Original Article

Workplace Environment And Utilization Of Personal Protective Equipment Among Welders In Sharkia Governorate

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Abstract

Background: Good working environment and using of personal protective equipment plays important role in preventing occupational hazards and related problems among welders.. **The aim** of the study was to assess workplace environment and utilization of personal protective equipment among welders in Sharkia Governorate. **Subjects & Methods: Design:** A descriptive cross- sectional design was used to conduct this study to achieve the aim of this study. **Setting:** This study carried out at Al'Ashir min Ramadan City in Sharkia Governorate. **Subject:** One hundred welders were selected by using a multistage random sample from nine steel industries. **Two tools** were used to collect data they were**: Tool I:** An interview questionnaire about: demographic characteristics, work related data, Welders health characteristics, and personal protective equipment. **Tool II**: Observational checklist about welding safety and workplace environment. **Results:** 48% of studied welders use personal protective equipment. Additionally, 76% of welders used welding goggles, 8% of them used earmuffs and helmet. Also, 41% of welding workplaces had adequate environment. **Conclusion:** Less than half of the studied welders were compliance with personal protective equipment and more than two fifths of welders' workplace had adequate environment. **Recommendation:** Educational & training programs should be conducted regularly to all welders about importance of using personal protective equipment and first aid, PPE should be available, and further studies in other industries for generalization the study results.

Key words: Workplace Environment, Personal Protective Equipment, Welder, Sharkia Governorate.

Introduction

In many developing countries, welding has become one of the most important occupational groupings to rapid urbanization and industrialization of many communities and towns **(Osagiede et al., 2020).** The process of welding is being used extensively for the last several decades as one of the most commonly used joining techniques for various metallic structures including ships, airplanes, automobiles, bridges, and pressure vessels. Welding, cutting, and brazing are hazardous activities that pose a unique combination of both safety and health risks to more than 500,000 workers in a wide variety of industries. Welding joins pieces of metal by the use of heat, pressure, or both **(Kumar and Gunasekaran, 2018**).

International Standard Classification of Occupations (ISCO) defined welders as workers who join and cut metal parts using flame or electric arc and other sources of heat **(Osagiede et al., 2020).** It is estimated that over 6 million people worldwide have the occupational title of welder either full-time or part-time. Globally, millions of workers not classified as full-time welders may perform welding duties in their jobs, such as shipbuilders, ironworkers, boilermakers, construction workers, farmers, manufacturers, and automotive workers (**De Perio, 2022)**.

Workplace environment is an important part of human environment and plays a major role in the performance and productivity of welders. An unsafe health facility environment such as unsuitable furniture, poorly designed workstations, lack of ventilation, excessive noise, inappropriate lighting, poor supervisor support, poor work space, poor communication, poor fire safety measures for emergencies, and lack of personal protective equipment, can adversely affect the productivity of the welder. Similarly, hazards as a result of the poorly managed surrounding can hinder welders productivity rate and lead to a low morale. This makes the workplace environment a very crucial determinant of the welder performance **(Edem, 2017).**

The health and efficiency of workers in any organization get influenced in large extent by conditions in their work environment. It is established a fact that no occupation without risk of hazard and welding is associated with various inherent occupational hazards. (**Mgonja, 2017).** Welding activities are dangerous if safety program is not properly implemented. The welding can pose a physical, chemical and mechanical hazard to the welders if the operation procedure is not adhered to. Industries accidents are avoidable that can be managed if personal protective equipment used **(Vora & Badheka, 2019).**

Personal protective equipment (PPE) provides a physical barrier between the worker and the hazard. PPE is considered the important effective control measure, because it requires a comprehensive program and a high level of worker involvement and commitment for proper use (**De Perio et al., 2022).** Personal protective equipment is one of the important measures to protect workers from occupational hazards particularly in developing countries where conventional occupational safety control principles are difficult to implement **(Tadesse et al., 2016).** Additionally, occupational Safety and Health Administration (OSHA) defined personal protective equipment, commonly known as "PPE", as equipment worn to minimize exposure to a variety of hazards. It includes eye and face protection (safety glasses, goggles, or face shields), foot protection (safety shoes), hand protection (gloves), head protection (helmet) and hearing protection (earplugs/earmus) (**Sehsah, 2020**).

PPE includes full-face respirators and gas masks, respiratory protective equipment protect welders against contaminants present in the workplace such as harmful gases and chemicals (**Safety Culture, 2022).** Ear plugs: Hearing loss is a serious detriment to quality of life, as is tinnitus, and in most cases it is absolutely avoidable workers need personal ear protectors**.** As well, body protection is needed to protect against hazards such as chemical splashes, heat and/or fire, electrical discharge, impact or penetration, pressure leaks and even against the risk of drowning such as welding apron (**Auton, 2018).**

Occupational health nurses work with welders to identify health and safety needs in the workplace. To meet those needs, occupational health nurses should coordinate and deliver services and programs, and promote an interdisciplinary approach to health care and advocate for the welder's right. Additionally, encourage welders to take responsibility for their own health through health education and disease management programs, such as exercise/fitness, nutrition and weight control, stress management, control of chronic illnesses, effective use of medical services and use of PPE. Moreover, monitor the health status of workers, and community groups and conduct research on the effects of workplace exposures, and hazard data (**Explore Health Careers, 2022).**

Significance of the study

Due to rapid urbanization and industrialization, welding has become an essential part of everyday life. It is a very common operation in many industries and workplaces **(Osagiede et al., 2020).** Welding is one of the occupations associated with these occupational health hazards, in both developed and developing countries. Occupational disease, injuries and accidents are the main causes of morbidity and mortality for welders. **So the present study aimed** to assess workplace environment and utilization of personal protective equipment among welders in Sharkia Governorate.

Research Questions:

1. Do the welders use the personal protective equipment?

2. What is the workplace environmental condition of welders?

Subjects & Methods

Design:
A descriptive cross-sectional design was used to conduct the current study.

Setting: The existing study was conducted at nine steel industries. These were namely the Kama Manufacturing, Arab Steel Fabrication El-Sewedy, Energya Steel Fabrication El-Sewedy, Abd-Elhamid for engineering, Elzaabalawy Complex for Decorative Iron, Linda Tube Manufacturing and Metal Processing, Metal Tube for Manufacturing Light, Arab valves, and Gest Metals in Al' Ashir min Ramadan City.

Subjects:
The existing study enrolled 100 welders, plus 10 welders' for pilot study, which were recruited from the above mentioned settings. So, the welders of pilot study were excluded from the study sample, and therefore the total subjects in the study were 100 welders.

Sample size:
Assuming the frequency of good knowledge about PPE was 33.3% vs 66.7% in those with work duration 1 year vs >6 years. At 80% power and 95 % CI. The estimated sample was 80 subjects.

Tools of data collection:
Two tools were used to carry out the present study, they were:
Tool I: An Interview questionnaire which was developed by the researcher in the light of the current related literature and composed of four parts.
Part (I): This involved questions concerning **the demographic data** of the welders such as; code number, age, educational level, marital status, income, residence, number of family member and number of rooms.

Part (II): This part asking about **work related data** such as; job, age at start, years of experience in welding , daily working hours, have breaks, weekly working days, work shift, work night shift, work double shifts, work overtime. Furthermore this part ask about welding job characteristics as, trained in welding, type of training, duration of training, welding type, gas type, weld tanks, weld painted surfaces, body position at work, and profession license and reasons for not having .

Part (III): entail collect data about Welders' history and health characteristics, developed by the researcher and guided by **Abd Alaleem et al. (2018),** such as smoking, type of smoking, pack-years, smoke at work, use substances, No. of meals, have regular meals, chronic diseases and had previous surgery .

Part (IV): Consist of questions to collect data about workplace safety measures and the use of personal protective equipment. Such as workplace safety measures as provided doctors, nurse and clinic, pre-employment examination and periodic medical examination, discovered problems, work provided PPE and provided training about PPE use (Questions 30 to 34). Additionally, this part covering questions related to **personal protective equipment :** as helmet, welding goggles, face shield, welding gloves, apron, safety shoes, ear muffs, and respiratory mask. Moreover, asking about the reasons for not utilization of personal protective equipments .

Tool II: Observational checklist about welding safety and workplace environment **(Appendix II):** To recognize safety of work environment condition of welders.This tool adopted by **Safety Culture (2022) a**nd **Abd Alaleem et al. (2018)**. It included 47 statements. **First; Pre-operation** classified into three domains as follows.

1st - Operators: Composed of **six** items asking about welding operators trained/certified, instructions clear and understood by operators, welding operators familiar with welding machine, types of materials to be weld, wear proper PPE, and welding operators aware of all safety and emergency protocols.

2nd - Welding machine: Three items such as welding cables, wirings, and electrode holder insulations in good working condition.

3rd - Work area: Eight items asking about clean and free of flammables and obstructions, work area well-ventilated, there a suitable fire extinguisher nearby while welding, combustible floors wetted or protected, combustible walls shielded or guarded, fire blanket available within the area, warning signs placed within the area, work area restricted to regular employees.

Second: On-going operation: Consists of **eight** items as arch shield used to provide an extra layer of protection, all welding operators wear an approved respirator, insulated from work and ground and use dry insulation, welding operators avoid coiling of electrode cable around any part of their body, oxygen cylinders handled with clean hands or gloves, fuel-gas cylinders placed with valve end up, and cylinder not attached when lifting a machine.

Third: post operation: Six items such as combustible materials swept away, welding equipment turned off and properly stored, gas cylinder valve fully closed and put away safely, equipment clean and stored properly, waste items disposed properly in designated and appropriate waste container, and incidents reported to a supervisor.

Additionally, Work environment: Consists of **eight** items such as adequate lighting, enough space between machines, work space is free from obstruction, safe water supply, waste disposal system, eating and rest area, source of radiation, and safe stairs. Furthermore, asking questions about **washing facilities: Two** items as kept clean, and number of toilets suitable to number of workers and type of work. As well, **Emergency exit: Two** items asking about exit enough to allow prompt escape, and exit clearly marked. As well, ask questions about the storage area far from the workers, welders are trained to put fire off, prepare with emergency equipment, and enough first aid supply with no expired products inside.

Scoring system:

Safety of work environment: Each item checked was scored 1 and the unchecked scored 0. The scores of the items of each category and for the total checklist were summed-up and the total converted into percent scores. The work environment safety was considered "adequate" if the percent score was 60% or more, and "inadequate" if less than 60%.

Pilot study:

The pilot study was carried out on 10 welders representing about 10% of the calculated total sample size. It was aimed at testing the adequacy of the research instruments, assessing whether the research protocol is realistic and workable, clarity of the questions, the format of the questionnaire, comprehensiveness of the items and to estimate the exact time required for filling out the questionnaire form. According to the results of the pilot, all modifications of items were performed according to the pilot results, and the tools were finalized accordingly. The welders who shared in the pilot study were not included in the main study sample.

Field work:

Upon securing all official permission. The process of data collection was started in June 2022 and continued through November 2023. The researcher met with the director of labour office and the director of occupational safety and health office of Al' Ashir min Ramadan, to seek the permission of the directors of the selected industries to allow the researcher carry out the study.

In addition the researcher met with each Occupational Safety and Health Manager of each industry mentioned above**.** Furthermore, the researcher took a tour of each selected industry accompanied by occupational safety and health manager mentioned above and get to know the nature of the work. Then, the

researcher set a schedule for data collection in collaboration with the director of each industry. The researcher spent some time with welders before the actual data collection procedure to be familiar with the welders. The researcher met with welders individually, explained to them the study aim and procedures, and invited them to participate. Those who gave their oral consents were interviewed using the two data collection tools. The time needed to fill- in the two forms ranged between 25 and 35 minutes for each welder. Moreover, observational checklist was done by the researcher; it took from 20- 25 minute. The researcher performed the field work three days weekly Saturday, Tuesday and Thursday, All of these activities done at the work places (welder industries), the number of persons ranged from 4-5 welder /day.

Validity

It was ascertained by a panel of five experts in the field of community health nursing and community medicine, two professors from the Departments of Community Health Nursing and Geriatric Nursing, Faculty of Nursing, Zigzag University. As well as, three professors from faculty of medicine from the Department of Community Medicine and occupational health and safety who reviewed the contents of the tools for clarity, relevance, comprehensiveness and understand ability. The tools were modified according to their comments and suggestions.

Reliability:

Reliability analysis of the proposed tools was done by Cronbach's Alpha test.

Items	**Cronbach's Alpha**
the use of personal protective equipment	0.851
Observational checklist of welding safety and workplace environment,	0.918

Ethical consideration:

The research protocol was approved by the research and ethical committee of the faculty of nursing, Zigzag University. The researcher was clarified the aim and the objectives of the study to welders included in the study before starting. Oral consent was obtained from the welders before inclusion in the study; a clear and simple explanation was given according to their level of understanding. They secured that all the gathered data was confidential and used for research purpose only. The researcher was assuring maintaining anonymity and confidentiality of subjects' data included in the study. The welders were informed that allowed to choose to participate or not in the study and have the right to withdrawal from the study at any time..

Administrative design:

The official permission was obtained from the workforce and migration Directorate in Sharkia Governorate based on letter issued from the postgraduates department at Faculty of Nursing, Zigzag University explaining the aim and procedures of the study. Then, the director of labour office and the director of occupational safety and health office of Al' Ashir min Ramadan referred the researcher to the directors of the selected industries with approval letters. Then the researcher met with each of them and explained the aim of the study and the nature of tool used for data collection. The researcher gave the director of each industry a copy of the tool and the formal letters.

Statistical design:
Data entry and statistical analysis were done using SPSS 20.0 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means and standard deviations and medians for quantitative variables. Cronbach alpha coefficient was calculated to assess the reliability of the developed tools through their internal consistency. Qualitative categorical variables were compared using chi-square test. Whenever the expected values in one or more of the cells in a 2x2 tables was less than 5, Fisher exact test was used instead. In larger than 2x2 cross-tables, no test could be applied whenever the expected value in 10% or more of the cells was less than 5. Spearman rank correlation was used for assessment of the inter-relationships among quantitative variables and ranked ones. In order to identify the independent predictors of workers' scores of exposure and awareness, multiple linear regression analysis was used and analysis of variance for the full regression models was done. To identify the independent predictors of the risk of exposure and the use of PPE, multiple logistic regression analysis was used. Statistical significance was considered at p-value <0.05.

Results

Table 1 clarifies that 50% of the study sample was at age group < 40, with mean± SD equal 40.3±9.3, and 51% of them had secondary education. Regarding workers' demographic characteristic, 91% of them were married and 68% of them had insufficient income. Concerning residence, 63% of them belonged to rural areas and their homes were mainly not crowded (<2/ room) as reported by 72% of workers.
Table 2 demonstrates that 95% of workers of study sample were welders, 63% of them started job at age more than 18 years, with mean± SD equal 19.0±5.8, regarding experience years in welding 40% of workers had 10 years' experience with mean ±SD equal 13.3±7.3. As for daily work hours, 78% of worker work < 9 hours per day, additionally 73% of them work 5 days per, additionally 73% of them work 5 days per week. Moreover 100% of workers had breaks and 82% of them had work overtime.

Table 3 reveals that 36% of workers in the study sample had training in welding, 52.8% had formal training. As duration of training, 66.7% of them trained <1 year. Concerning welding type, 85% of worker used gas welding, as for gas type, 97.6% of them used carbon dioxide. Regarding body position at work 49% of worker was standing position at work and 74% of worker had license, while reasons for not having license 61.5% of worker said that it is not requested by company.

Table 4 explains that 76% of workers use welding goggles, 78% of workers use welding gloves and 70% of workers use apron. The lowest uses of PPE as reported by workers were mask and earmuffs (21% & 8%) respectively.

Table 5 describes overall use of PPE and reasons for non-use as reported by workers in the study. As the table reveals that 52% of workers in the study sample did not use of personal protective equipment, regarding reasons for non-use, 68% of reasons was leave it to fate, 60% of reason was annoyance and 41% of reason was not available.

Table 6 explains total safety of work environment as observed in workers' workplaces. As the table displays, total welding environment was adequate (51%), moreover, work environment was adequate (62%).

As figure 1 display, total safety of work environment was adequate (41%) and inadequate (59%).

Table 7 displays that it is evident that there was statistically significant relations between use of PPE and experience years in welding (P= 0.01), daily work hours (P=0.002), weekly working days (P=0.002), work shifts (P=0.001), work night shifts (P=0.001) and work double shifts (P=0.001).

Table 8 demonstrates the relations between workers' welding job characteristics and their use of PPE. According to this table, it is obvious that there was a statistically significant difference relation between use of PPE and trained in welding (p=0.001) and weld tanks (p=0.001) .

Table 9 describes there was statistically significant relation between workers' workplace characteristics and their use of PPE .as well, between use of PPE , there is a doctor (p=0.001) , there is a nurse (p=0.001) , there is a clinic (p=0.001) , PPE provided (p=0.001), welding environment (p=0.001) and work environment (p=0.001)

Table 1: Demographic characteristics of workers in the study sample (n=100)

Demographic characteristics	Frequency	Percent
Age:		
<40	50	50.0
40-	29	29.0
50+	21	21.0
Range	20-59	
Mean±SD	40.3±9.3	
Median	39.5	
Education:		
Illiterate	16	16.0
Read/write	14	14.0
Basic	10	10.0
Secondary	51	51.0
University	9	9.0
Married:		
No	9	9.0
Yes	91	91.0
Income:		
Insufficient	68	68.0
Sufficient	32	32.0
Residence:		
Rural	63	63.0
Urban	37	37.0
Crowding index:		
<2	72	72.0
2+	28	28.0

Table 2: Job characteristics of workers in the study sample (n=100)

Job characteristics	Frequency	Percent
Job:		
Welder	95	95.0
Assistant	5	5.0
Age at start:		
<18	37	37.0
18+	63	63.0
Range	7-49	
Mean±SD	19.0±5.8	
Median	18.0	
Experience years in welding:		

<10	29	29.0
10-	40	40.0
20+	31	31.0
Range	1-30	
Mean±SD	13.3±7.3	
Median	13.5	
Daily work hours:		
<9	78	78.0
9+	22	22.0
Weekly working days:		
5	73	73.0
6	27	27.0
Have breaks	100	100.0
Work shifts	44	44.0
Work night shifts	34	34.0
Work double shifts	35	35.0
Work overtime	82	82.0
Overtime hours/month (n=82):		
<80	66	80.5
80+	16	19.5

Table 3: Welding job characteristics of workers in the study sample (n=100)

Welding job characteristics	Frequency	Percent
Trained in welding:		
No	64	64.0
Yes	36	36.0
Type of training (n=35):		
Informal	17	47.2
Formal	19	52.8
Duration of training (n=35):		
<1 year	24	66.7
1-2 years	5	13.9
3 years	7	19.4
Welding type:[@]		
Gas	85	85.0
Electric	59	59.0
Gas type (n=85):		
Carbon dioxide	83	97.6
Natural gas	2	2.4
Weld tanks	32	32.0
Weld painted surfaces	1	1.0
Body position at work:		
Standing	49	49.0
Sitting	10	10.0
Variable	41	41.0
Have license	74	74.0
Reasons for not having (n=26)		
No reason	5	19.2
Assistant	2	7.7
Not requested by company	16	61.5

Expired	3	11.5

(@) Not mutually exclusive

Table 4: Use of PPE as reported by workers in the study sample (n=100)

Personal Protective Equipment (PPE)	No		Sometimes		Yes	
	No.	%	No.	%	No.	%
Helmet	65	65.0	27	27.0	8	8.0
Welding goggles	0	0.0	24	24.0	76	76.0
Face shield	15	15.0	25	25.0	60	60.0
Welding gloves	17	17.0	5	5.0	78	78.0
Apron	18	18.0	12	12.0	70	70.0
Safety shoes	26	26.0	11	11.0	63	63.0
Earmuffs	36	36.0	56	56.0	8	8.0
Mask	27	27.0	52	52.0	21	21.0

Table 5: Overall use of PPE and reasons for non-use as reported by workers in the study sample (n=100)

Item	Frequency	Percent
Use of personal protective equipment (PPE):		
Yes	48	48.0
No	52	52.0
Reasons for non-use:@		
Annoyance	60	60.0
Decrease productivity	36	36.0
Low quality PPE	1	1.0
Not available	41	41.0
No training	22	22.0
Not convinced with its usefulness	0	0.0
Leave it to fate	68	68.0
According to need	11	11.0

(@) Not mutually exclusive

Table 6: Total safety of work environment as observed in workers' workplaces (n=100)

Adequate environment (60%+):	Frequency	Percent
Pre-operation:		
Operators	51	51.0
Welding machine	100	100.0
Work area	22	22.0
Total pre:		
Adequate	64	64.0
Inadequate	36	36.0
Ongoing operation:		
Adequate	49	49.0
Inadequate	51	51.0
Post operation:		
Adequate	72	72.0
Inadequate	28	28.0
Total welding environment:		
Adequate	51	51.0

Inadequate	49	49.0
Work environment:		
Adequate	62	62.0
Inadequate	38	38.0

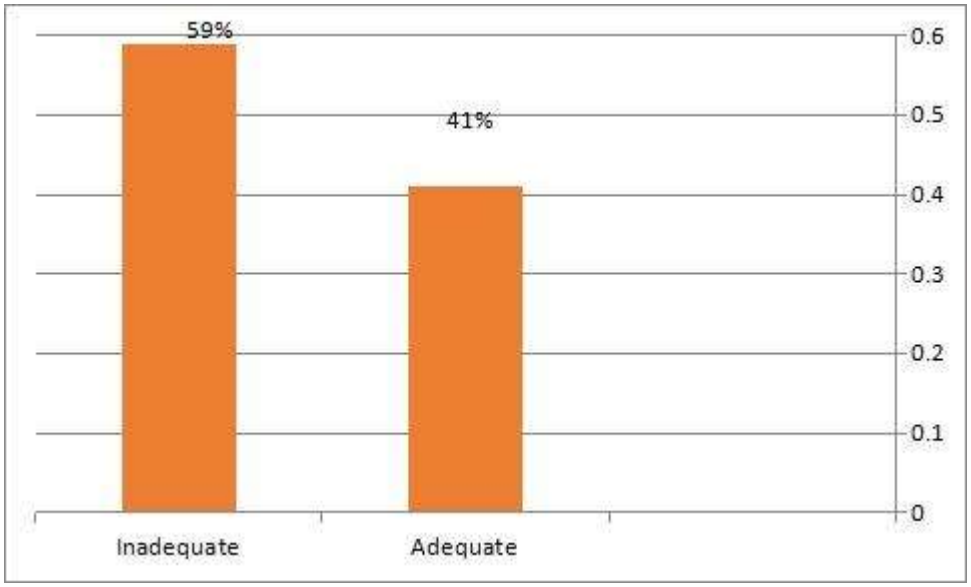

Figure 1: Total safety of work environment as observed in workers 'workplace (n- 100).

Table 7: Relations between workers' job characteristics and their use of PPE

job characteristics	Use of PPE				X^2 test	p-value
	Yes		No			
	No.	%	No.	%		
Job:						
Welder	44	46.3	51	53.7		
Assistant	4	80.0	1	20.0	Fisher	0.19
Age at start:						
<18	19	19.0	18	18.0		
18+	29	29.0	34	34.0	0.26	0.61
Experience years in welding:						
<10	18	62.1	11	37.9		
10-	22	55.0	18	45.0	9.20	0.01*
20+	8	25.8	23	74.2		
Experience years (total):						
<10	8	53.3	7	46.7		
10-	12	44.4	15	55.6	0.31	0.86
20+	28	48.3	30	51.7		
Daily work hours:						
<9	31	39.7	47	60.3		
9+	17	77.3	5	22.7	9.68	0.002*
Weekly working days:						
5	42	57.5	31	42.5		
6	6	22.2	21	77.8	9.85	0.002*
Work shifts:						
No	13	23.2	43	76.8		

Yes	35	79.5	9	20.5	31.33	<0.001*
Work night shifts:						
No	19	28.8	47	71.2		
Yes	29	85.3	5	14.7	28.71	<0.001*
Work double shifts:						
No	20	30.8	45	69.2		
Yes	28	80.0	7	20.0	22.09	<0.001*
Work overtime:						
No	7	38.9	11	61.1		
Yes	41	50.0	41	50.0	0.73	0.39
Overtime hours/month (n=82):						
<80	31	47.0	35	53.0		
80+	10	62.5	6	37.5	1.24	0.27

(*) Statistically significant at p<0.05

Table 8: Relations between workers' welding job characteristics and their use of PPE

job characteristics	Use of PPE				X^2 test	p-value
	Yes		No			
	No.	%	No.	%		
Trained in welding:						
No	22	33.8	43	66.2		
Yes	26	74.3	9	25.7	14.91	<0.001*
Type of training (n=35):						
Informal	11	64.7	6	35.3		
Formal	16	84.2	3	15.8	Fisher	0.26
Welding gas:						
No	6	40.0	9	60.0		
Yes	42	49.4	43	50.6	0.45	0.50
Welding electric:						
No	18	43.9	23	56.1		
Yes	30	50.8	29	49.2	0.47	0.49
Gas type (n=85):						
Carbon dioxide	40	48.2	43	51.8		
Natural gas	2	100.0	0	0.0	Fisher	0.24
Weld tanks:						
No	22	32.4	46	67.6		
Yes	26	81.3	6	18.8	20.84	<0.001*
Weld painted surfaces:						
No	47	47.5	52	52.5		
Yes	1	100.0	0	0.0	Fisher	0.48
Body position at work:						
Standing	23	46.9	26	53.1		
Sitting	3	30.0	7	70.0	1.85	0.40
Variable	22	53.7	19	46.3		
Have license:						
No	10	38.5	16	61.5		
Yes	38	51.4	36	48.6	1.28	0.26

(*) Statistically significant at p<0.05

Table 9: Relations between workers' workplace characteristics and their use of PPE

workplace characteristics	Use of PPE				X^2 test	p-value
	Yes		No			
	No.	%	No.	%		
There is a doctor:						
No	9	17.6	42	82.4		
Yes	39	79.6	10	20.4	38.42	<0.001*
There is a nurse:						
No	13	22.8	44	77.2		
Yes	35	81.4	8	18.6	33.71	<0.001*
There is a clinic:						
No	13	22.8	44	77.2		
Yes	35	81.4	8	18.6	33.71	<0.001*
PEE provided:						
No	1	100.0	0	0.0		
Yes	47	47.5	52	52.5	Fisher	0.48
PME provided:						
No	2	6.9	27	93.1		
Yes	46	64.8	25	35.2	27.65	<0.001*
Welding environment:						
Adequate	41	80.4	10	19.6		
Inadequate	7	14.3	42	85.7	43.7	<0.001*
Work environment:						
Adequate	39	62.9	23	37.1		
Inadequate	9	23.7	29	76.3	14.52	<0.001*
Company:						
Large (10+ employees)	36	45.0	44	55.0		
Small (<10 employees)	12	60.0	8	40.0	1.44	0.23

(*) Statistically significant at $p<0.05$

Discussion

The workplace is an important part of human environment. The health and efficiency of workers in any industry is influenced by conditions in their work environment and management practices. There are varieties of hazards in the occupational environment to which workers may be exposed. Thus, welding as an occupation despite its importance it is associated with hazards to health (**Fening et al., 2021**). it is important to wear proper PPE at all. Also, as part of staying safe and dealing with the hazards of the job, welders require personal protective equipment, to shield their body against hazards **(FTS Safety, 2021).**

Concerning first research question of this study was about determining the utilization of personal protective equipment among welders in Sharkia Governorate. The results of present study clarified that more than three quarters of them used welding goggles and gloves, three fifths of them used face shield, nearly two thirds of them used safety shoes, less than three quarters of them used apron, more than one fifth of them used mask. Moreover, minority of studied welders used helmet, earmuffs and earpuff. Additionally, the overall use of PPE was that less than half of the studied subjects used personal protective equipment.

From researcher point view, this results might be due to the poor utilization of personal protective equipment might be as a result of these welders' poor awareness about PPE and the major reasons for nonuse might be related to leave it to fate, uncomfortable feeling during use used PPE, not available of ppe and

decrease productivety. These findings in same line with study conducted by **Osagiede et al.(2020),**in **South Nigeria**" and reported that low levels of utilization of PPE regarding respiratory mask and hearing protection (10%) but used more of safety goggles (81%) and safety shoes (62.1%).

Similarly, **Joshi et al .(2020),** in **Nepal**" and showed that 10% of welders used helmet, ear safety device (2%), face masks (15 %) and most of them used safety goggles. This finding supported with study conducted by **Abd Alaleem et al .(2018),** in **Egypt** "and revealed that 88.3% of welders were used eye goggles.

Consistent results were revealed by nine evidenced studies. **First, Tadesse et al. (2016),** in **Ethiopia** and found that 35% of welders used PPE as ear plug (4.3%), helmet (5.4%), safety shoes (61.3%), respiratory mask (19.8%) and eye goggle (91.8%). **Second**, **Joseph et al.(2017),** in **India** and clarified that 66.7% of welders used face shield, 74.8% of them used eye goggles and 54.6% of them used gloves.**Third, Tagurum et al .(2018),** in **Nigeria** and reported that majority of welders were used eye goggles, facemask (30.2%), gloves (65.4%), boots (58%) and earplugs (12.9%). **Fourth, Hassan et al. (2017), in Pakistan**" and showed that 72.9% of the studied welders used eye goggles and 4.3% of them used helmets. **Fifth, Gebrezgiabher et al.(2019),** in **Ethiopia** revealed that 80.8% of welders used eye goggles and 76.9% of welders used apron.

Sixth,Chukwu et al .(2019), in **Nigeria** reported that 1.9% of welders were used helmet, 62.7% of welders used safety boot and none of welders used any PPE for hearing (ear plug or ear muff). **Seventh,Yadav et al. (2020)**, in **India** and represented that 66.7% of workers were used welding goggles, 16.7% were used mask, no welders used earmuffs and helmets. **Eighth, Onguto et al. (2020),** in **Kenya**" and showed that 93.5% of welders used safety goggles and 87.2% of them used gloves. **Lastly,** very recent research finding also supports these findings by **Fening et al. (2021),** in **Kumasi , Ghana** " and illustrated that 88.8% of welders used welding goggles and 4% of welders used ear plug.

The second question of this study recognizing the workplace environmental condition of welders in Sharkia Governorate. The results of current study illustrated that welding environment composed of three domines: Pre-operation, onging operation and post operation. Regarding pre-operation, all of welders' workplace had safety welding machine, and less than two thirds had adequate pre-operation. Additionally, nearly half of welders' workplace had adequate ongoing operation. As well, less than three quarters had adequate post operation.

Related to total welding environment, more than half of welders' workplace had adequate safety welding environment. Furthermore, more than three fifths had adequate work environment and lastly more than two fifths of welders' workplace had adequate overall environment**.** From researcher point view, this results might be due to lack of supervision and relaxed enforcement of regulations. Additionally, this results might be attributed to increase the overall exposures to occupational hazards and related problems. So, employers should prioritize welders safety by providing proper safety equipment, enforcing safety protocols, and monitoring the work environment for potential hazards.

The finding supported with study by **Joseph et al. (2017),** in **India**" and reported that welding workplace had adequate ventilation (93.1%) and had adequate lighting condition (100%).Similarly, this finding in same line with **Osagiede et al. (202 0),** and reported that 80% welders had a fifire extinguisher in Their workplace.

The results of this current study were higher as compared with four studies. **First,** study by **Hassan et al .(2017),** in **Pakistan**" and showed that lack of availability of a fire extinguisher (1.4%). **Second**, with study by **Abd Alaleem et al .(2018)**, in **Eygpt** "and mentioned that welding workplace had an adequate safety environment(25.7%), lighting(100%), enough space between machines (12.3%) and eating and rest area (9.4%). Regarding work environment as washing facilities: 31.1% kept clean and number of toilets suitable to number of workers and type of work(2.8%) and emergency exit enough to allow prompt escape 0.9% and exit clearly marked (3.8%)**. Third,** study by **Onguto et al. (2020),** In **Kenya**" and showed that 13% of workplace had safety warning signs on the wall, suitable fire extinguisher (15%), secured gas cylinder (13 %), first aid

kit (10.3%) and 44% of welding workplace were well-arranged. **Fourth,** study by **Joshi et al. (2020),**in **Nepal**" and showed that 11.4% of welding workplaces had Fire extinguishers, Gas cylinders are stored away from all heat sources(11.4%), availability of safety guidelines (2.9%), First aid kit (25.7%) , 48.6% of Work spaces is clean and free from obstruction, 88.6 % of work area had Adequate lighting and cross ventilation. Finally the two research question of this study had achaived.

As regards the demographic characteristics of welders. the present study showed that half of studied welders were aged <40 and the mean age of them was 40.3±9.3 . From the researcher point of view; this might be due to the need of physical activity for welding profession as well as, elderly people have marked decline in physical & mental function. These findings consistent with study conducted by **Z'gambo (2015), in Lusaka, Zambia,** and found that the mean age of welders was (33.0 ± 10.0). On other hand, this results disagreement with study conducted by **Osagiede et al. (2020), in South Nigeria** and reported that mean age was 25.78 ± 5.27 years, and 50% of welders were aged 21-25 years. As well, these previous outcomes agreement with study conducted by **Abd- Alaleem et al. (2018)**, in **Egypt** and mentioned that the mean age of welders was (29.11 ± 11.01). This contradiction might be related to differences in sample size and internal policy of industries.

Regarding to marital status, the current study displayed that most of the studied welders were married, from the researcher point of view, this might be due to the responsibility of the married male due he is a family host. This outcome disagreement with study carried by **Z'gambo (2015)**, in **Lusaka, Zambia** who reported that 69% of welders were married. Additionally, the previous study matched with study conducted by **Abd Alaleem et al (2018),** in **Egypt** reported the same results. Furthermore, previous finding agreement with study conducted by **Chukwu et al .(2019),** in **Nigeria** who reported that 56.1% of welders were married. Moreover, previous results consistent with study by **Onguto et al., (2020)**,in **Kenya** found that 67.8% of welders were married.These differences may be due to the variations of welder ages and socioeconomic status.

According to job characteristics of welders. As, experience years in welding, the results of current study displayed that around one third of welders had work experience years more than 20 years and the mean years of experience were (13.3 ± 7.3) **Table (2).** This outcome in same line with study conducted by **Abd Alaleem et al. (2018),** in **Egypt** and found that the mean years of experience of welders were (14.08 ± 10.83). Also, these findings supported with study conducted by **Yadav et al.(2020),** in **India** and showed that 31% of welders had work experience more than 10 years.

Concerning the relation between workers job characteristics and their use of PPE. the present study revealed that, there is statistically significant association between experience years in welding and use of PPE **(P= 0.01),** daily work hours, weekly working days and use of PPE **(P= 0.002),** work shifts, work night shifts, work double shifts and use of PPE **(P= 0.001)Table (20).** From the researcher point of view, this might be due to safety training should be provided and personal protective equipment used should be in forced at steel industries. This outcome matched with study by **Tagurum et al. (2018),** in **Nigeria** and revealed that there were statistically significant relationships between utilization of PPE and job characteristics as well as hours of work per day**(P= 0.015).**

Regarding to relation between workers demographic characteristics and their use of PPE. The current study indicated that there is statistically significant association between crowding index and use of ppe (p=0.048). But, there is no statistically significant association between age, education and use of PPE **Table (19).** From the researcher point of view, this might be due to low level of awareness as this lead to increase exposure to occupational hazard and related problems. this results supported by **Tagurum et al. (2018),** in **Nigeria** clarified that There were no statistically significant relationships between age, level of education and the utilization of PPE.

I. Conclusion

In the light of results of the present study, it can be concluded that, less than half of the studied welders were compliance with personal protective equipment's. Additionally, more than two fifths of welders workplace had adequate environment.

II. Recommendations

1. Educational & training programs should be conducted regularly to all welders about importance of using personal protective equipment and first aid by occupational health nurse.
2. Providing training about safety measures in the workplace and enforcement of appropriate workplace safety regulations.
3. PPE should be available in all industries.
4. Health inspectors need to check efficacy and compliance with safety devices at workplaces periodically.
5. Further research is recommended to investigate sustainable preventive strategies to control exposure to welding related safety and health hazards in order to preserve the health of welders.

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