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Occupational Hazards and use of Personal Protective Equipment among Small Scale welders in Owerri North LGA, Imo State, Nigeria.

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***Abstract**: Welders are a group of workers whose working ability and health condition are affected by specific work-related activities, condition or materials which are hazardous to health. Welding despite its importance has been regarded as a very risky job. People usually experience occupational injuries and diseases and majority even die at work due to frequent exposure to welding hazards. Incidentally, very few studies have addressed occupational hazards and use of personal protective equipment among small scale welders in Imo State Nigeria. But to the best of the researcher's knowledge, none of these studies included Owerri North Local Government Area Imo State, Nigeria. It is in view of the above that this work was carried out to determine occupational hazards and use of personal protective equipment (PPE) among small scale welders in Owerri North LGA, Imo State. The aim of the study was to assess occupational hazards and use of personal protective equipment (PPE) among small scale welders in Owerri North LGA Imo State. The study employed a descriptive cross sectional study design to elicit information from 212 small scale welders located in Owerri North LGA, Imo State. A well-structured interview guide and a hazard assessment checklist were used to collect data and the data was analyzed using descriptive statistics. Chi square test was used for comparing study variables. The level of significance was set at P≤0.05. The findings revealed that from observation, welders were exposed to hazards such as bright light, heat, noise and fumes (100%) respectively. The study showed that majority (40.1%) of the welders had low awareness regarding welding hazard, as bright light (91.5%) was the most common hazard identified, while majority (50.0%) of the welders had high awareness regarding PPE, as welding goggle (90.6%) was the most common PPE identified. The most commonly used PPE reported by welders were foot PPE and body PPE (62.7% and 53.8%) respectively. Also none of the welders used all the recommended PPE at the same time during their work. The findings also revealed that, socio-demographic characteristics such as age, marital status, level of education and work experience of welders influenced their awareness regarding hazards and their awareness regarding PPE. Welders in this study also used non - recommended PPE such as sunglasses, cotton mask and ordinary shoe during welding operations. Hence this study concluded that welders worked under dangerous conditions that exposed them to numerous hazards. A lot of welders in this study were not aware of welding hazards. Although most welders were aware of PPE but a much smaller proportion among them actually uses PPE during welding. These hazards if not prevented would lead to increase in occupational injuries and diseases and even death amongst welders. Therefore, there should be an intense focus on education on hazard identification and also strict enforcement on proper use of PPE among small scale welders in Owerri North LGA.*

***Key words:** Occupational Hazards; Use of Personal Protective Equipment; Small Scale welding*

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I. Introduction

Welders are a group of workers whose working ability and health condition are affected by specific work-related activities, condition or materials which are hazardous [24; 25; 23; 18]. A daily task analysis showed that experienced welders spend on average 8 hours of their time cutting, grinding, hammering, welding, cleaning and painting metals. These activities is associated with inherent hazards which include; exposure to welding fumes and gases, noise, vibrations, heat, fire, flying sparks/particles, uncomfortable work postures, bright light, electric shock [10; 17; 4]. Welding is associated with various health effects which include; Acute health effects include; Metal fume fever, conjunctivitis (welders eye), skin burns, temporal hearing loss, stress, burns, heat stroke, cuts, musculoskeletal complaints(back pain, muscle fatigue and injuries) [11; 2; 9; 5].

Chronic effects of welding include; Bronchitis, asthma, skin and lung cancer, blindness, permanent hearing loss, risk of cardiovascular diseases, hand arm vibration syndrome, carpal tunnel syndrome [19; 2]. Occupational hazard according to [22] is defined as a work material substance, process or situation that predisposes one to disease or accident, or can directly cause disease or accident to workers in the work place, and even years after the workers might have left the workplace. According to the International Labour Organization [12] global estimates, every year over 2.3 million men and women die at work as a result of an occupational injury or disease.

Welding is a joining process in which metals are heated, melted and mixed to produce a joint with properties similar to those of the materials being joined [21]. Welding, despite its importance in employment generation in developing countries has been regarded as a very risky job as it is associated with various inherent hazards which have the potential to cause injury or harm to the health of welders performing the task, other fellow workers and the public at large [12; 16]. Hence, welders need to be aware of hazards related to their work as well as protect themselves at all times from exposure to these hazards. Notwithstanding that personal protective equipment is considered as the last resort for control of hazards in a workplace, to be used only when other possible engineering and management controls have been put in place, it stands out as the most decent measure of protection for welders in small enterprises where conventional occupational safety control principles remain a challenge to implement [3].

Incidentally, very few studies have addressed occupational hazards and use of personal protective equipment among small scale welders in Imo State Nigeria. But to the best of the researcher's knowledge, none of these studies included Owerri North Local Government Area. Such information is vital in understanding the extent of the problem and may be useful when designing intervention strategies targeted at promoting and upholding good health and safety standards in this important working group. It is against this background that the study sought to assess occupational hazards and use of PPE among small scale welders in Owerri North Local Government Area Imo State, South-Eastern Nigeria.

II. Materials and Methods

This study was carried out on small scale welders who are registered under the welders union across the various districts in Owerri North Local Government Area Imo State, Nigeria from July 2018 to February 2019. A total of 212 small scale welders were used in the study.

Study design The study adopted a descriptive cross sectional study design.

Study location: This was a community based study done in Owerri North LGA, Imo State, Nigeria

Study duration: July 2018 to February 2019.

Sample size: 212 small scale welders

Sample size calculation: A total of Two Hundred and Twelve (212) registered small scale welders, consisting 50% of the target population was used for the study. The target population from which we randomly selected our sample was 420 small scale welders. This figure was gotten from the Chairman of welders association in Owerri North. The sample size was worked out using Nwana's sample size determination technique which states that if a population is a few hundred, a 40% or more samples could be applied. Fifty percent (50%) of the entire population of registered welders was used to determine the sample size. The sample size of welders in each district was obtained from proportionate sharing, as shown in the table below.

Subjects & selection method: A systematic sampling method was used for the study. The sampling interval was determined. The population of welders in the seven districts that make up Owerri North was used to divide the sample size in each district and an interval of two (2) was determined. Once a workshop is visited, the researcher skips two workshops and samples the next. For a selected workshop, whereby the welder or an experienced apprentice is not available, the next workshop was sampled. Based on this method, the registered small scale welders were visited at their workshops and those who gave their consent in the various districts were interviewed until the required sample size was attained.

Population of Welders and Respective Sample Size for each District in Owerri North.

District	Population	Sample size
Egbu	120	60
Naze	195	98
Orji	15	8
Emekuku	19	10
Emii	24	12
Obibi-Uratta	21	11
Ihitte Ogada/ Oha	26	13
Total	420	212

Inclusion criteria:
1. Small scale welders who are registered under the welders union in Owerri North
2. Apprentices with more than six months experience
3. Either sex

Exclusion criteria:
1. Small scale welders who are not registered under the welders union in Owerri North
2. Apprentices with less than six months experience
3. Welders who did not give consent to participate in the study

Procedure methodology:

After a written informed consent was obtained, a well- designed interview guide and hazard assessment checklist was used to collect data from welders. The validated structured interview guide was divided into three (3) sections with twenty seven (27) items on the whole. Section A; contained data on socio-demographic and work-related data of the respondent, Section B; hazard and PPE knowledge and section C; contained data on use of PPE. Also a hazard assessment checklist was used during workplace inspections to collect data on work related health hazards and personal protective equipment used by welders. The checklist was adapted from the welding health and safety assessment tool developed by the Department of Labour of New Zealand as well as the hazard assessment checklist of workplace safety and health hazards developed by the California Department of Industrial Relations [8].

Data collection was done by the researcher with the help of two (2) research assistants. The research assistants (Public Health Graduates) were selected based on previous experience in research. In addition to experience, the research assistants were trained. Their training was based on the objectives of the study, the selection of respondents and the interpretation of questions. Prior to data collection, the researcher visited the Chairmen of welders association in each district to notify them of the researchers' presence and an introductory letter from the Head of Department of public health was given to them. They were also briefed with regards to the significance of the study. Upon acceptance and eventual conclusion of data collection in a welding stand, the researcher requested for the location of other registered welders.

The welders were interviewed individually to ensure privacy and independence of the responses given. The researcher read out the questions in the interview guide to the respondents and their responses were entered by the researcher. Welders that did not give consent were thanked and the researchers went on to interview other welders until the required sample size was gotten.

Statistical analysis: Data was analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL). Descriptive statistics was used to analyze the data and the results were presented in form of charts, frequency distribution tables and cross tabulation of variables. Chi-square test was used for testing the significance of associations between variables. The level of significance was set at $P \leq 0.05$.

III. Results

Results of socio-demographic characteristics of welders in this study as shown in Table 1 indicated that all the welders were male 212 (100%). Majority was in between 31-45years old 98 (46.2%). Majority 119 (56.1%) were married. Concerning the educational qualification of the Welders; 138 (65.1%) attained secondary education, 69 (32.5%) attained primary education and 5 (2.4%) attained tertiary level. All welders 212 (100%) learnt how to weld through apprenticeship under an experienced welder. Majority 105 (49.5%) of welders in this study spent 5-10 years welding.

Table no 1: Socio-demographic and work related characteristics of welders' characteristics of welders in Owerri North Local Government Area.

Welders' characteristics	Frequency (n=212)	Percentage (%)
Sex of welders		
Male	212	100.0
Age of welders		
<16 years	28	13.2
16-30 years	55	25.9
31-45 years	98	46.2
>45 years	31	14.6
Marital status		
Single	85	40.1
Married	119	56.1
Divorced	3	1.4
Widowed	5	2.4
Level of Education		
Primary	69	32.5

Secondary	138	65.1
Tertiary	5	2.4
Type of training		
Apprenticeship training	212	100
Work experience		
<5 years	38	17.9
5-10 years	105	49.5
11-16 years	40	18.9
>16 years	29	13.7
Welding method		
Manual metal arc welding	212	100

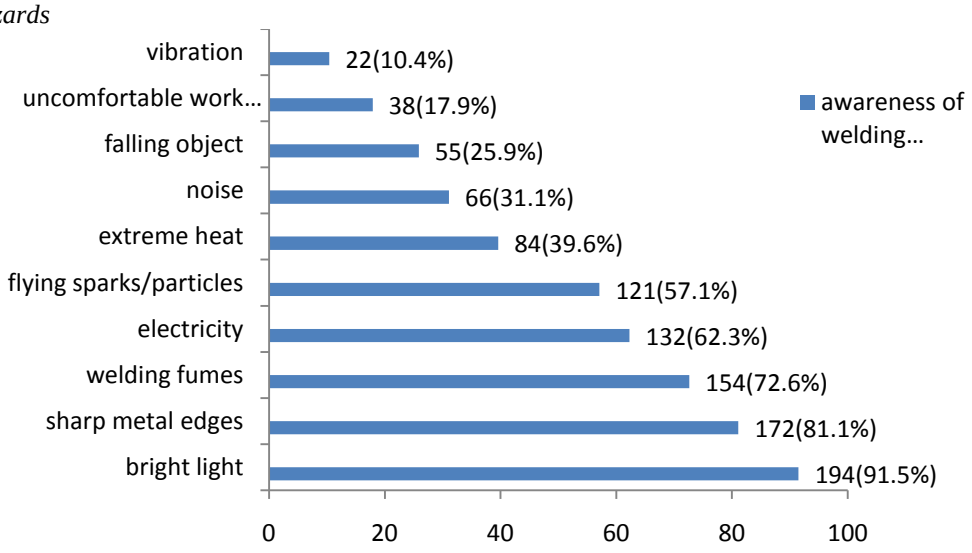
The study as presented in Table 2 showed that airborne dusts/fumes/gases, noise, intense light, extreme heat, sharp and rough edges, uncomfortable work posture and chemicals/solvents were the hazards found in all welding stands visited 212 (100%) each. Despite the fact that work was done on road sides and open areas, shields or screens were not available during welding in all the places visited 212 (100%). In some places visited, electricity 121 (57.1%), flying particles 195 (92.0%), Wet and slippery surfaces 61 (28.8%), and vibration 35 (16.5%) were also common hazard observed.

Table no 2: Frequency distribution of welding related hazards observed in Owerri North LGA

Welding Related Hazards Observed	**Frequency (n=212)**	**Percentage (%)**
Airborne dusts/fumes/gases	212	100.0
Electric hazard	121	57.1
Noise hazard	212	100.0
Flying particles hazard	195	92.0
Intense light hazard	212	100.0
Wet and slippery surface hazard	61	28.8
Vibration hazard	35	16.5
Extreme heat hazard	212	100.0
Sharp and rough edges	212	100.0
Uncomfortable work posture	212	100.0
Chemicals and solvents	212	100.0

Result of the study as presented in Fig 1 showed that bright light 194 (91.5) was the most common hazard identified by the welders working in the area followed by sharp metal edges 172 (81.1%). Uncomfortable work posture 38 (17.9%) and vibration 22 (10.4%) were the least hazards reported.

Welding hazards



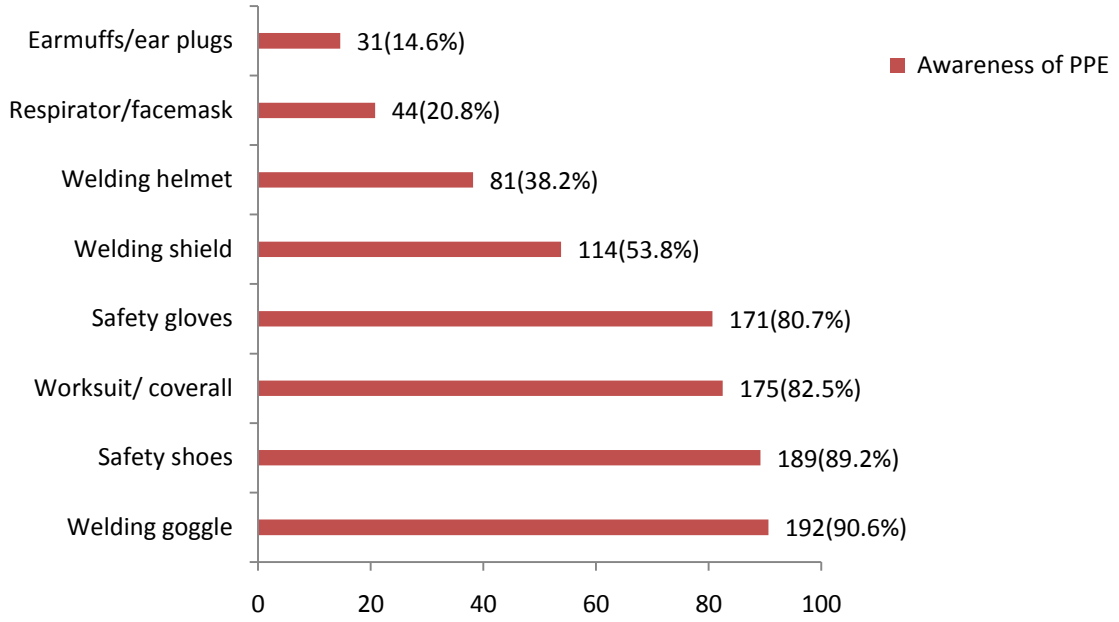
Proportion of welders aware of welding hazard

Multiple responses hence, frequency and percentage not additive.

Fig. no 1: Bar chart of welders' awareness regarding welding hazards in Owerri North LGA

The study as presented in Fig 2 showed that majority of welders were aware of welding goggles 192 (90.6%), safety shoes 189 (89.2%) and work suit/coveralls 175 (82.5 %). Welders were least aware of respirators/facemask 44 (20.8%) and ear muffs/ear plugs 31 (14.6%).

Welding PPE



Proportion of welders aware of welding personal protective equipment (PPE)

Multiple responses hence, frequency and percentage not additive.

Figure no 2: Bar chart of welders' awareness regarding welding personal protective equipment in Owerri North LGA

Results of PPE usage as presented in Table 3 revealed that 133 (62.7%) welders indicated use of safety boots, 105 (49.5%) indicated use of work suits/coveralls. The least commonly used PPE reported by welders were respirators and facemask (2.8% and 5.2% respectively). None of the welders used any PPE for hearing (ear plug or ear muff). Welders also reported to use protective equipment not recommended for their use. For instance, the majority 117 (55.2%) of welders reported to use sunglasses as eye protective equipment, others reported working on ordinary cloth and ordinary shoes (46.2% and 31.6%) respectively.

Table no 3: Frequency distribution of specific personal protective equipment used by welders in Owerri North LGA

Specific Personal Protective Equipment (PPE) used by Welders	Frequency (n=212)	Percentage (%)
Eyes and face		
Safety goggles	81	38.2
Welding shield	7	3.3
Welding helmet	4	1.9
Sunglasses*	117	55.2
None	3	1.4
Ear		
Ear muffs	0	0
Ear plugs	0	0
None	200	100
Lungs		
Facemasks	11	5.2
Respirators	6	2.8
Cotton mask*	32	15.1
None	163	76.9
Feet		
Safety boot	133	62.7
Ordinary shoes*	67	31.6
Bathroom slippers*	12	5.7

Hand		
Insulated safety gloves	68	32.1
Ordinary gloves*	21	9.9
None	123	58.0
Body trunk		
Work suit/ coverall	105	49.5
Leather apron	9	4.2
Ordinary cloth*	98	46.2

Note: welders used more than one type of the respective PPE
PPE used either sometimes or always
*indicates personal protective equipment (PPE) not recommended for use by welders
(included for descriptive purposes only).

The result showed a statistical significant association between age of welders and their awareness regarding welding hazard (X^2=131.905 P-value= 0.001). In addition, the result showed a significant statistical association between welders' level of education and their awareness regarding welding hazard (X^2=33.630 P-value= 0.005). Also, result showed a statistical significant association between welders' work experience and their awareness regarding welding hazard (X^2=145.366 P-value= 0.001). Furthermore, the result showed a statistical significant association between welders' marital status and their awareness regarding welding hazard (X^2=64.221 P-value= 0.002) as shown in Table 4.

Table no 4: Relationship between socio-demographic characteristics of welders and their awareness of hazard in Owerri North LGA

Characteristics	**Level of Awareness of Hazard**					
	Frequency (%)			**Total**	**X^2**	**P-value**
	Low	**Medium**	**High**			
Age					131.905	**0.001***
<16	28(32.9%)	0(0.0%)	0(0.0%)	28(13.2%)		
16-30	52(61.2%)	20(29.9%)	1(1.7%)	73(34.4%)		
31-45	5(5.9%)	46(68.7%)	29(48.3%)	80(37.7%)		
>45	0(0.0%)	1(1.5%)	30(50.0%)	31(14.6%)		
Total	85(100%)	67(100%)	60(100%)	212(100%)		
Level of Education						
Primary	31(36.5%)	6(9.0%)	32(53.3%)	69(32.5%)	33.630	**0.005***
Secondary	53(62.4%)	60(43.5%)	25(41.7%)	138(65.1%)		
Tertiary	1(1.2%)	1(1.5%)	3(60.0%)	5(2.4%)		
Total	85(100%)	67(100%)	60(100%)	212(100%)		
Work experience						
<5 years	47(55.3%)	0(0.0%)	0(0.0%)	47(22.2%)	145.366	**0.001***
5-10 years	37(43.5%)	52(77.6%)	4(6.7%)	93(49.3%)		
11-16 years	1(1.2%)	15(22.4%)	25(41.75)	41(19.3%)		
>16 years	0(0.0%)	0(0.0%)	31(51.7%)	31(14.65)		
Total	85(100%)	67(100%)	60(100%0	212(100%)		
Marital Status					64.221	**0.002***
Single	62(72.9%)	21(31.3%)	2(3.3%)	85(40.1%)		
Married	22(25.9%	46(68.7%)	51(85.0%)	119(56.1%)		
Divorced	1(1.2%)	0(0.0%)	2(3.3%)	3(1.4%)		
Widowed	0(0.0%)	0(0.0%)	5(8.3%)	5(2.4%)		
Total	85(100%)	67(100%)	60(50.0%)	212(100%)		

* = Significant at $P \leq 0.05$

The result showed a statistical significant association between age of welders and their awareness regarding welding PPE (X^2=122.162 P-value= 0.001). The result further showed no significant statistical association between welders' level of education and their awareness regarding welding PPE (X^2=6.382 P-value= 0.172). Also, the result showed a statistical significant association between welders' work experience and their awareness regarding welding PPE (X^2=94.334 P-value= 0.001). In addition, the result showed a statistical significant association between welders' marital status and their awareness regarding welding PPE (X^2=69.216 P-value= 0.003) as shown in Table 5.

Table 5: Relationship between socio-demographic characteristics of welders and their awareness of personal protective equipment in Owerri North LGA

Characteristics	**Level of Awareness of PPE**					
	Frequency (%)			**Total**	**X^2**	**P-value**
	Low	**Medium**	**High**			
Age					122.162	**0.001***
<16	16(30.8%)	12(22.2%)	0(0.0%)	28(13.2%)		
16-30	32(61.5%)	29(53.7%)	12(11.3%)	73(34.4%)		
31-45	4(7.7%)	13(24.1%)	63(59.4%)	80(37.7%)		
>45	0(0.0%)	0(0.0%)	31(29.2%)	31(14.6%)		
Total	52(100%)	54(100%)	106(100%)	212(100%)		
Level of Education					6.382	0.172
Primary	17(32.7%)	15(27.8%)	37(34.9%)	69(32.5%)		
Secondary	35(67.3%)	39(72.2%)	64(46.4%)	138(65.1%)		
Tertiary	0(0.0%)	0(0.0%)	5(4.7%)	5(2.4)		
Total	52(100%)	54(100%)	106(100%)	212(100%)		
Work experience					94.334	**0.001***
<5 years	29(55.8%)	17(31.5%)	1(0.9%)	47(22.2)		
5-10 years	22(42.3%)	34(63.0%)	37(34.9%)	93(43.9%		
11-16 years	0(0.0%)	0(0.0%)	41(19.3%)	41(19.3%)		
>16 years	0(0.0%)	0(0.0%)	31(29.2%)	31(14.6%)		
Total	52(100%)	54(100%)	106(100%)	212(100%)		
					69.216	**0.003***
Marital Status						
Single	39(75.0%)	32(59.3%)	14(13.2%)	85(40.1%)		
Married	12(23.1%)	22(40.7%)	85(71.4%)	119(56.1%)		
Divorced	1(1.9%)	0(0.0%)	2(1.9%)	3(1.4%)		
Widowed	0(0.0%)	0(0.0%)	5(4.7%)	5(2.4%)		
Total	52(100%)	54(100%)	106(50.0%)	212(100%)		

* = Significant at $P \leq 0.05$

IV. Discussion

The study showed that airborne dusts/fumes/gases, noise, intense light, extreme heat, sharp and rough edges, uncomfortable work posture and chemicals/solvents were the hazards found in all welding stands visited 212 (100%) each. These are well documented occupational hazards related to welding processes [11; 4]. This finding is also similar to what was obtained in a related study done in Lusaka, Zambia, where sharp and rough edges, uncomfortable work posture and chemicals/solvents, vibrations, electricity, noise, intense light, extreme heat were observed [14;20]. In this study welders were observed working in open areas, exposed to direct heat from the sun, dust from the immediate environment and rain. In addition, it was observed that exposure to welding hazards were also extended to co-workers who were not involved in welding and traders who operated in the same premises as non of the welders used screen to prevent public exposure. Also residents living closer to welding workshops were also exposed. This is a public health concern as persons who do not work, but who trade or happens to be in the area even for a short period, may also be exposed to welding hazards.

In the present study, the majority of welders (41.1%) had low awareness regarding welding hazard. This is probably due to the fact that all respondents had no formal training for the vocation and hence might not have had the opportunities to learn about the health hazards associated with their occupation. In this study, bright light and sharp metal edges were the most common hazard identified by the welders (91.5% and 81.1%) respectively. Also welders were least aware of uncomfortable work posture (17.9%) and vibrations (10.4%). This agreed with the researcher's observation which indicated that bright light, sharp metal edges and uncomfortable work postures were found in all places visited 212(100%) each. It also disagreed with works carried out by [13] which reports high awareness of hazard among welders. This is in agreement with the study carried out in Eastern Nepal were welders were less aware of vibrations [6].

Findings in this study revealed that of 212 welders, 106(50%) of the welders had high level of awareness regarding welding PPE. This is in agreement with a work carried out by [15] in Puducherry coastal south India were 134 (64.1%) were aware of PPEs. It also agreed with [1] which indicated 90.6% awareness of PPE by welders. The result of welders' awareness of PPE corresponds with another study carried out at Lusaka, Zambia where majority of welders were aware of safety shoes (87%), work suit/coveralls (68 %), welding

goggles (66%) and safety gloves (57%). Overall, welders were least aware of respiratory (25%) and ear protection (10%) [14].

Results of welders use of PPE corresponded with a study carried out by [21] which indicated that welders used one or more types of protective device with eye goggles (60.9%), hand gloves (50.3%) and boots (34.5%) having the greatest percentages. It is also in agreement with another study carried out at Lusaka, Zambia which indicated that coveralls 288 (67%) and safety boots 247 (57%) were the most commonly used PPE reported by welders [14]. Ear PPE (6%) and respiratory PPE (16%) had the lowest frequency of reported PPE use. This was higher in a study carried out in Eastern Nepal where welding goggles/face-shield use was seen among only 18% of welders [7]. This contradiction could be attributed to differences in geographical location and other socio-demographic factors considered in the previous study. This finding also agreed with the researcher's observation that the most commonly used PPE were safety boots 72 (34%) and work suits/coveralls 64 (30.2%). Although the proportion was lower than the reported PPE use.

Socio-demographic characteristics of the welders have been found to influence their awareness of welding hazard. In this study, age, level of education, welders experience and marital status were significantly associated with awareness of welding hazard. Those who attained tertiary level of education all had high awareness regarding welding hazard compared to those who had primary level. This is not surprising because the higher your educational attainment, the more knowledgeable you become. Similarly, a study on welders in Eastern Nepal found that level of education was significantly related to awareness of hazard. The authors attributed this association to the tendency of welders with higher education to read news, and other media sources [7]. In similar studies welders in Northern Nigerian and Lusaka Zambia, it was also observed that there was an association between educational attainment and awareness of hazard, which was attributed to better understanding of instructions by educated welders [21]. Welders aged 45 years and above had high awareness compared to their younger counterparts. Also, those that have worked for 16 years and above had high awareness of PPE compared to those that have spent ≤ 5years welding. The lack of experience (≤ 5years) of young welders compared to those older (> 16 years) might be the reason behind the lower awareness of PPE among the young and inexperienced welders. In another study in Puducherry Coastal South India, it was observed that age group was significantly associated with awareness of PPE [15].

In this study, age, welders experience and marital status were significantly associated with awareness of welding PPE. Level of education was not significantly associated with awareness of PPE. This finding disagrees with a study on welders in Eastern Nepal which found out that level of education was significantly related to awareness of PPE [7]. This finding is also in contrast to studies on welders in Northern Nigerian and Lusaka Zambia, which observed that there was an association between educational attainment and awareness of PPE [21; 14]. This variation could be attributed to differences in geographical location and other socio-economic factors considered in the previous study. Those welders aged between 31-45 years had high awareness of PPE compared to their younger counterparts. Also, those that have worked for 11-15 years had high awareness of PPE compared to those that have spent ≤ 5years. The lack of experience of young welders compared to those older might be the reason behind the lower awareness of PPE among the young and inexperienced welders. In another study in Puducherry Coastal South India, it was also observed that age group was significantly associated with awareness of PPE [15].

V. Conclusions and Recommendations

Based on the findings of the study, welders in this study worked under dangerous conditions that exposed them to numerous hazards. A lot of welders were not aware of welding hazards. Although most welders were aware of PPE but a much smaller proportion among them actually uses PPE during welding. A good number reported to have never used some of the recommended PPE while none of the welders reported to have used the complete PPE for the various body parts at any given time during welding. Majority of welders in this study also used non recommended PPE. Socio-demographic characteristics of welders also influenced their awareness regarding hazards and PPE. Our findings suggest that a policy that will make it compulsory for welders to use the recommended PPE consistently and correctly during welding operation should be made by responsible agencies, particularly focusing on small scale welders. Also there should be an intense focus on education on hazard identification among small scale welders.

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