

SHORT REPORT

Pulmonary effects of spot welding in automobile assembly

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Background	Spot welding is a type of resistance welding in which pieces of metals are pressed together and an electric current is passed through them. Spot welders are at risk of contact with some potentially hazardous agents but there are few studies about the respiratory effects of spot welding.
Aims	Our objective was to study lung function and respiratory symptoms among spot welders and office workers at an automobile assembly factory in Iran.
Methods	This was a cross-sectional study of 137 male spot welders and 129 office workers. We used a questionnaire to record demographic data, smoking habits, work history and respiratory symptoms. Spirometry was performed to assess lung function status. Metal fume samples from the respiratory zone of spot welders were analysed.
Results	The concentrations of metal fume were less than the American Conference of Industrial Hygienists (ACGIH) threshold limit values. There were significantly lower values for average forced expiratory volume in 1st second (FEV ₁), FEV ₁ /forced vital capacity and 25–75% forced expiratory flow in spot welders compared to controls. There was also a significantly raised prevalence of respiratory symptoms (sputum and dyspnoea) in spot welders. Fifteen per cent of spot welders and 1% of controls had an obstructive pattern in spirometry.
Conclusions	Our survey suggests that spot welders are at risk of developing respiratory symptoms and decreasing pulmonary function values despite their exposure to components of welding fume being within ACGIH guidelines.
Key words	Pulmonary function; respiratory symptoms; spirometry; spot welding.

Introduction

Spot welding is a type of resistance welding in which pieces of metals are pressed together and an electric current is passed through them [1]. There is localized heating at the contact point due to contact resistance. Ozone [above American Conference of Industrial Hygienists (ACGIH) ceiling threshold limit values (TLV)], nitrogen dioxide and welding fume (below ACGIH TLV) can be found in this process [2].

Spot welding on parts coated with oil and paints which degrade during welding can cause olfactory, respiratory and eye irritation [3]. Lee *et al.* [4] described a case of occupational asthma from fumes due to spot welding.

Although spot welding was considered to be less hazardous than other types of welding [1], a recent study reported a significant dose–response relationship between pulmonary function abnormalities and spot welding [1]. Therefore, this study was performed to look at the respiratory effects of spot welding.

Methods

This cross-sectional study was performed from January to August 2007. In all, 137 male spot welders and 129 male office workers were selected by simple random sampling, in an automobile assembly factory in Tehran, Iran. The study was approved by the medical ethics committee of Tehran University. Written informed consent was obtained from all participants. Subjects with a self-reported history of respiratory diseases that could affect pulmonary function such as rhinitis, the common cold, pneumonia, as well as a history of past occupational exposure to asbestos, silica, paints and solvents were excluded.

Data were gathered using a questionnaire and spirometry. The questionnaire included demographic data, work

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history, smoking habit and questions regarding respiratory symptoms. Chronic bronchitis was defined as having a productive cough for at least 3 months of the year for at least two consecutive years. Spirometry was performed using a calibrated spirometer (Spirolab II, Rome, Italy) from 8.00 a.m. to 12.00 a.m. in a standing position and according to American Thoracic Society criteria [5]. We measured forced vital capacity (FVC), forced expiratory volume in 1st second (FEV₁), 25–75% forced expiratory flow (FEF_{25–75%}) and peak expiratory flow rate, all were expressed as a percentage of predicted value and FEV₁/FVC ratio.

Mean metal fume concentrations of zinc, copper, nickel, lead and iron were measured using National Institute of Occupational Safety and Health 7300 [6] in the respiratory zone of spot welders.

Data were analysed using SPSS software version 11.5 (SPSS, Inc., Chicago, IL, USA). An unpaired Student's *t*-test was used to compare continuous variables between groups. We used chi-squared tests to compare differences in the prevalence of symptoms. Odds ratios with 95% confidence interval were calculated with Mantel–Hanszel method. Linear regression and logistic regression analyses were used to control the effects of potential confounders (i.e. age, work duration and smoking).

Table 1. Demographic data and pulmonary function values in spot welders and controls

	Spot welders (<i>n</i> = 137)		Controls (<i>n</i> = 129)		<i>P</i> value
	Mean	SD	Mean	SD	
Age (year)	28.6	3.0	34.7	6.8	<0.01
Work duration (year)	5.3	2.6	9.9	5.8	<0.01
Smoker, <i>n</i> (%)	19 (14%)	–	31 (24%)	–	<0.01
FVC (% predicted)	95.7	10.5	95.5	9.2	NS
FEV ₁ (% predicted)	92.5	12.3	95.3	9.2	<0.05
FEV ₁ /FVC	81.5	7.4	83.4	4.5	<0.05
FEF _{25–75%} (% predicted)	84.1	23.5	91.1	18.4	<0.01
PEFR (% predicted)	86.4	17.1	88.1	18.8	NS

NS, not significant; PEFr, peak expiratory flow rate.

Table 2. Prevalence of respiratory symptoms in spot welders and controls

Respiratory symptoms	Spot welders, <i>n</i> (%)	Controls, <i>n</i> (%)	Odds ratio (95% confidence interval)	Adjusted odds ratio ^a (95% confidence interval)	<i>P</i> value
Cough	27 (20)	23 (18)	1.1 (0.6–2.1)	1.2 (0.7–2.4)	NS
Sputum	37 (27)	21 (16)	1.9 (1.04–3.4)	2.2 (1.2–4.2)	<0.05
Dyspnoea	16 (12)	4 (3)	4.2 (1.3–12.5)	5.0 (1.1–16.7)	<0.01
Wheeze	14 (10)	8 (6)	1.7 (0.7–4.4)	1.8 (0.7–4.6)	NS
Chronic bronchitis	7 (5)	3 (2)	2.3 (0.6–9.1)	2.6 (0.6–11.1)	NS

NS, not significant.

^aOdds ratio adjusted for smoking.

Results

In this study metal fume concentrations of zinc, copper, nickel, lead and iron were less than ACGIH TLV [7]. Work duration of spot welders was 8 h/day (48 h/week).

Demographic details and lung function data of the two groups are shown in Table 1, and the clinical findings among the two groups are summarized in Table 2.

Spot welding was found to be significantly associated with decreased FEV₁ (*P* < 0.05), FEV₁/FVC and FEF_{25–75%} (*P* < 0.01) in linear regression analyses, while these associations were not affected by age, work duration and smoking.

In logistic regression analyses, spot welding exposure was found to be significantly associated with reporting of sputum production (*P* ≤ 0.05) and dyspnoea (*P* < 0.01). Smoking was significantly associated with cough (*P* ≤ 0.01) and sputum production (*P* < 0.01). Fifteen per cent of spot welders and 1% of controls had an obstructive pattern on spirometry (*P* ≤ 0.001).

Discussion

Compared with controls, spot welders had a significant reduction in FEV₁, FEV₁/FVC and FEF_{25–75%}. Some respiratory symptoms were significantly increased among spot welders after adjusting for smoking.

These findings were observed in workers whose exposure to components of welding fume was within ACGIH guidelines. This finding is consistent with another recent study where concentrations of airborne particles from spot welding operations in automotive plants were found to be significantly lower than ACGIH recommended levels [8].

One of the strengths of our study was that we studied a larger number of spot welders when compared to similar previous studies which may better elucidate the respiratory effects of spot welding.

However, this study was limited by being a cross-sectional study, which may underestimate the effects of occupational exposure due to the healthy worker effect and cannot yield a causal inference. Also, the socio-economic status of the participants was not adjusted for. Measuring concentrations

of workplace gases would have also provided further information on the hazardous effects of spot welding.

Our data are consistent with the findings of a study by Luo *et al.* [1] which reported lower pulmonary function values in spot welders when compared to controls, although in our study, spot welding exposure had no effect on FVC. This could be possibly due to a younger exposure group and relatively lower work duration in our study.

Our findings are in accordance with most of studies in which welders had a higher prevalence of respiratory symptoms than controls [1,9].

We found a significant association between smoking and symptoms of cough and sputum production. Like some other studies [1], we found no significant association between decrease of pulmonary function values and smoking.

Based on potential hazardous respiratory effects of spot welding, we recommend prevention measures such as mechanization of the process, proper ventilation, respiratory protective equipment, education (including advice on smoking cessation) and periodic medical surveillance. Cohort studies would be helpful in the future to evaluate these findings further.

Key points

- Spot welders are at risk for developing respiratory symptoms and decreasing pulmonary function values.
- Obstructive airway abnormalities were more prevalent in spot welders than controls.
- Based on potential hazardous respiratory effects of spot welding, we recommend preventative measure including mechanization of the process, proper ventilation, respiratory protective equipment, education and periodic medical surveillance.

Conflicts of interest

None declared.

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