

## ORIGINAL ARTICLE

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# AWARENESS OF OCCUPATIONAL HAZARDS AND UTILIZATION OF SAFETY MEASURES AMONG WELDERS IN KADUNA METROPOLIS, NORTHERN NIGERIA

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### Abstract

**Background:** Welders are exposed to a variety of occupational hazards with untoward health effects. However, little is known of welders' awareness of health hazards and their adherence to safety precautions in developing countries. This study assessed the awareness of occupational hazards and adherence to safety measures among welders in Kaduna metropolis in northern Nigeria.

**Methods:** A structured questionnaire was administered on a cross-section of 330 welders in Kaduna metropolis in northern Nigeria. Information was sought on their socio-demographic characteristics, their awareness of occupational hazards and adherence to safety measures.

**Results:** All welders were males with a mean age of  $35.7 \pm 8.4$  years. The illiteracy rate was 7.6%. Overall, 257 (77.9%) of the welders were aware of one or more workplace hazards. This was positively influenced by educational attainment, age, nature of training and work experience. Of the 330 respondents, 282 (85.3%) had experienced one or more work-related accidents in the preceding year. The most common injuries sustained were cut/injuries to the hands and fingers (38.0%), back/waist pain (19%), arc eye injuries/foreign bodies (17.0%), burns (14.0%), hearing impairment (7.0%), fractures (4.0%) and amputation (1.0%). Only 113 (34.2%) welders used one or more types of protective device with eye goggles (60.9%), hand gloves (50.3%) and boots (34.5%) being more frequently used. Regular use of safety device, shorter working hours and increasing experience were protective of occupational accidents.

**Conclusions:** The level of awareness of occupational hazards was high with sub optimal utilization of protective measures against the hazards. There is therefore need for health and safety education of these workers for health and increased productivity.

**Keyword:** Occupational Health Hazards, Welders, Nigeria

### Résumé

**Fond:** Des soudeuses sont exposées à une variété de risques professionnels avec des effets de santé impropres. Cependant, peu est connu conscience de soudeuses' des risques sanitaires et de leur adhérence aux mesures de sécurité dans les pays en voie de développement. Cette étude a évalué la conscience des risques professionnels et de l'adhérence aux mesures de sécurité parmi des soudeuses dans la métropole de Kaduna au Nigéria nordique.

**Méthodes:** Un questionnaire structuré a été administré sur une section transversale de 330 soudeuses dans la métropole de Kaduna au Nigéria nordique. L'information a été cherchée sur leurs caractéristiques socio-démographiques, leur conscience des risques professionnels et adhérence aux mesures de sécurité.

**Résultats:** Tous les soudeurs étaient des mâles avec un âge moyen de  $35.7 \pm 8.4$  années. Le taux d'analphabétisme était 7.6%. De façon générale, 257 (77.9%) des soudeuses se rendaient compte d'un ou plusieurs risques de lieu de travail. Ceci a été franchement influencé par accomplissement éducatif, âge, nature de la formation et expérience professionnelle. Des 330 répondants, 282 (85.3%) avaient éprouvé un ou plusieurs accidents travailler-connexes par année précédente. Les dommages les plus communs soutenus ont été coupés/dommages aux mains et aux doigts (38.0%), douleur arrière/taille (19%), dommages d'oeil d'arc/corps étrangers (17.0%), brûlures (14.0%), affaiblissement d'audition (7.0%), ruptures (4.0%) et amputation (1.0%). Seulement 113 (34.2%) soudeuses ont employé un ou plusieurs types de dispositif protecteur avec des lunettes d'oeil (60.9%), des gants de main (50.3%) et des initialisations (34.5%) plus fréquemment étant employées. L'utilisation régulière du dispositif de sécurité, les heures de travail plus courtes et l'expérience croissante étaient protectrices des accidents professionnels.

**Conclusions:** Le niveau de la conscience des risques professionnels était élevé avec l'utilisation optimale secondaire des mesures de sauvegarde contre les risques. Il y a donc besoin d'éducation de salubrité et de sûreté de ces ouvriers pour la santé et la productivité accrue.

**Mot-clé:** Risques sanitaires professionnels, soudeuses, Nigéria

According to World Health Organization, there are about 250 million cases of work-related injuries per year worldwide.<sup>1</sup> One of the jobs that contribute to these occupational injuries is non-industrial welding, especially in developing countries including Nigeria. Welders cut and join metal parts using flame, electric arc or other sources of heat. There are three main classes of welding, namely, arc, oxyacetylene-fuel and robotic welding. Some of the hazards of this occupation include ultraviolet (UV) and infrared radiation (IR) exposure, fumes and particulate generation, thermal burns, occupational heat stress, exposure to electromagnetic fields, and electrocution.<sup>2</sup> Similarly, the excessive lighting (glare) and exposure to UV radiation may lead to 'arc eye' or 'flash burn' injuries to the cornea, photokeratosis and double vision and consequent retinal damage.<sup>2,3</sup> Welders are also exposed 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 influenza-like condition called metal fume fever.<sup>4-7</sup>

Employment of safety measures and practices among welders are important ways of preventing or reducing the levels of health hazards associated with the occupation. While adherence to these precautions is nearly universal in the developed world, little is known about the situation in developing world including Nigeria.

In metropolitan Kaduna, the former administrative capital of northern Nigeria, welders are usually located around mechanic workshops, motor spare-parts markets and along major highways where they establish privately owned small-scale workshops. This group has no organized occupational health service and their adherence to safety

measures is unknown. We, therefore assessed the level of awareness of these hazards among welders in Kaduna metropolis and the safety measures and practices they adopt to safeguard their health, with a view to making recommendations on ways of ameliorating the effect of the hazards.

## Materials and Methods

### Study design and population

The study was carried out among welders in Kaduna metropolis. The study population was restricted to the workmen cadre only, excluding their apprentices. The survey was descriptive and cross-sectional in design. A sample size of 355 was obtained using the hypothesis testing method<sup>8</sup> and based on the following assumptions; 95% confidence level, an expected knowledge level of 70.0% from a previous study<sup>9</sup> and a 5% margin of error. The calculated minimum sample was inflated by 10% to account for anticipated subject non-response. The membership register maintained by the welders association formed the sampling frame. The systematic sampling technique was used in selecting respondents from the sampling frame. Informed consent was obtained from prospective respondents prior to commencement of the interviews. Approval for the study was obtained from the institutional review board at Ahmadu Bello University Teaching Zaria, Nigeria.

### Instrument description and data collection

A pre-tested structured interviewer-administered questionnaire containing both open and closed-ended questions was used. The questionnaire was

pre-tested and validated among welders in Sabongari, Zaria. Some of the questions were rephrased for clarity based on observations made during the pretest.

### Data analysis

The data was cleaned, validated and analyzed using SPSS version 12.<sup>10</sup> Quantitative variables were summarized using range, mean and standard deviation. Categorical variables were tabulated using frequencies and percentages. Bivariate analysis involved the use of the  $\chi^2$  test and Fisher exact test for testing the significance of associations between categorical variables. The level of significance was set at  $P < .05$ .

### Results

A total of 330 out of 355 welders agreed to be interviewed giving a response rate of 92.9%. Seventy-nine (24.0%) of the welders worked with oxyacetylene flame (gas welding) while 251 (76.0%) were electric welders. None of the respondents used robotic welding. They were all males with a mean age of  $35.7 \pm 8.4$  years with most of them, 147 (44.5%) in the 30-39 years age bracket. Twenty-five (7.6%) of the welders had no formal education, 98 (29.7%) had primary school education, while 207 (62.7%) had completed their secondary education. Majority 209 (63.3%) were married and were almost equally distributed between the two major religions. Despite the study location, welders were predominantly Yoruba as shown in Table 1.

The majority 302 (91.5%) of welders received their training through hands-on apprenticeship training. The rest 28 (8.5%) attended a formal welding school. Duration of training ranged from 18 months to 8 years with more than half of them trained for 2-3 years. They have been engaged in welding for periods ranging from 1 year to 21 years with a median of 5 years.

Table 2 shows that 257 (77.9%) of the welders were aware of one or more workplace hazards. This was positively influenced by educational attainment ( $\chi^2 = 54.8$  df = 2,  $p < .001$ ), age, nature of training and work experience. Specifically, a higher proportion of older welders were aware of occupational hazards compared to their younger colleagues ( $\chi^2 = 17.5$  df = 3  $P < .001$ ). Paradoxically, a higher proportion of welders trained through apprenticeship were aware of occupational hazards compared to those that attended formal welding schools (Fisher exact  $P = .001$ ). Expectedly, a higher proportion of experienced welders were aware of occupational hazards compared to their inexperienced counterparts ( $\chi^2 = 16.2$  df = 4,  $p = .003$ ).

Of the 330 respondents, 282 (85.3%) had experienced one or more work-related accidents in the preceding year. The most common injuries sustained were cut/injuries to the hands and fingers (38.0%), back/waist pain (19%), arc eye injuries/foreign bodies (17.0%), burns (14.0%), hearing impairment (7.0%), fractures (4.0%) and amputation (1.0%). Table 3 shows the ownership and utilization of protective/safety equipments by the welders. Only a total of 113 (34.2%) used one or more types of protective device against work place hazards with eye goggles (60.9%), hand gloves (50.3%) and boots (34.5%) being more frequently used.

Table 4 shows that regular use of safety equipment, shorter working hours and increasing experience were all protective of occupational accidents. Specifically, a significantly lower proportion of experienced welders reported occupational accidents compared to new comers ( $\chi^2 = 54.0$  df = 3,  $p < .001$ ). Similarly, accident was more likely among welders engaged for longer hours per day compared to those that worked for shorter duration ( $\chi^2 = 32.2$  df = 3,  $p < .001$ ). Age, educational attainment and type of training received did not significantly affect the occurrence of occupational accidents.

**Table 1.** Socio-demographic characteristics of respondents (n = 330)

Characteristic	No. (%)
<b>Age (years)</b>	
<20	7 (2.1)
20 – 29	120 (36.4)
30 – 39	147 (44.5)
40 – 49	35 (10.6)
50 – 59	19 (5.8)
≥60	2 (0.6)
<b>Marital status</b>	
Single	209 (63.3)
Married	109 (33.0)
Widowed	5 (1.5)
Divorced	7 (2.2)
<b>Educational status</b>	
None	25 (7.6)
Primary	98 (29.7)
Secondary	207 (62.7)
<b>Ethnic origin</b>	
Yoruba	113 (34.2)
Hausa	70 (21.2)
Ibo	42 (12.7)
Others	105 (31.8)
<b>Religion</b>	
Islam	154 (46.7)
Christianity	176 (53.3)

**Table 2.** Factors associated with awareness of welding hazards (n = 330)

characteristic	No. (%)		Total (%)	p
	Aware	Not aware		
<b>Education</b>				
None	5 (20.0)	20 (80.0)	25 (7.6)	<0.001
Primary	76 (77.6)	22 (22.4)	98 (29.7)	
Secondary	176 (85.0)	31 (15.0)	187 (56.7)	
Total	257 (77.9)	73 (22.1)	330 (100.0)	
<b>Age (years)</b>				
<20	5 (71.4)	2 (28.6)	7 (2.1)	<0.001
20 – 29	108 (80.0)	12 (20.0)	120 (36.4)	
30 – 39	100 (68.0)	47 (32.0)	147 (44.5)	
40 – 49	27 (77.1)	8 (22.9)	35 (10.6)	
≥50	17 (81.0)	4 (19.0)	21 (6.4)	
Total	257 (77.9)	73 (22.1)	330 (100.0)	
<b>Type of training</b>				
Apprenticeship	277 (91.7)	25 (8.3)	302 (91.5)	0.01
Welding school	21 (75.0)	7 (25.0)	28 (8.5)	
Total	257 (77.9)	73 (22.1)	330 (100.0)	
<b>Work experience (years)</b>				
<5	14 (40.0)	21 (60.0)	35 (10.6)	0.003
5 – 9	42 (35.0)	78 (65.0)	120 (36.4)	
10 – 14	37 (40.7)	54 (59.3)	91 (27.6)	
15 – 19	8 (38.1)	13 (61.9)	21 (6.4)	
≥20	41 (65.1)	22 (3.9)	63 (19.1)	
Total	257 (77.9)	73 (22.1)	330 (100.0)	

**Table 3.** Ownership and utilization of safety devices (n = 330)

Type of safety device	No. (%)	
	possession	utilization
Face masks	86 (26.1)	76 (23.0)
Helmets	96 (29.1)	65 (19.7)
Eye goggles	209 (63.3)	201 (60.9)
Ear muffs	108 (32.7)	34 (10.3)
Overall/apron	108 (32.7)	82 (24.8)
Hand gloves	177 (53.6)	166 (50.3)
Boots	129 (39.1)	114 (34.5)

**Table 4.** Factors associated with work related accidents among welders in Kaduna (n = 330)

Factors	No. (%)		Total (%)	p
	accident	No accident		
<b>Age (years)</b>				
<20	6 (85.7)	1 (4.3)	7 (2.1)	0.48
20 – 29	106 (88.3)	14 (11.7)	120 (36.4)	
30 – 39	124 (84.4)	23 (15.6)	147 (44.5)	
40 – 49	29 (82.9)	6 (17.1)	35 (10.6)	
≥50	16 (76.2)	5 (23.8)	21 (6.4)	
Total	281 (85.2)	49 (14.8)	330 (100.0)	
<b>Type of welding</b>				
Gas	64 (81.2)	15 (18.8)	79 (24.0)	0.24
Electrical	217 (86.4)	34 (13.6)	251 (76.0)	
Total	281 (85.2)	49 (14.8)	330 (100.0)	
<b>Working experience (years)</b>				
<5	33 (94.3)	2 (5.7)	35 (10.6)	<0.001

**Table 4 continued**

5 – 9	112 (93.3)	8 (6.7)	120 (36.4)	
10 – 14	85 (93.4)	6 (6.6)	91 (27.6)	
15 – 19	14 (66.7)	7 (33.3)	21 (6.4)	
≥20	37 (58.7)	26 (41.3)	63 (19.1)	
Total	281 (85.2)	49 (14.8)	330 (100.0)	
<b>Hours of work per day</b>				
<5	3 (42.8)	4 (57.2)	7 (2.1)	<0.001
5 – 6	6 (42.8)	8 (57.2)	14 (4.2)	
7 – 8	105 (87.5)	15 (12.5)	120 (36.4)	
9 – 10	116 (88.2)	17 (11.8)	133 (40.3)	
11 – 12	51 (91.1)	5 (8.9)	56 (16.9)	
Total	281 (85.2)	49 (14.8)	330 (100.0)	
<b>Use of safety devices</b>				
Regular	78 (69.0)	35 (31.0)	113 (34.2)	<0.001
Not regular	203 (93.5)	14 (6.5)	217 (65.8)	
Total	281 (85.2)	49 (14.8)	330 (100.0)	

## Discussion

The welding profession provides a means of livelihood for many Nigerians, but like other professions it is not without risks. Awareness of these hazards is the first step in avoiding them. We found an all male membership of the welding profession in northern Nigeria, perhaps reflecting differential gender roles in this part of the country. Males tend to select themselves into more hazardous jobs and females are assigned less physically demanding jobs. It is interesting to note that reports from southern Nigeria<sup>11</sup> showed the same gender bias. The finding that a majority (44.5%) was in the 30-39 years age bracket contrasts with reports from Benin,<sup>11</sup> Nigeria where the welders were mostly between 15-39 years age group. It appears more matured apprentices are recruited in our study area compared with the apprentices in Benin City.<sup>11</sup> Although the literacy rate of the welders is higher than the national literacy rate,<sup>12</sup> 7.6% had no formal education. Literacy could facilitate understanding and appreciation of basic safety measures. In contrast with the reports from other parts of Nigeria, there were no school dropouts among the welders in this study compared with 14.9% and 22.0% reported in other studies.<sup>11,13</sup> This could be a reflection of the reported high school dropout rate among boys in other parts of Nigeria.<sup>14</sup> In the South East in particular, there seems to be a widespread perception that children will be better off in the long run if they get apprenticed at an early age, so that they learn a marketable skill, whereas the education received in school is academic, non-functional and of poor quality.<sup>14</sup>

The majority (91.5%) of welders received their training through hands-on apprenticeship training. This could be a cost saving measure since formal welding schools charge fees whereas apprenticeship training actually provide some pocket money for the trainees during the period of training. The wide

variation in the period of training could be due to the differences in the rates of skill acquisition since apprenticeship programmes graduate their students based on skills acquisition rather than a fixed period of training.

A majority of the welders (77.9%) were aware that their jobs were hazardous to their health. This proportion is lower than observed among welders in Benin City (91.6%).<sup>11</sup> We also found that awareness was positively influenced by educational attainment, increasing age, nature of training and work experience. This is not surprising because educational attainment facilitates easy assimilation of instruction. Similarly, maturity and work experience are expected to increase awareness of occupational hazards. The observed paradox in which a higher proportion of welders trained through apprenticeship were aware of occupational hazards compared to those that attended formal welding schools could be due to the skill based nature of apprenticeship and their longer duration of training.

A recognized risk among welders is the flash injury called the arc eye. This causes a red eye with feeling of sands in the eye due to inflammation. In the present study only 17% of the welders had experienced arc eye injuries compared to much higher proportions of 75.7% and 73% reported in other studies.<sup>3,11</sup> The higher proportion of welders using eye goggles (60.9%) in the present study could explain this. Some welders do not use eye goggles due to discomfort and poor visibility when using them. The problems of visibility and comfort of ocular protective devices have been addressed over the years with improvements made in their design to reduce the incidence of ocular injuries among welders.<sup>15, 16</sup> Auto-darkening filters now being incorporated into the protective devices automatically change from a clear to a darkened state when the welding arc is struck thus allowing uninterrupted work by the welder.<sup>15, 16</sup>

Cut and injuries to the hands and fingers accounted for a significant total of 38% of the health complaints among the study group. This is not surprising considering that only half of the respondents used gloves regularly. The reported hearing impairment among 7.0% of our respondents could be explained by low (10.0%) use of earmuffs despite the noise associated with the welding process. A generally low perception of the occupational risks to the auditory and respiratory systems was also reported among welders in Benin City.<sup>11</sup> As expected, regular use of safety equipment, shorter working hours and increasing experience were all protective of occupational accidents. Specifically, a significantly lower proportion of experienced welders reported occupational accidents compared to new comers. This protective effect of experience was also clearly demonstrated in a study conducted by the All Indian Institute of Hygiene and Public Health which showed that half of employees had accidents in their first 6 months of employment, 23% in the next 6 months and only 3% subsequently.<sup>17</sup> Factors responsible for accidents among our respondents were similar to another report.<sup>9</sup>

Only a third of the welders regularly used some form of protective measures against these hazards. The poor economic condition in the country may have played a major role in the availability and afford-ability of these all-important protective devices as already reported from Benin.<sup>11</sup> The back and waist pain experienced by 19% of our respondents could be due to poorly designed workshops and the absence of pits and hydraulic lifts that facilitate the work of welders in developed countries. In addition, working for long hours in un-physiological postures could cause backache, fatigue and overstretching of muscles and joints leading to impairment of welders' health and efficiency.

There is need for proper education of this economically viable group on workplace hazards, the types and proper use of the different protective devices in order to safeguard their health. Similarly, training in ergonomics could contribute toward reduction of work-related accidents. Other factors are the appropriate design of tools and machines to achieve greater efficiency of both man and machine. There is also need for a strong welder's association that should make adequate and proper representation to the appropriate level of government. The Ministries concerned should collaborate to provide an occupational health service

for this group of workers through the informal sector segment of the National Health Insurance Scheme.

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