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Health Hazards of Excessive Light and Utilization of Safety Measures among Small Scale Welders in Nigeria

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Abstract Welding is associated with various occupational hazards, such as high-intensity lights, which results in severe consequences on health, particularly on visual acuity of workers performing their task. This study assessed the impact of excessive light on the health of welders and their use of Personal Protective Equipment (PPE). Cross-sectional study was conducted among 80 welders that were randomly selected in Yalwa and Gwallameji districts of Bauchi metropolis, Bauchi State, Nigeria using a validated self-administered questionnaire and the Snellen's chart for the data collection. The study showed that most of the respondents scored below average 20/20 (1.0) in the Snellen's chart test. Majority of the respondents (60%) never used PPE. The most reported health symptoms by more than half of the respondents were eyes irritation, watery eyes and eye strain. There was a positive correlation for age, and year of experience with vision acuity test ($p < 0.005$ and <0.001 respectively). An inverse relationship was recorded for the use of PPE and reported health symptoms ($p < 0.05$). The study revealed that welders were slightly experiencing ocular disorders. Thus, welders should be encouraged to the use of PPE in their work in order to avert these health impacts.

Keywords: *welding, health impacts, light pollution, personal protective equipment*

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1. Introduction

In the early 1980s, a global dark-sky movement has emerged, with concerned people campaigning to reduce the amount of light pollution. The International Dark-Sky Association (IDA) is one non-profit advocacy group involved in this movement. Light pollution is a consequence of industrial civilization. Its sources include building exterior and interior lighting, advertising, commercial properties, offices, factories, streetlights, welding and illuminated sporting venues. As we move towards increasing urbanization and globalization, the demand for artificial lighting will increase to enable people to live safely and comfortably. Light pollution, can adversely affect humans, plants, and wildlife [1]. A major source of light pollution that affects human health is welding operation, which is an important tool in the construction in industry, and also a source of artificial lighting which emits Ultraviolet (UV) radiation. Welding emits a wide spectrum of radiations ranging between 200nm – 1400nm. These radiations include ultraviolet (UV) rays (200-400nm). Visible light (400-700nm) and infrared Rays (700-1400nm). Ultraviolet radiation and far infra-red (IR) are absorbed by the cornea and lens whereas visible light and near infra-red penetrate to the retina [2,3]. Exposure of the eyes to these light rays beyond acceptable thresholds is known to cause acute and chronic ocular disorders. Acute exposure to UV radiation, for instance, causes photokeratitis (popularly referred to as welder's flash eye or arc eye). This condition has long been associated with welders who strike their arc before lowering their protective helmets [3]. It is characterized by foreign body sensation (grittiness), photophobia, tearing, blepharospasm, and pain. Photokeratitis is usually seen a few hours following exposure and typically resolved within 72 hours. It does not have long-term squeal [3,4]. Chronic UV radiation exposure, on the other hand, is associated with a high prevalence and incidence of long-term changes in the outer part of the eye in welders [5,6]. About 400-1400nm penetrates the eye to be absorbed by the retina and may cause thermal or photochemical damage. Retinal damage induced by arc welding is referred to as phototoxic maculopathy. In most cases, retinal injuries heal spontaneously without loss of vision [4]. These kinds of research are seldom carried out in Nigeria, a country generally characterized with poor health and safety practices among occupational workers [7]. Thus, the aim of this research was to analyze the impact of excessive light on the health of welders and their usage of PPE. The study focused on visual acuity defects among small scale welders of Yalwa and Gwallameji districts of Bauchi metropolis, Bauchi state, Nigeria.

2. Methodology

2.1. Study Area and Design

Bauchi metropolis is one of the cities in the North Eastern, Nigeria. It is the capital of Bauchi state located at the north edge of Jos Plateau at an elevation of 616m. The study area represents the part of the topographic map of Bauchi North as produced by the federal survey of Nigeria and it falls within N-E part of the map basement complex. It is located on the coordinate of latitude 10^0.15 -10^0. 22 North and longitude 9^0.45 – 9^0.55 East. The study adopted a cross-sectional design whereby 80 welders participated in the study between the ages of 18-60 years that have worked for at least five years. A stratified simple random sampling technique was used in data collection. The population was divided into two strata; Yalwa and Gwallameji, from which samples were collected.

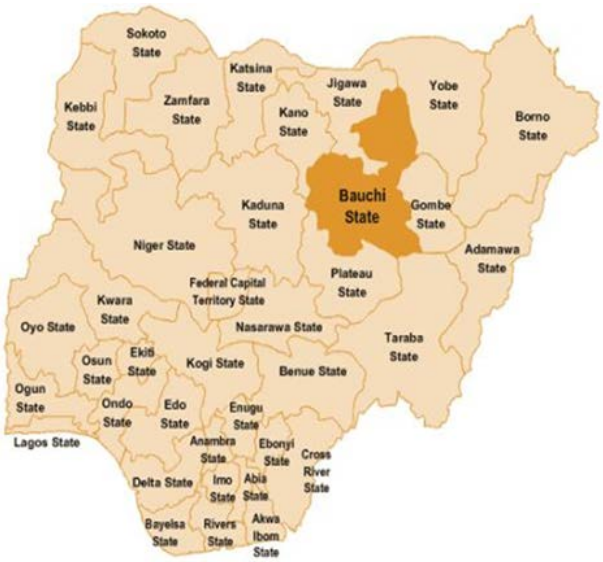

Figure 1. Political map of Nigeria showing Bauchi State

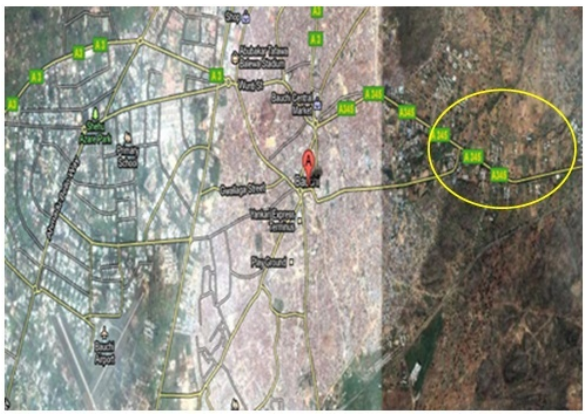

Figure 2. Map of Bauchi metropolis showing the study area

2.2. Survey Instrument

2.2.1. Questionnaire and the Snellen's Chart

The questionnaire comprises of five different sections, where Section A; contain socio-demographic data of the respondents, Section B; Exposure information, Section C; Hazard and PPE Knowledge, Section D; Use of PPE and Section E; provided data on reported health symptoms or illnesses. The questionnaire was validated by a panel of experts which comprises of researchers from a University in Nigeria as recommended [8]. A pilot study was conducted to test the reliability of the questionnaire and to ensure that its wording are understood by the respondents. The Cronbach's alpha values of the pilot study and the actual study are 0.88 and 0.80 respectively which are reliable because any value above 0.7 is accepted as recommended [9].

The Snellen's chart was used to determine vision quality among welders. The respondents were asked to sit 6 meters away from the chart. Each eye was tested at a time starting with the right eye without pressing on it, covering the left and vice versa. Subjects were asked to read optotypes from largest to the smallest. Respondents who are able to read optotypes on the 8^{th} line were graded 20/20 (average visual acuity for adults). The Snellen's chart used to determine eye acuity defects in the study is very convenient and is still considered very useful for routine eye tests. Snellen's defined a new font which he called "optotypes" and which he laid out on a 5 x 5 grid. Using the standard of dividing a degree into 60 minutes, he defined "standard vision" as the ability to recognize his optotypes from a distance of 6 meters (20 feet) when they subtended an angle of 5 minutes of arc.

2.3. Data Analysis

Descriptive statistics was used to analyze; the data on socio-demographic characteristics, exposure status, use of personal protective equipment and reported health symptoms and illnesses. The relationship between visual acuity and age, years of experience, and hours of work was determined using Pearson correlation coefficient. The use of PPE and reported health symptoms and illnesses were also correlated. The data were analyzed using the statistical package for social sciences (SPSS) version 21.0.

3. Results

3.1. Socio-Demographic Characteristics of the Respondents

Table 1 shows that the mean age of the respondents was 28 years representing young adults and all the respondents were males. The result showed that majority of the population only attended primary and secondary school with 27.5 and 52.5% respectively. The survey found the mean income of welders to be ₦3, 655/day. The results indicated that about 52% of the welders learnt welding through apprenticeship in road-side workshops.

3.2. Welders' Exposure Status

From Table 2, it can be seen that 82.5% of the sample population affirmed not to be exposed to other sources of high intensity light. The majority of the welders have been working for about 9 years, spending almost 8 hours per day. More than half of the respondents 50 and 15% of the welders scored 20/25 (0.8) and 20/32 (0.63) points accordingly in the eye acuity test. The mean score of the study population was 0.84 (0.12).

Table 1. Socio-demographic distribution of the respondents

Variables	Mean (SD)	n (%)
Gender		
Male		80 (100)
Female		0 (0)
Age (Years)	28.93 (5.26)	
Level of Education		
No formal education		3 (3.8)
Primary school		22 (27.5)
Secondary school		42 (52.5)
Tertiary education		13 (16.3)
Mode of Training		
Apprenticeship		42 (52.5)
Technical training		38 (47.5)
Daily Income of Welders (₦)	3655 (2071.37)	

Table 2. Welders' Exposure Status

Variable	Mean	n (%)
Exposure to other sources of high intensity light		
Yes		5 (6.3)
No		66 (82.5)
Others		9 (11.3)
Welding years	8.49 (5.25)	
Working hours	7.85 (2.44)	
Other activities aside welding		
Grinding		19 (23.8)
Painting		14 (17.5)
Cutting		30 (37.5)
Hammering		16 (20.0)
Cleaning		1 (1.3)
Welding methods		
Manual Metal		14 (17.5)
Arc Welding		45 (56.3)
Gas Welding		21 (26.3)
Eye acuity score	0.81 (0.12)	
1.0 (20/20)		28 (35.0)
0.8 (20/25)		40 (50.0)
0.63 (20/32)		12 (15.0)

3.3. Use of PPE

Table 3 shows that 60% of the welders never protect their eyes and faces during welding operations, with only about 20% of the study population protecting their eyes during operations very often. Majority of the respondents recorded never use of safety boots, hand gloves and overall coats with 53.8, 58.8 and 47.5% responses respectively.

3.4. Respondents' Reported Health Symptoms or Illnesses

Table 4 shows respondent self-reported health symptoms or illnesses. Very often (16.3%) and often (12.5) respondents experience difficulty in their reading ability. They as well reported decrease in vision ability very often with 28.8%. About 30% of the respondents reported having blurred or double vision very often, while another 34% reported experiencing watery eyes often. Almost half of the respondents reported having eye strain and increase in sensitivity to light often.

Table 3. Welders' Usage of Personal Protective Equipment (PPE)

Statements	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
Do you use anything to protect your eyes and face when welding?	48 (60)	11 (13.8)	5 (6.3)	0 (0)	16 (20.0)
Do you use anything to protect your ears when welding?	14 (17.5)	16 (20.0)	15 (18.8)	19 (23.8)	16 (20.0)
Do you use anything to cover your nose/mouth when welding?	22 (27.5)	21 (26.3)	22 (27.5)	4 (5.0)	11 (13.8)
Do you use safety boots when welding?	43 (53.8)	19 (23.8)	8 (10.0)	5 (6.3)	5 (6.3)
Do you use hand gloves when welding?	47 (58.8)	13 (16.3)	16 (20.0)	4 (5.0)	0 (0)
Do you use overall coats?	38 (47.5)	17 (21.3)	7 (8.8)	10 (12.5)	8 (10.0)

Note. 1=Never, 2= Rarely (once a month), 3= Fairly often (once a week), 4=Often (alternate days), 5=Very often (everyday).

Table 4. Respondents' reported health symptoms or illnesses

STATEMENTS	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
Are you having difficulty when reading?	12 (15.0)	29 (36.3)	16 (20.0)	10 (12.5)	13 (16.3)
Is your vision ability decreasing?	5 (6.3)	14 (17.5)	17 (21.3)	21 (26.3)	23 (28.8)
Do you experience eye irritation?	9 (11.3)	11 (13.8)	16 (20)	20 (25)	24 (30)
Do you experience watery eyes?	4 (5.0)	2 (4)	21 (42)	17 (34)	8 (16)
Do you experience eye strain?	2 (2.5)	11 (13.8)	28 (35.0)	30 (37.5)	9 (11.3)
Do you experience increased sensitivity to light?	6 (7.5)	9 (11.3)	20 (25.0)	24 (30.0)	21 (26.3)

Note. 1=Never, 2= Rarely (once a month), 3= Fairly often (once a week), 4=Often (alternate days), 5=Very often (everyday).

3.5. Relationship between Age, Years of Welding Experience, and Hours of Work with Vision Acuity Test

Table 5 presents the results of the Pearson correlation computed to determine relationship between age, years of experience and hours of work with the vision acuity of welders. There was a weak positive correlation for age ($p < 0.05$) and a moderate correlation for years of experience and the acuity test conducted ($p < 0.001$). Hours of work is not correlated with the acuity vision test.

Table 5. Relationship between Age, years of experience and hours of work with vision Acuity Test

Variables	Vision Acuity Test	
	r	P
Age	0.294**	0.008
Years of experience	0.464**	<0.001
Hours of work	0.172	0.128

**Significant at the 0.01 level (2-tailed).

3.6. Relationship between Respondents' Usage of PPE and Reported Health Symptoms or Illnesses

Table 6 presents the Pearson correlation between usage of PPE and reported health symptoms or illnesses. There was a weak correlation between the use of PPE and reported health symptoms.

Table 6. Relationship between use of PPE and reported health symptoms and illness

Variables	Reported health symptoms and illnesses	
	r	p
Use of PPE	-0.265**	0.017

**Significant at the 0.05 level (2-tailed).

4. Discussion

Young adults being the majority of the respondents may be as a result of them being more physically suited to cope with the demands and rigors of the welding profession. It may also be attributed to the fact that most individuals within this age (28 years) are presumed to be married and are sole providers for their families, thus, needing a stable source of income. The reason why majority of the welders learnt welding through apprenticeship at road-side workshops, may be attributed to socio-economic factors such as poverty, lack of awareness and accessibility to technical training schools. This is in conformity with the study by [10], where the respondents also falls within the young adults and 62% secondary education and were married.

The results of the eye acuity test indicated that most of the respondents scored slightly below average according to the Snellen's chart, which stipulates the average visual acuity for an adult to be a score of 20/20 (1.0) points on the chart, however majority (65%) scored below 1.0 in the test. This may be attributed to the poor safe health practices of the welders as 60% of them reported do not use any protective mask or glasses to cover their eyes and faces. Thus increasing their vulnerability and risk to the effects of excessive lighting on their eye acuity. This is in conformity with the study by [11], who reported that chronic exposure to welding light without adequate precautionary measures caused ocular disorders. There was a higher incidence of pingueculum, cataract, keratoconjunctivitis, corneal scars and allergic conjunctivitis ($P < 0.01$) among welders. Majority of the respondents never use personal protective equipment such as face mask, goggles, safety boots, hand gloves and overall coats. The result is however in disagreement with the study by [12], where majority of the respondents adhere to the use of PPE. However, is in agreement with the study carried out by [13], where majority of the respondents likewise never use PPE's, and the study of [10], which also showed that only 34% of the respondents use protective equipment. Many of the respondents reported health symptoms such as ocular disorders, which comprises of eyes irritation, watery eyes and eye strain. This is in conformity with the study by [12], where symptoms such as; watery and irritating eyes, after images and eye strain. Chronic UV radiation exposure on the other hand is associated with a high prevalence and incidence of long term changes in the outer part of the eye in welders [5,6].

The results showed a positive significant correlation for age and years of experience in welding with vision acuity test. This is possible because IR spectrum (400-1400nm) penetrates the eye to be absorbed by the retina and may cause thermal or photochemical damage. Retinal damage induced by arc welding is referred to as phototoxic maculopathy. Severe burns of the macula may lead to permanent, complete or partial loss of central vision. [4]. A significantly inverse correlation was found for the use of PPE and reported health symptoms and illnesses, whereby as the use of PPE increases reported health symptoms and illnesses decreases. This indicates that the use of PPE helps in curtailing the effects of welding light. This finding is in line with the study by [7], where he describes lack of compliance to eye safety rules among Nigerian welders. According to [14], the prevalence and seriousness of eye disorders depend on both the intensity and characteristics of emitted radiation and the availability as well as use of protective measures.

The prevalence of eye disorder and other health related injuries caused by welding practice is determined by the length of exposure, type of welding, the environment and the availability and use of protective devises. As such, in a study carried out in India most of the respondents did not use protective devise and therefore had one or more symptoms of eye defects [15].

5. Conclusion

The findings showed that majority of the respondents scored below average in the vision acuity test. The report also revealed that many of them never use PPE. The most frequent health symptoms among the respondents include eye irritation, watery eyes and eyes strain. Age and years of welding experience were seen to have a positive correlation with the vision acuity test, while an inverse relationship was seen between the use of PPE and health reported symptoms or illnesses. Welders were seen to be experiencing slight ocular disorders.

Preventive strategies should include good welding equipment, environmental background lighting, eye protection redesign, and training of workers. Workers should be adequately informed about the danger of welding too close to the eyes and of looking round the side of the visor, even for a very short period. Based on the outcome of this investigation it is recommended that training on occupational hazards associated with welding should be given to respondents. The use of relevant and adequate PPE devises should be encourage among the welders. In this respect, relevant government agencies should provide the devises to the welders at subsidized rate and ensure the enforcement of relevant law for their uses.

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