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Risk Assessment of Physio-Mechanical Hazards and Utilization of Personal Protective Equipment Among Welders in Kut City, Iraq

Ghassan Shaker Abdul Ridha [1*]

Affiliations
[1]Department of Electrical Techniques, Technical Institute Kut, Middle Technical University, Baghdad, Iraq

Correspondence
Ghassan Shaker Abdul Ridha, gshaker66@gmail.com

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Abstract

This study was conducted to quantify the physical and mechanical hazards in welding shops and assess the use of personal protective equipment (PPE) in these environments. The cross-sectional field survey took place in 10 welding shops selected by appropriate sampling methods from Kut city of Wasit Governorate, Iraq, and collected environmental measurements regarding temperature, humidity, and noise levels. All welders experienced hazardous levels of noise, humidity, and temperature. Electrical shock was experienced by 87.2% of welders, and 20.5% were exposed to fire. The temperature levels ranged between 38–41°C with 10–13% humidity. The heat index was a moderate 35–38° C in all welding shops, and the reported noise levels were unacceptably high. All of the work is manual labor. This assessment revealed that welders are regularly exposed to various mechanical and physical hazards and the use of PPE among them is very low, despite it being vital to their protection from hazards and prevention of accidents.

Keywords: Noise, Heat index, Humidity, Welding, PPE

الخلاصة:

أجريت هذه الدراسة لتحديد المخاطر الفيزيائية والميكانيكية في ورش اللحام وتقييم استخدام معدات الحماية الشخصية (PPE) في هذه البيئات. تم إجراء المسح الميداني المقطعي في 10 ورش لحام تم اختيارها بطرق أخذ العينات المناسبة من مدينة الكوت بمحافظة واسط، العراق، وتم جمع القياسات البيئية المتعلقة بدرجة الحرارة والرطوبة ومستويات الضوضاء. واجه جميع عمال اللحام مستويات خطيرة من الضوضاء والرطوبة ودرجة الحرارة. تعرض 87.2% من اللحامين لصدمة كهربائية، وتعرض 20.5% للحريق. تتراوح درجات الحرارة بين 38-41 درجة مئوية مع رطوبة 10-13%. وكان مؤشر الحرارة معتدلاً بين 35-38 درجة مئوية في جميع ورش اللحام، وكانت مستويات الضوضاء المبلغ عنها مرتفعة بشكل غير مقبول. كل العمل هو عمل يدوي. وكشف هذا التقييم أن عمال اللحام يتعرضون بانتظام لمختلف المخاطر الميكانيكية والفيزيائية وأن استخدام معدات الوقاية الشخصية بينهم منخفض للغاية، على الرغم من أهميتها لحمايتهم من المخاطر والوقاية من الحوادث.

1. INTRODUCTION

Welding field workers perform various forms of strenuous activity pertaining to metallurgy, the manufacture of shipyards, the mining industry, civil engineering structures, transportation, and the petrochemical industry [1]. Of all the engineering processes, welding is one of the most well-known for causing illness and injury to workers around the world [2–4].

Welding is considered to be a pillar among industries worldwide, especially in developing countries experiencing increased urbanization and expansion of their cities, which creates a demand for welding [5]. Globally, it is estimated that welders make up more than one million members of the working population. In addition, over three million industrial workers are reported to practice welding as part of their daily duties intermittently [6]. Gas welding (oxyacetylene) and shielded metal are the two major welding types, these types have significant associations with the health effects of physical and chemical agents [7]

The risk factors of this job are physical (e.g., noise and vibrations), mechanical, chemical, and psychosocial [8–11]. Remarkably, in some countries, these risk factors cause an overwhelming majority of fatalities and occupation diseases [12, 13]. Operations of welding produce aerosol and gaseous that include a metal oxide, complex metal

array (i.g. manganese, iron, nickel, chromium, etc.), and other species of chemical volatilized from the rod of welding and the material of flux that is incorporated within it [14]. Recent studies have noticed that chronic exposure to light of welding can cause ocular disorders [15].
Safety measures and personal protective equipment (PPE) play a fundamental role in reducing occupational hazards that would otherwise result in substantial human suffering and financial loss [16]. Risk identification also contributes to the success of managing occupational hazards, as it extends beyond the financial aspects to include inefficiencies or failures of the people, processes, and systems that are substantial factors affecting employee productivity, performance, and morale, and are essential to the success of an organization [17]. The implementation of safety precautions can help in avoiding welding hazards. The adherence to procedures of safety by welders is mostly reliant on the owners of welders' work [18]. This study evaluated welding shops in terms of physical and mechanical hazards in Kut city, Iraq, and assessed the uses of PPE in these environments.

2. Subjects, Materials, and Methods

Study design, location, and duration: A descriptive (cross-sectional) study was performed to assess the physical and mechanical hazards and utilization of PPE among welders in Kut city, Iraq, over a six-month period from March–August 2020.
Study participants, sample, and methods: All 39 welders working in 10 welding shops were invited to complete a questionnaire. The results were collected during (approximately) eight-hour workdays for six days per week during the study period. A random sampling method was used to select welders from shops that fulfilled the inclusion criteria, such as workers being at least 15 years old with at least one year of experience in workshops.
Interview technique: The questionnaire requested demographic data and information about physical and mechanical hazards and PPE utilization. As the majority of welders were Arabian, the questionnaire was written in the Arabic language. The first part of the questionnaire requested information about personal characteristics of the welders, such as age, marital status, residence, and educational level. It also requested information regarding work profiles (i.e., hours of work per day, how many days per week, years of experience, training level, and mobility during work). The second part included eight items related to physical hazards, and the third part consisted of six items related to mechanical hazards. The fourth part included 10 questions about the use of PPE. A two-point Likert scale was used to assess the utilization of PPE, ranging from 1 (indicating no) to 2 (indicating yes). The general scores ranged from 10–20 with a minimum of 10, a maximum of 20, and a medium of 15. The mediam was calculated for each question, and scores below 15 were considered poor, while scores above or equal to 15 were acceptable or good.
Environmental measurements: The measurements of temperature and humidity in indoor welding shops were taken with a temperature meter and digital humidity meter (Thermometer, TA2018, Chinas). Temperatures below 18–25.5°C and humidity below 40–60% were considered the normal limit value as per the World Health Organization [19]. Noise levels were measured with a mini sound meter (UNI-T, U7353, China). A measurement of about 90 dB in the daytime was considered the normal limit value, according to a scientific study [20]. The normal limit value for the heat index, as determined by the National Oceanic and Atmospheric Administration, was classified by the following [21]: below 91°F was low, 91–103°F was moderate, 103–115°F was high, and above 115°F was extremely high.
Measurement date and time: This study used the EXTECH device EN300 to measure noise, temperature, and humidity levels in all welding shops during the mornings (at 10:00AM) during the month of August 2020 after implementing optimization methods. This device, identified as the 5-in-1 model, is capable of measuring five distinct variables: temperature, acoustic sound, air moisture, air speed, and light intensity. A user-friendly LCD screen displays the recorded values. Equipped with six 9-volt batteries for operation, the instrument features six buttons for easy navigation. The air velocity function, activated by a fan-like structure at the bottom, facilitates the measurement of air speed. Additionally, a light sensor functions as a lamp to gauge the surrounding light intensity, while a built-in thermometer measures temperature. Positioned at the top of the instrument is a microphone for capturing acoustic sound. Relying on a multitude of sensors, this instrument ensures accuracy and ease of use. It boasts a rapid response time and can measure temperatures in the surroundings up to an impressive 2372°F (1300°C).
Administrative consideration: Oral consent for the study was obtained from the owner of each welding shop and the participating workers to ensure cooperation.
Statistical analysis: Data was analyzed using the Statistical Package for the Social Sciences, Windows (SPSS) version [25]. Descriptive statistics were used to assess welders' characteristics and other variables, including the measurement of frequencies, percentages, and the mean and standard deviation (SD), and the range.

3. Results and Discussion

The study was conducted on 39 welders of different welding shops in Kut city. It was observed from the study that the majority of workers (56% of the welders interviewed) were youths between the ages of 15–30 years old. This fact disagreed with the findings of G. K. S. Kumar [22] in India, who reported that the majority (76.6%) of welders were aged between 20–40 years old. The mean age in the study population was 32.87 (give or take 13 years) and ranged from 15–58 years. This assertion is in line with the findings of Isah E. C. and Okojie O. H [23] in their study of welders in Benin City, Nigeria, which had a mean age of 32.2, give or take 10.6 years.
In Iraq, all respondents were found to be male, indicating that welding is a male-dominated industry, which may be due to the arduous nature of the work and the customs and traditions that govern the country. In the same vein, Isah E. C. and Okojie O. H reported that all welders were male [23].
Nearly 90% of welders were found to live in urban areas. This percent is much higher than the observation of welders in South India in a study by [24], which indicated that 66.7% of them had a primary level of education, only 2.6% could read and write, and 2.6% was completed higher education. Five welders (12.8%) completed intermediate education, and four welders (10.3%) completed secondary education. This is consistent with the findings from a study among welders in Sokoto, Nigeria [25]. Regarding marital status, 59% of the workers were married. Correspondingly, the findings of [25] showed that 56.4% of welders were married. The details of personal characteristics can be seen in Table 1.

Table 1: Distribution of welding workers regarding personal characteristics

Personal characteristics		***f****	**%**
Age	≤ 30	22	56.4
	> 30	17	43.6
Mean ± SD (Range): 32.87 ± 13.013 (15–58 years)			
Residence	Urban	35	89.7
	Rural	4	10.3
Marital status	Single	16	41
	Married	23	59
Education level	Illiterate	2	5.1
	Literate	1	2.6
	Primary	26	66.7
	Secondary	5	12.8
	Intermediate	4	10.3
	Higher education	1	2.6

**f*: Frequency; SD: Standard deviation.

It was seen that the majority of welders (74.4%) worked eight hours daily and the vast majority (97.4%) worked more than five days weekly. The total working experience was divided into two categories, with 46.6% of them having 1–10 years of experience (with a mean of 13.56 ± 10.86 in a range of 1–40 years), and 48.7% having more than 10 years of work experience. This fact disagrees with the findings of [26] in Nepal, who reported that 16.3% of welders had been working for more than 10 years with a mean duration of 6.94 years.
Nearly 90% of welders were untrained, and only 10.3% were trained. More than half of the welders stated that their mobility during work depended on the work being performed. This finding was opposite to a study done by [27] in India, in which most welders claimed to sit for most of their time at work, with a rate of 46% (see Table 2).
The physical hazards experienced by welders are shown in Table 3. All welders experienced noise, humidity, and temperature hazards, 87.2% experienced electrical shock, and 20.5% were exposed to fire. This is supported by the previous findings of [28] in which heat and noise exposure was experienced by 77.8% and 70.4% of female welders respectively.

As for environmental measurements, various physical factors that affect welders, such as heat, humidity, and noise, were investigated in this study. Table 4 shows temperature levels of 38–41°C with a mean and SD of 39.9 ± 1.101, and humidity levels of 10–13% with a mean and SD of 11.3 ± 1.337 (a range of 10–13). The heat index in all

welding shops was moderate, between 91–103°F. In addition, this study reported a level of noise that is higher than acceptable limits. The noise levels ranged from 107–122dB in all welding shops, with a mean and SD of 117.7 ± 4.244. This is in tandem with a study by [29].

Table 2: Distribution of welders regarding work profile

Work profile		***f****	**%**
Hours of work per day	8	29	74.4
	> 8	10	25.6
Days of work per week	5	1	2.6
	≥ 5	38	97.4
Years of experiences	≤ 10	20	51.3
	> 10	19	48.7
Mean ± SD (range): 13.56 ± 10.86 (1–40 years)			
Training	Trained	4	10.3
	Untrained	35	89.7
Mobility during work	Most of the time spent standing	14	35.9
	Most of the time spent moving	2	5.1
	Mobility varied	23	59

Table 3: Physical hazards experienced by welders

Physical hazard		***f****	**%**
Noise	Yes	39	100
	No	0	0
Electrical shock	Yes	34	87.2
	No	5	12.8
Fire	Yes	8	20.5
	No	31	79.5
Humidity	Yes	39	100
	No	0	0
Temperature	Yes	39	100
	No	0	0

The mechanical hazards experienced by welders are shown in Table 5. The most common mechanical hazard was the manual labor. These findings agree with what was stated by [27] in India, who found that the manual part of welding was the majority of the work (64%). Exposure to machines and the risks related to them was the largest hazard revealed by the study. However, these findings are at odds with those of [28] in Brazil, who revealed that among the dangers identified, the machinery was not as hazardous as the other risks.

Table 4: Results of environmental measurements of physical hazards in welding shops

Shops	Temperature °C	Humidity %	Heat index F/C	Noise dB
First shop	40	11	99/37	107
Second shop	39	12	97/36	117
Third shop	41	10	100/38	119
Fourth shop	39	13	98/37	115
Fifth shop	41	10	100/38	121
Sixth shop	40	11	99/37	118
Seventh shop	41	10	100/38	119
Eighth shop	41	10	100/38	119
Ninth shop	38	13	96/35	122
Tenth shop	39	13	98/37	120
Mean ± SD (range)	39.9 ± 1.101 (38–41)	11.3 ± 1.337 (10–13)	-	117.7 ± 4.244 (107–122)

Table 5: Mechanical hazard experienced by welders

Mechanical hazard		*f**	%
Manual	Yes	39	100
	No	0	0
Risks related to the machine itself	Yes	38	97.4
	No	1	2.6
Risks related to the location of the machine	Yes	37	94.9
	No	2	5.1
Risks related to the nature of the machine	Yes	38	97.4
	No	1	2.6
Risks related to the tools and equipment	Yes	24	61.5
	No	15	38.5
Risks related to chips, particles, and splinters	Yes	24	61.5
	No	15	38.5

The use of PPE is an integral part of creating safe working conditions and an important component of hazard prevention and control. Compliance with PPE use and the recommended precautions are critical to preventing hazards and preserving welders' lives. Table 6 details all the PPE used by welders. In the present study, 17.9% of PPE was used appropriately among welders, with the most utilized PPE being eye goggles (*f* =38, 97.4%), and ear protectors (n=37, 94.9%). This result coincides with Jessy Z'gambo (2015) in Norway, who found that the use of PPE among welders was low [30]. This result is also supported by [31] in Indonesia, who found that many welders do not use full PPE.

Table 6: Utilization of PPE

PPE		*f**	%
Use of eye shields (eye goggles)	Yes	38	97.4
	No	1	2.6
Use of appropriate face protectors	Yes	18	46.2
	No	21	53.8
Use of lenses with appropriate filters	Yes	1	2.6
	No	38	97.4
Use of heat resistant suits	Yes	18	46.2
	No	21	53.8
Wearing appropriate clothing	Yes	9	23.1
	No	30	76.9
Use of sleeves and special covers for arms and legs	Yes	4	10.3
	No	35	89.7
Use of special helmets	Yes	3	7.7
	No	36	92.3
Use of appropriate protective shoes	Yes	14	35.9
	No	25	64.1
Use of leather bibs	Yes	3	7.7
	No	36	92.3
Use of ear protectors	Yes	37	94.9
	No	2	5.1
Overall score of PPE use	Poor	32	82.1
	Good or acceptable	7	17.9

4. Conclusions

This study found that welders are regularly exposed to many mechanical and physical hazards. The study highlights that the use of PPE by welders is very low, despite its importance for protection of welders and prevention of accidents and hazards. Steps must be taken to ensure adequate access to PPE for welders and strict guidelines must be followed to increase the use of PPE in these workshops.

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