



## The Impact of Occupational Safety Practices among Welding Workers in Al Diwaniya Province, Iraq

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### Abstract

**Background:** Welding is a skilled manual craft that relies on human labor and artistry to fuse metal components using heat and tools. It's crucial in manufacturing, maintenance, and construction. Despite technological advances, intricate projects still depend on welders. However, this profession exposes workers to various occupational hazards, making health and safety a top priority. **Objectives:** The study assessed the impact of workplace safety protocols on Iraqi welders in Al Diwaniyah Province. **Methodology:** A cross-sectional descriptive study was performed. There were 291 participants in the study, which used a simple method of random sampling. It began in September of 2024 and ended in February of 2025. **Results:** The study found that the majority of welders were young adults aged 25–34, with limited educational levels and a high prevalence of smoking. Most participants worked more than 8 hours per day, primarily in residential areas, and had experience ranging from 5 to 10 years. Electric welding was the most common method used, while the use of Personal protective equipment (PPE) (especially for respiratory and auditory protection) was notably low. Statistical analysis revealed no significant correlation between demographic or occupational variables and PPE use, indicating substantial gaps in safety compliance. **Conclusions:** This study highlights the demographics of welders and the relationship with the application of occupational safety practices. PPE use remains inadequate. This study emphasizes the need for targeted interventions and stricter workplace safety compliance.

**Keywords:** Impact, Occupational safety, Welding, PPE, Al-Diwaniyah province, Iraq.

## **Introduction**

The American Welding Society describes welding as "a metal joining process in which coalescence is achieved by applying pressure or heating to a suitable temperature, with or without the addition of filler metal [1]. In business settings, various forms of welding are employed. The most popular method among them is electric arc welding. Electricity passing through a gas between two electrical conductors produces heat fusion in electric arc welding, which may reach temperatures of above 4000°C [2].

The metal vapor generated at extremely high temperatures cools in the gas stream and condenses to form fumes when an electric welding arc is formed between the electrode and the base metal, either in air or an inert gas [3]. Since the electrode, filler wire, and any fluxes employed are the main sources of welding fumes (WFs), their composition might vary. Furthermore, the base metal, shielding gases, and surface paints or coatings can all contribute to the creation of fumes [4].

Fumes are produced when vaporized metal reacts with oxygen, forming metal oxides that condense into particulate matter. Shielding gases can help reduce oxidation. Welding fumes may contain various metal oxides, including aluminum, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc [5]. Common welding processes also emit toxic gases such as ozone, nitrogen oxides, carbon dioxide, and carbon monoxide. Stainless steel welding fumes generally include iron, chromium, manganese, and nickel, while mild steel fumes consist mainly of iron. Stainless steel

welding presents additional risks due to hexavalent chromium and nickel, both carcinogens [6]. Fume generation rates vary by welding process; techniques like submerged arc welding, gas metal arc welding, and gas tungsten arc welding can reduce emissions with shielding gases, though they can also increase ultraviolet radiation, potentially creating ozone and nitrogen oxides [7]. A 2023 study in Duhok found elevated blood lead levels among industrial workers, with a mean of 19.8 µg/dl, rising from 13.8 µg/dl in 2010, indicating increased pollution and poor safety. Many workers lack knowledge of lead hazards and rarely use PPE, further heightening their risk. Factors like smoking and dusty environments increase lead absorption [8], highlighting the need for urgent public health interventions, including education and improved access to safety gear [9].

Promoting and preserving the best level of physical, mental, and social well-being for employees across all professions is the goal of occupational health [10]. Workplace risks have the potential to harm employees' health and well-being; thus, it is important to foresee, identify, assess, and manage them [11]. It is a recommended and safe practice for welders to always use personal protective equipment (PPE) to guard against any risks and accidents while welding or cutting. Occupational safety and health (OSH) is not an archaic field [12]. However, working conditions for welders and workers in Iraq are unsatisfactory, with low awareness and utilization of safety measures. Contributing factors include low education levels, lack of training, and inadequate regulatory measures.

Ensuring worker safety during welding operations requires the use of occupational safety procedures, including PPE, that promote the highest degree of well-being for welders. Examples of PPE include welding goggles, which cover the eyes from sparks and debris, and welding helmets, which shield the face and eyes from UV and infrared radiation. Gloves constructed of heat-resistant materials protect hands from cuts and burns, while welding masks filter dangerous gases and fumes. Steel-toed safety shoes shield the feet from heavy objects that fall, while flame-resistant welding gear shields the body from heat and spark hazards. When used in tandem, these instruments reduce hazards and improve welders' safety at work [13,14]. Iraq still has a low and lax enforcement of PPE, especially in high-risk industries like oil and gas. Lack of training, inadequate supervision, and disregard for safety protocols are the main causes of many workplace mishaps [15]. PPE is rarely provided because workers frequently exhibit inadequate safety awareness, and management rarely gives safety measures priority. Furthermore, insufficient investment in safety systems and a weak safety culture lead to insufficient utilization of protective gear [16]. Furthermore, a second study on welders' health was conducted in the Najaf province of Iraq. It was shown that the elevated levels of heavy metals in welders' blood can be explained by their exposure to welding fumes that include high amounts of these metals, indicating poor occupational safety [17]. Research conducted in the Al-Qadisiyah Governorate found that soil samples from the Iraqi city of Al-Diwaniyah had exceptionally high levels of heavy

metals, which can be brought on by a number of things, including welding [18]. Therefore, the purpose of this study is to evaluate the application of occupational safety practices among welding workers.

## **Material & Methodology**

### **Study Design and Study Period**

Data for this descriptive cross-sectional study were gathered between September 2024 and February 2025.

### **Inclusion Criteria and Exclusion Criteria**

All male welders employed during the study period in the province of Al-Diwaniyah. All women who work in welding and children under the age of ten.

### **Sample size and Sampling Techniques**

An internet application called the "Raosoft" sample size calculator was used to determine the study's sample size: <http://www.raosoft.com/samplesize.html>. A statistical tool called "Raosoft" calculates and estimates the sample size. "Raosoft" uses four parameters to calculate sample size: the population, the response distribution, the level of confidence, and the error margin [19]. The predicted minimum sample size was 291 welders with a 50% response distribution, 5% error margin, and 95% confidence level. Half of the workplaces in Al-Diwaniya province were chosen at random using a straightforward approach. There were 10 locations in all: Al Hamza, Al-Sideer, the North center of Al-Qadisiyah (industrial district), South center (Al-Judaidah), and Al-Shamiyah. Geographically, these locations are dispersed throughout the governorate's north, middle, and south. The ratio of welders in each area to all welders in the ten districts, multiplied by the sample size, was used to calculate the number of participants from each area.

## Variables of The Study

### Dependent Variables

Application of occupational safety practices among welding workers.

### Independent Variables

Welder demographics (age group, educational attainment, marital status, and smoking status) and occupational characteristics are the independent factors.

### Data Collection Method

To achieve research goals, a structured interview questionnaire was used. The questionnaire's questions are derived from prior research as well as WHO guidelines. About fifteen to twenty-five minutes were spent on the interview [20].

### Data Scoring and Statistical Analyses

Participants' responses to the questionnaire's section on occupational safety procedures were either "Yes" or "No". Answers were scored with "1" point for "yes" or "2" points for "no."

The available statistical program, SPSS-27, was used to analyze the data. The data was

presented using the straightforward metrics of frequency, percentage, mean, and standard deviation. The Pearson chi-square test (2-test) was used to determine whether the percentage differences (qualitative data) were significant. In every instance where the P value was 0.05 or less, statistical significance was taken into account.

### Ethical Considerations

The Research Ethics Committee at Southern Technical University and the Directorate of Health in Al-Qadisiyah gave its approval for our study's visit to medical facilities. Interviews were conducted with participants who verbally and in writing agreed. In order to encourage collaboration, we made sure they were anonymous, explained the project's goals clearly, and assured them that their information would only be utilized for the study.

**Results** The distribution of welders by demographic attributes is displayed in Table 1.

**Table 1. Demographic characteristics of welders**

Variable	Category	Frequency (n)	Percentage (%)
Age	< 25 years	61	21%
	25-34 years	97	<b>33.3%</b>
	35-44 years	67	23%
	≥ 45 years	66	22.7%
	<b>Mean ±SD 35.11 ± 12.03</b>		
Educational level	Illiterate	41	14.1%
	Primary	103	<b>35.4%</b>
	Secondary	96	33%
	University	51	17.5%
Marital status	Single	73	25.1%
	Married	197	<b>67.7%</b>
	Divorced	12	4.1%
	Widowed	9	3.1%
Smoking status	Currently smoking	152	<b>52.2%</b>
	Quit smoking	43	14.8%
	Never smoked	96	33%

The mean age of the participants was  $35.11 \pm 12.03$  years, with a range of 12 to 60 years. The age group of 25–34 years old had the highest rate (33.3%), while the age group of under 25 years old had the lowest percentage (21%). The largest proportion of welders, 35.4% (n=103), have only completed primary school, while 33% (n=96) have completed secondary school. The lowest proportion of

individuals, 14.1% (n=41), were illiterate at the same time. Furthermore, the study's results show that a significant portion of welders (67.7% (n=197)) were married, with 25.1% (n=73) being unmarried. Finally, because smoking is an easy habit to pick up when working long hours, the majority of participants in this study (52.2% (n=152)) were current smokers.

**Table 2: Work-related characteristics of Participants**

Variable	Category	Frequency (n)	Percentage (%)
<b>Work Experience</b>	< 5 years	49	16.8%
	5-10 years	82	<b>28.2%</b>
	11-15 years	51	17.5%
	16-20 years	42	14.4%
	> 20 years	67	23%
	<b>Mean <math>\pm</math> SD 14.81 <math>\pm</math> 10.67</b>		
<b>Working Hours per Day</b>	< 8 hours	113	38.8%
	$\geq$ 8 hours	178	<b>61.2%</b>
	<b>Mean <math>\pm</math> SD 7.59 <math>\pm</math> 2.55</b>		
<b>Workplace</b>	Living neighborhoods	142	<b>48.8%</b>
	Industrial neighborhoods	96	33%
	Welding company	53	18.2%
<b>Welding Method Used</b>	Electric welding	184	<b>63.2%</b>
	Gas welding	85	29.2%
	Arc welding	6	2.1%
	Other (Gas Electric)	16	5.5%

Table 2 shows the distribution of welders according to occupational characteristics. The results found that the years of work experience ranged from 1 to 40 years, with a mean of  $14.81 \pm 10.67$  years. The highest percentage (28.2%) of welders have work experience of 5 to 10 years, while the lowest percentage (14.4%) of them have an experience of 16 to 20 years. The results also

found that the working hours ranged from 4–12 hours, with a mean of  $7.59 \pm 2.55$ . The highest percentage (61.2%) of welders have to work for equal to or more than 8 hours. While this study found that the highest percentage (48.8%) was working in living neighborhoods, and the lowest percentage (18.2%) was working in welding companies. Lastly, the findings of the present study the

highest percentage (63.2%) of welders work in electric welding, followed by 29.2% in gas welding. At the same time, the lowest welding.

percentage was 2.1 % of participants who were working in Arc

**Table 3: Occupational safety practices**

Protective Measure	Yes n (%)	NO n (%)
Wearing a special mask to protect against welding gases	78 (26.8%)	213(73.2%)
Wearing a welding iron mask and goggles to protect the face and eyes	266 (91.4%)	25 (8.6%)
Wearing protective gloves and special clothing to prevent skin injury and burns	263 (90.4%)	28 (9.7%)
Wearing earplugs to reduce noise in the work environment	18(6.2%)	2733.8%)

Table 3 shows that a low percentage (26.8%) of welders were wearing a special mask to protect against welding gases, and 6.2% were wearing earplugs to reduce noise in the working environment. While most welders

(91.4%) were wearing a welding iron mask and goggles to protect the face and eyes, and (90.4%) were wearing protective gloves and special clothing to prevent skin injury and burns.

**Table 4: Relationship between occupational safety practices use and demographic characteristics.**

Variables		Welders using PPE*		p-value
		Yes n (%)	No n (%)	
Age group	< 25 years	60 (21.5%)	1 (8.3%)	0.105
	25-34 years	95 (34.1%)	2 (16.7%)	
	35-44 years	64 (22.9%)	3 (25%)	
	≥ 45 years	60 (21.5%)	6 (50%)	
Education level	Illiterate	40 (14.3%)	1 (8.3%)	0.103
	Primary	95 (34.1%)	8 (66.7%)	
	Secondary	93 (33.3%)	3 (25%)	
	University	51 (18.3%)	0 (0%)	
	< 5 years	45 (16.1%)	4 (33.3%)	0.47

<b>Work experience</b>	5-10 years	80 (28.7%)	2 (16.7%)	
	11-15 years	48 (17.2%)	3 (25%)	
	16-20 years	41 (14.7%)	1 (8.3%)	
	> 20 years	65 (23.3%)	2 (16.7%)	
<b>Work place</b>	Living neighborhoods	134 (48%)	8 (66.7%)	0.212
	Industrial neighborhoods	92 (33%)	4 (33.3%)	
	Welding company	53 (19%)	0 (0%)	
Chi-square test used at a significance level of 0.05				

According to Table 4, all demographic characteristics and occupational safety procedures do not statistically significantly correlate, with a p-value greater than 0.05.

### Discussion

The distribution of welders based on demographic traits is established in this study. The mean age of the participants was  $35.11 \pm 12.03$  years, with a range of 12 to 60 years. The age group of 25–34 years old had the highest rate (33.3%), while the age group of under 25 years old had the lowest percentage (21%). This is due to the fact that individuals between the ages of 25 and 34 can work even two shifts or finish household chores, while the majority of the younger generation (less than 25) is either finishing school or has not chosen welding as their primary career. These findings concurred with a cross-sectional research of 219 welders in northwest Tanzania, where the sample's mean age was 28 (24–32) years [21]. Furthermore, a cross-sectional study of 39 welders in Kut City, Iraq, found that their mean age was  $32.87 \pm 13.013$  (15–58 years), which is in line with this result [22]. The largest proportion of welders, 35.4% (n=103), have only completed primary school, while 33% (n=96) have completed secondary school. The lowest proportion of individuals, 14.1% (n=41), were illiterate at the same time. This is due to the fact that the

majority of welders come from low-income homes and drop out of school to work in the family company. Our results are comparable to those of research conducted in rural Delhi [23]. According to the study's findings, a significant proportion of welders—67.7% (n=197)—were married, with 25.1% (n=73) being unmarried. Marriage and starting a family are appropriate at this age. This conclusion was congruent with the findings of a prior study conducted in Mysuru city in 2024, which found that 61.1% of the participants (n=181) [24]. Finally, this study showed that most participants, 52.2% (n=152), were current smokers because it is simple to develop this habit after working for a long time. Similar results were found in a study that explains the same percentage [25]. As shown in Table 1.

Regarding work-related characteristics of participants, the highest percentage (28.2%) of welders have work experience of 5 to 10 years, while the lowest percentage (14.4%) of them have an experience of 16 to 20 years. Many welders are forced to leave this occupation because of the dangerous health risks and long working hours. A cross-sectional study conducted in Kenya agreed

with our results, which reported that the welders' work experience, with a high percentage of  $9 \pm 16$  years, is 33% [26]. This study demonstrated that the highest percentage (61.2%) of welders have to work for equal to or more than 8 hours. In a past study, findings found that the highest percentage were working for more than 8 hours [23]. The current study found that the highest percentage (48.8%) of workers in living neighborhoods were working in welding companies. This may be a second job or a private project. A past study done in Africa disagreed with our study, which distributed working areas into rural and city areas and reached different findings [27]. Finlay, the findings of the present study show that the highest percentage (63.2%) of welders work in electric welding. At the same time, the lowest percentage was 2.1 % of participants who were working in Arc welding. The percentage varies from the easy and fast method to the difficult and slow method. A past study found that the highest percentage was of Arc welding, which disagrees with our findings (28). As shown in Table 2.

When checking the application of occupational safety practices, it reveals that only 26.8% of welders wore a specialized mask to shield themselves from welding fumes, and 6.2% wore earplugs to cut down on noise levels at work. The inadequate and subpar function of health and other institutions in the welding field could be the cause of this. Similar to our findings, a study conducted in Thailand revealed that just 25% of participants wore earplugs [29]. Because the equipment was readily available and reasonably priced, the majority of welders

(91.4%) wore welding iron masks and goggles to protect their faces and eyes, and 90.4% wore protective gloves and special clothes to prevent burns and skin injuries. Our findings are corroborated by a previous study that discovered that 36% of people wear breathing masks, 60% wear gloves and gowns, and 86% wear glasses for eye protection [30]. As shown in Table 3.

In this study, there is no statistically significant correlation between all demographic traits and occupational safety practices. Regarding age, we found that younger welders (<25 years) seem more likely to use PPE compared to older ones ( $\geq 45$  years), but the p-value (0.105) suggests no significant association. A study done in Kenya found that there is no association between age and using PPE, which supports our study [21]. Additionally, education level may influence PPE use, with university-educated welders showing 100% compliance. However, the p-value (0.103) suggests this relationship is not statistically significant either; another past study reached a similar finding [21]. While work experience does not show a strong pattern in PPE use, the p-value (0.47) further supports this. Also, a study in 2014 had no significant association (p-value 0.648) [31].

Welders working in living neighborhoods appear to have lower PPE compliance than those in welding companies because the companies have a safety officer who is not employed in neighborhoods, but again, the relationship is not statistically significant (p-value: 0.212). Our results are supported by the study, which demonstrated that the relationship is not statistically significant [26]. As shown in Table 4.

### **Conclusions**

The demographic and occupational features of welders are highlighted in this study, which shows that the majority are between the ages of 25 and 34, have low levels of education, and smoke heavily. Most welders work in residential areas and mostly do electric welding, even if they have a decent amount of job experience and put in lengthy hours. PPE utilization is still insufficient, especially when it comes to protecting the respiratory and auditory systems. Nevertheless, no statistically significant correlations between PPE use and demographic factors were discovered. These results highlight the necessity of more focused interventions and stricter adherence to workplace safety regulations.

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### **Conflict of interest statement**

There are no disclosed conflicts of interest.

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تأثير ممارسات السلامة المهنية بين عمال اللحام في محافظة الديوانية، العراق.

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#### الخلاصة:

**الخلفية العلمية:** اللحام حرفة يدوية ماهرة تعتمد على العمل البشري والمهارة لصهر المكونات المعدنية باستخدام الحرارة والأدوات. وهو أمر بالغ الأهمية في التصنيع والصيانة والبناء. وعلى الرغم من التقدم التكنولوجي، لا تزال المشاريع المعقدة تعتمد على اللحامين. ومع ذلك، تعرض هذه المهنة العمال لمخاطر مهنية مختلفة، مما يجعل الصحة والسلامة أولوية قصوى.

**الأهداف:** قيمت الدراسة تأثير بروتوكولات السلامة في مكان العمل على اللحامين العراقيين في محافظة الديوانية. **المنهجية:** أجريت دراسة وصفية مقطعية. كان هناك 291 مشاركاً في الدراسة، والتي استخدمت طريقة بسيطة لأخذ العينات العشوائية. بدأت في سبتمبر 2024 وانتهت في فبراير 2025. النتائج: وجدت الدراسة أن غالبية اللحامين كانوا من الشباب الذين تتراوح أعمارهم بين 25 و34 عاماً، بمستويات تعليمية محدودة وانتشار كبير للتدخين. عمل معظم المشاركين أكثر من 8 ساعات في اليوم، في المناطق السكنية بشكل أساسي، وكان لديهم خبرة تتراوح من 5 إلى 10 سنوات. كان اللحام الكهربائي الطريقة الأكثر شيوعاً، بينما كان استخدام معدات الوقاية الشخصية (PPE) خاصةً لحماية الجهاز التنفسي والسمعي منخفضاً بشكل ملحوظ. لم يجد التحليل الإحصائي أي صلة مهمة بين المتغيرات الديموغرافية أو المهنية واستخدام معدات الوقاية الشخصية، مما يشير إلى وجود فجوات كبيرة في الامتثال لمعايير السلامة. **الاستنتاج:** تُسلط هذه الدراسة الضوء على التركيبة السكانية للحامين وعلاقتها بتطبيق ممارسات السلامة المهنية. لا يزال استخدام معدات الوقاية الشخصية غير كافٍ. تُؤكد هذه الدراسة على الحاجة إلى تدخلات مُستهدفة وامتثال أكثر صرامة لمعايير السلامة في مكان العمل.

**الكلمات المفتاحية:** تأثير، السلامة المهنية، اللحام، معدات الوقاية الشخصية، محافظة الديوانية، العراق.