

## Respiratory health of a population of welders

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ABSTRACT

**Objective:** The aim was to identify respiratory symptoms and respiratory function of welders in comparison to a “nonexposed group.” **Materials and Methods:** Information was collected by means of a questionnaire completed during an interview, and spirometry of all subjects. **Results:** This study involved 41 welders and 41 comparable nonexposed group. Sixteen (39%) welders reported bringing up phlegm from the chest first thing in the morning, compared with seven individuals (17.1%) in the nonexposed group. The difference is significant (Chi-square = 3.87 odds ratio (OR) 3.11 [1.0-9.9],  $P = 0.0182$ ). Eleven welders had chronic bronchitis, which they had experienced most days for as long as 3 months, compared with one person in the nonexposed group. The difference was statistically significant, and OR was 1.7 (95% confidence interval 1.19-2.53). On the other hand, the difference in cough, shortness of breath and lung function was statistically insignificant when the welders were compared with the nonexposed group. **Conclusion:** This study showed more respiratory complaints, particularly chronic bronchitis, among welders compared with the nonexposed group, which is believed to be the result of welding emissions. Spirometry showed no impairment in lung function in both the welders and the nonexposed group.

**Key words:** Health, respiratory, welders

### INTRODUCTION

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.<sup>[1,2]</sup>

The majority of welding processes produce toxic fumes, which are often released by the heating of metals such as nickel, chrome, cadmium, iron, copper, magnesium, and zinc. Furthermore, welders are exposed to numerous other gases and particulates emitted during the process. The effect of the fumes depends on the composition and concentration of the airborne particles.<sup>[3-5]</sup>

The adverse health effects of welding are due to multiple agents, and thus difficult to attribute to a single-fume contaminant. Studies of industrial workers have revealed

occupational diseases which seem to be the result of exposure to welding emissions. Respiratory disorders range from deterioration of pulmonary function, dryness of the throat, coughing, tightness in the chest, wheezing, and difficulty in breathing to chronic bronchitis,<sup>[6-13]</sup> and metal fume fever resulting from inhalation of excessive amounts of metallic oxide fumes from metals.<sup>[14-16]</sup> Other studies report a 30-40% greater incidence of lung tumors among welders.<sup>[17]</sup>

The objectives of this study were to identify respiratory symptoms and respiratory function of welders and compare them to a nonexposed group.

### MATERIALS AND METHODS

Saudi Aramco was selected for the study as it is one of the largest companies in the area with a high volume of processes of joining ferrous and nonferrous metals. The most common type of arc welding used at Saudi Aramco is shielded metal arc welding. Furthermore, gas welding processes such as oxyfuel and argon are still widely used to weld pipes and tubes, and do repair work. The line management of the company was officially contacted, and their cooperation sought. Verbal consent (participation in

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this study was voluntary, so there was no need for written consent) was obtained from all participants after the aim of the study was explained to them. Participants were told that they were free to withdraw from the study at any time, and were assured of the confidentiality of the recorded data. The “nonexposed groups” were selected if they:

- A. Were not exposed to welding fumes and gases in their current jobs and
- B. Had no past history of work involving exposure to welding emissions.

The nonexposed group was composed of operators employed in the same company in order to minimize the bias of the healthy worker effect. It should be noted that the company’s records were not checked for those who had left the job or had died. It is believed that this was unimportant, for it was the same in the studied subjects since the healthy worker effect was considered in both groups of people. A standardized, validated questionnaire was completed by the investigator for each participant in an interview. In addition to the personal characteristics of each subject (age, sex, ethnic origin, educational level, and smoking habits), were recorded present and past occupations, including details of any type of exposure during work as well as the duration of work. The respiratory questions were derived from the Medical Research Council (MRC) questionnaire.<sup>[18-20]</sup>

Chronic bronchitis was defined as having a cough productive of phlegm on most days for 3 months over two or more consecutive years.<sup>[21]</sup>

The questions on demographic and personal information and work history in the interview recording sheet were phrased and arranged in sequence to avoid introducing any bias into the study. The wording of the MRC questionnaire remained unchanged.

A vitalograph spirometry was conducted by an experienced technician as per international standards, during working hours for both groups.<sup>[22]</sup> The test was done at the end of the shift after the last cigarette, and last meal had been taken and at least 1 hour or more had elapsed. Furthermore, subjects were asked about any contraindications they had to spirometry. The test was done with the subject standing, and a minimum of three readings were taken. A variation of < 5 was considered as the final reading.

Data were checked and entered into a personal computer on a daily basis. Statistical Package for Social Science (SPSS/PC+) version 15.0 was utilized in the analysis. Statistical procedures used included: Frequency distribution, basic descriptive, Chi-square ( $\chi^2$ ), Fisher’s

Exact test and Student’s *t*-test.  $P < 0.05$  was considered as statistically significant.

## RESULTS

Because of a number of problems encountered, only 41 welders in Saudi Aramco, who were willing to participate in the study, were included. A total number of 41 volunteers who met the criteria for inclusion in the nonexposed group were selected for this study. The welders were compared to the nonexposed group in terms of: Age, gender, ethnic origin, education, duration of work and smoking habits:

- Age: The mean age of the welders was 36.3 (standard deviation [SD] of 13.1) compared to 38.6 (SD: 12.8) of the nonexposed group. This difference was statistically insignificant (Student’s *t*-test,  $P = 0.417$ ). The welders’ ages ranged from 22 to 55 years compared to 21-57 years in the nonexposed group
- Gender: All welders and nonexposed group were males
- Ethnic origin: 90.2% of the welders and 78.0% of the nonexposed were Saudi, while the rest were of other ethnic origins. The difference proved to be statistically insignificant (Fisher’s exact test,  $P = 0.1129$ )
- Level of education: Of the exposed group (welders), approximately 2.0% were illiterate, 5.0% had primary school education, approximately 90% of the welders had secondary school education or more. 12.2% of the nonexposed group had a postsecondary school education (Fisher’s exact test,  $P = 0.6438$ )
- Duration of work: The mean duration of the present work of the welders was 4.7 (SD: 2.5) years compared to 4.0 (SD: 2.8) years of the nonexposed group. The difference was statistically insignificant (Student’s *t*-test,  $P = 0.534$ )
- Smoking: Smoking is considered a risk factor in the causation of respiratory disorders. 65.9% of the welders were current smokers (still smoking during the time of this study) compared to 51.2% of the nonexposed group, while the percentages of ex-smokers (stopped smoking 1 month or more prior to the study) among welders and nonexposed group were 19.5% and 14.6%, respectively. The remaining subjects had never smoked. The differences were statistically insignificant,  $\chi^2$ ,  $P = 0.1203$ .

It was, therefore, apparent that the two groups (welders and nonexposed group) were comparable in terms of age, gender, ethnic origin, level of education, duration of work and smoking habits.

### Respiratory complaints among the study subjects

1. Cough: The prevalence rate of cough during the day or at night was 34.1% among the welders compared

to 14.6% in the nonexposed group [Table 1]. The statistical difference was insignificant, but suggestive of a difference due to small sample size ( $\chi^2 = 3.24$ ,  $P = 0.0718$ , odds ratio (OR) = 3.02 (95% confidence interval [CI]: 0.92-10.28)).

2. Phlegm: Sixteen (39%) welders reported bringing up phlegm from the chest first thing in the morning, compared to seven individuals (17.1%) in the nonexposed group as shown in Table 1. The difference was statistically significant ( $\chi^2 = 3.87$ ,  $P = 0.0182$ , OR: 3.11 (95% CI: 1.0-9.9)).
3. Shortness of breath: 9.8% of the welders experienced shortness of breath when hurrying on level ground or walking up slight incline (Grade 2) versus 4.9% among the nonexposed group as shown in Table 1. The difference proved to be statistically insignificant ( $\chi^2 = 0.18$ ,  $P = 0.6715$ , OR: 2.1 (95% CI: 0.3-17.78)).
4. Chronic bronchitis: Eleven welders had cough with phlegm, which they had experienced most days for as long as 3 months, compared to only one person in the nonexposed group. The difference was statistically significant where  $\chi^2 = 6.64$ ,  $P < 0.001$ , OR was 1.7 (95% CI: 1.19-2.53).

**Respiratory functions among the study subjects**

Table 2 shows respiratory function of both groups. The welders had a high average of forced vital capacity (FVC) 2.97 Liter (L), forced expiratory volume in 1 second (FEV1s) of 2.61 L compared to the nonexposed group (FVC 2.72 L, FEV1s of 2.43 L), but the difference was statically

insignificant ( $P = 0.21$  and  $0.16$  respectively). Further analysis showed that the observed value for the welders was significantly lower than their predicted one ( $P < 0.01$ ). This means that if the sample size had been large enough a comparison of the welders and the nonexposed group was likely to have yielded a significant statistical difference.

**DISCUSSION**

The results of this study showed a significant difference between welders and the nonexposed group for respiratory complaints (productive cough) and chronic bronchitis. However, the respiratory functions were the same in the two groups. Smoking did not contribute much to the respiratory complaints of the welders since it was excluded as a confounding factor as the proportion of the welders who smoked was not much larger than those in the nonexposed group. Respiratory complaints are reported by many researchers to be common among welders because of exposure to welding emissions,<sup>[23,24]</sup> and impaired respiratory functions among welders have been reported in several studies.<sup>[8,25,26]</sup> This was not a finding in this study perhaps, as a result, of the small sample size, as only 41 welders were recruited.

The conclusion of this study is that respiratory symptoms and chronic bronchitis was more prevalent among welders than the nonexposed group, but no impairment in lung function was observed in either group.

**Limitation of the study**

As with other cross-sectional studies, this study is susceptible to survivor bias because it assessed prevalence rather than incident cases, and did not take into account people who had left the job.

There is a possibility that individuals with symptoms were more willing to participate than those without symptoms, therefore, subject selection was not truly random.

The total number of welders included in this study was 41. Therefore, inadequate sample size could explain the lack of statistical difference in the analysis.

The initial plan was to have a nonexposed group which was twice the size of the study group, but, unfortunately, because of the number of difficulties encountered, a one-to-one ratio was studied instead.

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**Table 1: Respiratory symptoms of welders and nonexposed group**

Symptoms	Welders (n=41)		Nonexposed group (n=41)		P value
	Number	Percentage	Number	Percentage	
Cough	14	34.1	6	14.6	0.0718
Phlegm	16	39	7	17.1	0.0182
Dyspnea	4	9.8	2	4.9	0.6715
Chronic bronchitis	11	26.8	1	2.4	<0.001

**Table 2: Respiratory functions of welders and nonexposed group**

Variable	Welders (n=41) (mean (SE))		Nonexposed group (n=41) (mean (SE))		P value
	Observed	Predicted	Observed	Predicted	
	FVC in liter	2.97 (0.10)	3.34 (0.05)	2.72 (0.06)	
FEV1s in liter	2.61 (0.7)	2.75 (0.5)	2.43 (0.07)	2.70 (0.06)	0.16

SE is more appropriate to use rather than SD in statistical analysis when the numbers are small as shown in the above table. SE: Standard error, FVC: Forced vital capacity, FEV1s: Forced expiratory volume in 1 s, SD: Standard deviation

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