.34-0.79 | 0.04 |
| Marital status (REF. Married)<br>Single | 0.86 | 0.25-2.93 | 0.82 |
| Education level (REF. University) | | | 0.89 |
| Elementary | 1.08 | 0.37-3.09 | 0.88 |
| Secondary | 1.52 | 0.24-9.56 | 0.65 |
| Years in welding job (REF. >20) | | | 0.25 |
| 1-10 | 0.39 | 0.13-1.26 | 0.12 |
| 11-20 | 0.32 | 0.05-1.95 | 0.21 |
| Smoking (Reference: YES) | 1.02 | 0.39-2.60 | 0.97 |

## Discussion

The overall prevalence of respiratory symptoms in the study participants (according to plant type) were – shortness of breath (42.1%), wheeze (31.8 %), cough (36.4 %) and phlegm (42.7%). The highest prevalence of respiratory symptoms (shortness of breath 23.6%, wheeze 36.1%, cough 33.3%, and phlegm 37.5%) were found in the steel plant. The association between exposures to welding fumes and gases and the development respiratory symptoms has been investigated previously in many studies. (14) One of these studies on respiratory symptoms among welders in Saudi Aramco was reported prevalence of shortness of breath 9.8 %, cough 34.1%, phlegm 39%. (15)

In our study we found a significantly higher prevalence of cough (36.4%), phlegm (42.7%) related to age of welders. Also, our study was shown no significant associations between (marital status and education level) and respiratory symptoms. In our study we found a significantly higher prevalence of respiratory symptoms (wheeze (19.1%), cough (9.1%) and phlegm (36.4%)) related to duration of employment.

Therefore, the long-term exposure to high concentration of welding fumes and gases has caused an increase in the prevalence of respiratory symptoms (wheezing, cough, phlegm). (16)

In summary, this study has documented work related respiratory symptoms in welders performing oxyacetylene and arc welding.

## Conclusion

As a conclusion, we found a high prevalence of respiratory symptoms related to type of plant, age of welders and duration of employment. Welders should understand the hazards of the materials they are working with. OSHA's Hazard Communication standard requires employers to provide information and training for workers on hazardous materials in the workplace.(17), Welding surfaces should be cleaned of any coating that could potentially create toxic exposure, such as solvent residue and paint, General ventilation, the natural or forced movement of fresh air can reduce fumes and gases levels in the work area, Local exhaust ventilation systems can be used to remove fumes and gases from the welder's breathing zone.

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