

Original Research Article

Awareness of occupational hazards and utilization of PPE amongst welders in Jos metropolis, Nigeria

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ABSTRACT

Background: Welding poses a range of both well-known and subtle hazards to health and safety. These hazards can act quickly or may show up only in the long term. They can be rapidly fatal (electric shock or exposure to cadmium fumes) or have delayed effects (lung changes over time). This study aimed to assess the awareness of occupational hazards and utilization of PPE amongst welders in Jos metropolis.

Methods: This was a descriptive, cross-sectional study involving 295 welders in Jos metropolis. An interviewer-administered questionnaire was used to collect data which was entered and analyzed using Epi-info version 3.5.4 statistical software. A probability value of $p \leq 0.05$ was considered statistically significant.

Results: All the respondents were males with a mean age of 24.6 ± 7.7 years. The study revealed that 293 (99.3%) were aware of occupational hazards in welding. In this study, goggles were the most frequently used PPE 98%, then gloves 65.4%, boots 58%, overalls 36.3%, facemask 30.6% and earplugs 12.9%. A statistically significant ($p \leq 0.05$) relationship was found between employment pattern as well as working hours per day and the use of safety devices.

Conclusions: The study showed that most of the welders had fair knowledge of welding related health problems, hazards and safety devices, and utilization of safety devices was less than optimal. An educational campaign on workplace hazards, types and proper use of different personal protective devices should be instituted for welders on a regular basis by the welders association, local and state government.

Keywords: Awareness, Occupational hazards, Occupational health problems, PPE, Welders

INTRODUCTION

In many developing countries, welding has become one of the most important occupational groups, owing to rapid urbanization and industrialization.^{1,2} In Nigeria, welding is usually an informally learnt occupation. The informal sector contributes significantly to the economic development of the country. The operators of this sector are artisans with mainly primary education, and sometimes no formal education at all. These artisans are

found in mining and quarrying (excluding petroleum), small scale manufacturing companies, building and construction, woodwork and furniture making, tailoring, electronics and electrical gadgets repairing industries among others.³ The 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. There are varieties of these processes but the commonest types in Nigeria are the gas welding by the use of oxyacetylene flame and the electric

arc welding involving the use of electricity. The workers get exposed to a range of hazards during the welding process.

Welding poses a range of both well-known and subtle hazards to health and safety. These can act quickly or may show up only in the long term. They can be rapidly fatal (electric shock or exposure to cadmium fumes) or have delayed effects (lung changes over time).⁴ Hazards affecting welders can be classified into physical, chemical, mechanical and ergonomic. Physical hazards are hazards that cause physical damage or injury and it includes exposure to noise, vibration, radiation (ionizing and laser) or excesses of heat, cold and physical trauma.⁵ The excessively high temperature generated by the hot oxyacetylene flame or the electric current may lead to burns and electric shocks. Injuries such as lacerations and cuts by sharp or pointed metal panes, from high velocity particles and occasional explosions of the oxyacetylene gas tanks may also occur.

It is further stated that sound as high as 120 decibels (dB) is produced by welding machine and this is very dangerous to the hearing organ. Exposure to high levels of noise (>90dB) for an eight-hour period or more is likely to cause noise-induced hearing loss (NIHL) which results in damage to the sensory hair cells of the cochlear causing permanent deafness, fatigue and nervousness may also result. It has been further opined that welding machines produce vibrations which may give rise to soft tissue injury and injury to the digital circulation of the hand and arm resulting in a condition known as Hand-Arm Vibration Syndrome (HAVS) which has symptoms similar to that of Reynaud's Syndrome i.e. blanding of the fingers.⁶

Chemical hazards on the other hand refer to the deleterious effects the chemical component of welding materials welders are exposed to on a daily basis. These include exposure to noxious metal fumes containing a cocktail of metals like zinc, copper, cobalt, nickel, chromium, platinum, and their oxides leading to various respiratory dysfunctions and to the influenza-like condition known as metal fume fever. Symptoms of metal fume fever may occur 4 to 12 hours after exposure, and include chills, thirst, fever, muscle ache, chest soreness, coughing, wheezing, fatigue, nausea and a metallic taste in the mouth.⁷

Welders have a high prevalence of musculoskeletal complaints, including back injuries, shoulder pain, tendinitis, reduced muscle strength, carpal tunnel syndrome, white finger, and knee joint diseases. Work postures (especially welding overhead, vibration, and heavy lifting) can all contribute to these disorders. These problems can be prevented by proper lifting, not working in one position for long periods of time, keeping the work at a comfortable height, using a foot rest when standing for long periods, locating tools and materials conveniently, and minimizing vibration.⁸

The World Health Organization (WHO) states that there are about 250 million cases of work-related injuries per year and one of the occupations that contributes to these work-related injuries is non-industrial welding in developing countries.¹ In the United Kingdom, 1.5 million workers suffer from occupational hazards. The fumes given off by welding processes is a varied mixture of airborne gases and very fine particles which if inhaled cause respiratory problems.² India reported a 44% prevalence of respiratory morbidity among welders resulting from their exposure to welding fumes.⁹ In a study conducted in 2009 on awareness of occupational hazards and utilization of safety measures among welders in Kaduna Metropolis (north-west Nigeria), it was discovered that 85.3% of the subjects had experienced one or more work-related accidents and occupational hazards. The most common injuries sustained were cuts or injuries to hands or fingers (38.0%), back or waist pain (1%), arc eye injuries due to foreign bodies in the eye (17.0%), burns (14.0%), hearing impairment (7.0%), fractures (4.0%) and amputation (1.0%). It was also observed that there was sub-optimal utilization of protective measures against these occupational hazards with only 34.2% of the welders using one or more types of protective devices.¹⁰

According to the International Health and Safety Association, safe work practices are generally written methods outlining how to perform a task with minimum risk to people, equipment, materials, environment, and processes. Some practices that can prevent hazards among welders include good housekeeping, personal protective equipment, availability of first aid, some principles such as assuming that every surface is hot etc. Certain work, especially where safety critical items are fabricated, requires a high level of skill and competency (e.g. welding pressure vessels) whereas a high skill level may not be so critical in some general purpose welding.⁴

Welding and cutting operations present a variety of hazards, not only to those carrying out the operation, but also to those who reside within the vicinity in which they operate. A considerable number of the general diseases that affect individuals are related to work. In Jos and environs, welders are often found by roadsides with poor practice of safety measures to minimize risk of occupational disease related to them and those residing around them. This study aimed to assess the awareness of occupational hazards, use of PPE and identify factors affecting use of PPE amongst welders in Jos metropolis in order to add to the pool of knowledge, and to make recommendations for improving their occupational health.

METHODS

The study was conducted in Jos metropolis of Plateau State in Nigeria. The city has a population of about 900,000 residents based on the 2006 census.¹¹ Jos metropolis has a number of business and industrial

layouts spreading from Bukuru (Jos South) to Jos North where welders usually set up their workshops for their business or are employed as staff of industries. The study population comprised welders and welding shops within Jos metropolis. Those included were welders and their apprentices who had spent up to six months in training and welding shops who gave consent to participate in the study. A descriptive cross-sectional design was used for the study. Using a prevalence rate of 77.9% (proportion of welders with knowledge of occupational hazard in a previous study), an absolute standard error of 0.05 and a standard normal deviate of 1.96, a minimum sample size of 291 was calculated using the formula for cross sectional study.^{12,13}

Purposive sampling technique was used to select the subjects for the study, where 50 welding workshops were selected from a pool of 105 workshops within Jos metropolis, and all the eligible workers available interviewed for the study. Informed verbal consent was obtained from each respondent before being enrolled into the study; after being assured of confidentiality and anonymity without any loss of benefits or penalty. A semi-structured interviewer-administered questionnaire was used for data collection divided into sections;

- Socio-demographic data,
- Awareness of occupational hazards,
- Assessment of use of PPE, and
- Factors affecting use of PPE.

Responses to the questions on the section for awareness were scored and then graded. For every correct answer the respondent gets a score of one and for every wrong or blank the respondent gets a zero. A total of 15 was obtainable for awareness. 0-7 was graded as poor knowledge and 8-15 as good knowledge.

The data collected was analyzed using Epi-info software version 3.5.4 and quantitative data were presented using means and standard deviation while qualitative data was presented using frequency tables, percentages and charts. Tests of statistical significant relationships were carried out using Chi-square test. A probability values of ≤ 0.05 was considered statistically significant.

RESULTS

A total of 295 respondents participated in this study. The age range of respondents was between 11 and 50 years with a mean age of 24.6 ± 7.7 years and the highest proportion of respondents, 129 (43.7%) were aged 21-30 years. All the respondents were males 295 (100%). A larger proportion were single, 189 (64.3%) and almost half of them had secondary education, 130 (44.1%) while only 12 (4.1%) had no education at all. Two hundred and thirty-four (79.3%) worked full time, while 61 (20.7%) worked part time. Majority of them 258 (87.4%) had apprenticeship training, while 15 (5.1%) had institutional training (Table 1).

Table 1: Socio-demographic data of the respondents.

Variable	Frequency (n=295)	Percentage (%)
Age (years)		
≤20	106	35.9
21-30	129	43.7
31-40	51	17.3
41-50	9	3.1
Gender		
Males	295	100.0
Female	0	0.0
Marital status		
Single	189	64.3
Married	101	34.4
Divorced	4	1.4
Educational status		
None	12	4.1
Primary	113	38.3
Secondary	130	44.1
Post-secondary	40	13.6
Employment pattern		
Full time	234	79.3
Part time	61	20.7
Work experience		
<5 years	164	55.6
>5years	131	44.4
Hours worked per day		
<6 hours	37	12.5
>6 hours	258	87.5
Training		
Institutional	15	5.1
Apprenticeship	258	87.4
Missing	22	7.5

The study revealed that 293 (99.3%) respondents were aware of at least one occupational health hazard associated with welding. Occupational hazards mentioned include noise and vibration 275 (93.2%), manual handling 274 (92.4%), fumes 269 (91.2%) and heat stress 135 (45.8%).

The table also shows that the most known health problems by the respondents were eye problems 279 (94.6%), backache 248 (84.1%) and burns 238 (81.0%) with cancers 74 (25.1%) the least known health problem. Majority of respondents 289 (98.0%) were aware of goggles, gloves 272 (92.2%) and facemasks 223 (75.6%) as PPE with only 148 (50.2%) mentioning earplugs. One hundred and seventy-three (58.6%) respondents had good knowledge about health problems and safety practices associated with welding (Table 2).

Almost all the respondents reported using PPE in the workplace with goggles (98%) being the most commonly used followed by gloves 65.4%, boots 58% and overalls 36.3% (Figure 1).

There were statistically significant relationships between utilization of PPE and employment pattern as well as hours of work per day ($p < 0.05$). There were no statistically significant relationships between age, level of

education, work experience and form of training received by respondents and the utilization of PPE ($p > 0.05$) (Table 3).

Table 2: Awareness of occupational hazards among respondents.

Variable	Frequency	Percentage (%)
Awareness of occupational hazards		
Yes	293	99.3
No	2	0.7
Occupational hazards mentioned*		
Noise and vibration	275	93.2
Manual handling	274	92.9
Fumes	269	91.2
Heat stress	135	45.8
Hazardous chemicals	117	39.7
Electric shock	70	23.7
Fires	29	9.8
Asphyxiant gases	7	2.4
Health problems mentioned *		
Eye problems	279	94.6
Backache	248	84.1
Burns	238	81.0
Cough	236	80.0
Skin disease	166	56.3
Hearing problems	140	47.5
Breathlessness	112	38.0
Cancer	74	25.1
PPEs mentioned*		
Goggles	289	98.0
Gloves	272	92.2
Facemask	223	75.6
Boots	240	81.4
Overalls	201	68.1
Earplug	148	50.2
Knowledge score		
0-7	122	41.4
8-15	173	58.6

*Multiple responses allowed

DISCUSSION

The respondents in this study were aged between 11-50 years with a mean age of 24.6 ± 7.7 years. This means that some of the respondents were children and the welding work they are engaged in could be hazardous to their growth. A separate study exploring hazardous work among children would be useful in evaluating the effect welding could have on their growth and development. Majority of the respondents in this study were less than 50 years of age. Studies conducted in Osogbo, Benin-City (southern Nigeria) and Coastal East India also have similar findings with respect to the age of majority of the respondents.^{8,9,14} Majority of the respondents in this study had apprenticeship training and this is similar to findings from other studies in Nigeria in Osogbo and Ilorin.^{8,13}

This is because apprenticeship is the most common form of training welders receive in Nigeria and only a small proportion of welders are trained in formal educational institutions.

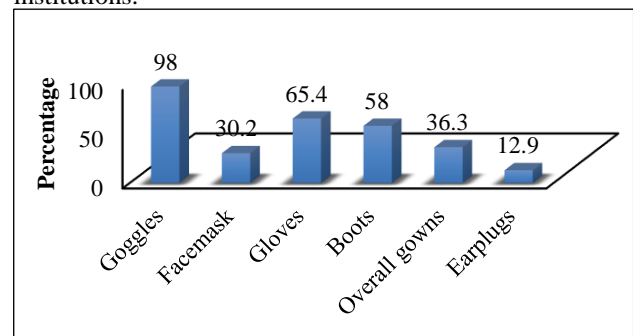


Figure 1: Percentage utilization PPE by respondents.

The study revealed a fair level of awareness of health hazards associated with the welding vocation among the respondents. About half of the respondents had good knowledge about health problems associated with welding. This is a positive finding and it could be due to the long working experience of majority of the respondents. However, a similar study carried out in Coastal South India on awareness of occupational hazards and utilization of safety measures among welders revealed a much higher level of awareness of 83.3%.⁹

Our study also revealed the most frequently mentioned occupational health problems as eye problems (94.6%), backache (84.1%), burns (81%) with cancers (25.1%) the least known health problem. This is similar to the survey carried out in Benin which revealed the most common complaints were arc eye injuries (75.7%); foreign bodies in the eyes (70.0%); and back/waist pain (52.1%).¹⁴ Majority of the respondents in this study were able to mention at least four PPE used by welders in reducing occurrence of hazards and associated health problems.

Table 3: Factors affecting utilization of PPEs by respondents.

Variable	Utilization of PPE			p-value
	Yes (%)	No (%)	Total	
Age				
≤20	106 (99.1)	1 (0.9)	107 (36.3)	0.8409*
21 – 30	128 (99.2)	1 (0.8)	129 (43.7)	
31 – 40	51 (100.0)	0 (0.0)	51 (17.3)	
41 – 50	8 (100.0)	0 (0.0)	8 (2.7)	
Total	293 (99.3)	2 (0.7)	295 (100.0)	
Level of education				
None	12 (100.0)	0 (0.0)	12 (4.1)	0.8306*
Primary	112 (99.1)	1 (0.9)	113 (38.3)	
Secondary	129 (99.2)	1 (0.8)	130 (44.1)	
Post-Secondary	40 (100.0)	0 (0.0)	40 (13.6)	
Total	293 (99.3)	2 (0.7)	295 (100.0)	
Employment pattern				
Full time	234 (100.0)	0 (0.0)	234 (79.3)	0.042*
Part time	59 (96.7)	2 (3.3)	61 (20.7)	
Total	293 (99.3)	2 (0.7)	295 (100.0)	
Work experience (years)				
<5	162 (98.8)	2 (1.2)	164 (55.6)	0.446*
>5	131 (100.0)	0 (0.0)	131 (44.4)	
Total	293 (99.3)	2 (0.7)	295 (100.0)	
Hours of work per day				
<6	35 (94.6)	2 (5.4)	37 (12.5)	0.015*
>6	258 (100.0)	0 (0.0)	258 (87.5)	
Total	293 (99.3)	2 (0.7)	295 (100.0)	
Form of training				
Apprenticeship	257 (99.6)	1 (0.4)	258 (94.5)	0.527*
Institutional	15 (100.0)	0 (0.0)	15 (5.5)	
Total	272 (99.3)	1 (0.7)	273 (100.0)	

Employment of safety measures and practices among welders are important ways of preventing or reducing the levels of health hazards associated with the occupation. Adopting health promotional measures such as the use of PPE in the workplace is an important step towards providing a healthier workplace, especially in developing countries where such measures are commonly not well considered. Utilization of PPE was found to be high in

this study with goggles being the most frequently used followed by gloves, boots, overalls, facemasks and earplugs. This is quite encouraging and it correlates with the level of knowledge of safety measures among the respondents. It also compares favourably with findings from a study in Ethiopia which showed that majority of the respondents also used goggles, overalls, and safety shoes.¹⁵ One of the hazards welders are exposed to is cadmium fumes but unfortunately in this study, not much

was being done to protect the workers against this hazard as the use of face mask was not as high among the workers.

Previous studies have shown that factors that affect the use of PPE include age, level of education, knowledge of safety measures, form of training received, work experience and presence of safety regulatory measures in the workplace among others.^{3,8-10,12,14,15} Our study however, revealed statistically significant relationships between utilization of PPE and employment pattern as well as hours of work per day ($p < 0.05$). We did not find statistically significant ($p > 0.05$) relationships between the use of PPEs among our respondents and age, level of education, duration of work experience and the form of training (apprenticeship versus vocational) received by them. This is similar to the findings from the work done in Osogbo, Nigeria which showed that there was no statistically significant relationship between the use of safety devices and age, level of education and the working experience of welders.⁸

Our study only explored the use of PPE among welders and associated factors. A different study which will investigate other safety measures in the workplace like use of engineering and administrative controls, regulations and enforcement is highly recommended in order to further evaluate the safety practices of welders.

From this study, it was discovered that most of the respondents were aware of workplace hazards including welding fumes, manual handling of welding equipment, noise and vibrations as well as some of the welding-related health problems. The study also revealed that use of at least one PPE was high and factors associated with this included employment pattern and hours of work per day. However, not much was being done to prevent lung-related health problems among them. It is recommended that continuous educational campaign on workplace hazards, types and proper use of different PPE should be sustained for welders on a regular basis by the welders' association, local and state governments. Safety devices should be made readily available and accessible through sale at subsidized rates to welders by local and state governments. Local and state governments should institute a program that could give financial rewards to welders who maintain a work-related accident free record yearly.

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