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Ophthalmic Challenges in People Exposed to High Intensity Light, with Special Reference to Welders in Anambra State.

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ABSTRACT

Background; Exposure to high-intensity light, especially in occupational settings, can have adverse effects on ocular health. The aim of this study was to investigate the ophthalmic challenges faced by individuals, specifically welders, who were exposed to high-intensity light in both urban and rural areas of Anambra State, Nigeria.

Methods; The study consisted of three hundred (300) welders between the ages of 15 to 50 years males who were exposed to high-intensity light in both urban and rural areas of Anambra State. A pretested semi structured questionnaire was used to obtain information on the socio-demographic characteristics, history of eye injury, welding types, and the use of personal protective equipment during welding activities. The test for pterygium was done by physical examination according to the directions given by the Optometrist. Visual acuity was assessed using a Snellen chart placed at a standardized distance of 10 meters. The tests were done for all the three hundred (300) respondents. Descriptive statistics was used to analyze continuous and categorical variables.

Results; The results showed that electric arc welding was more predominant (86%), and electric welders exhibit a higher incidence of eye injuries (32%) compared to gas welders (2%). The majority of affected welders fall within the 21-24 and 19-21 age groups. Pterygium cases were insignificantly lower in rural welders 16% compared to Urban welders 18%. Pterygium is more common among electrode welders than oxyacetylene welders .

Conclusion; The results revealed that visual acuity declined with an increase in the number of years spent welding. The result showed that electrode welding machine emitted more light intensity 2000 compared to oxyacetylene welding machine 1000. Findings from this study demonstrated that exposure to high light intensity causes serious harm to ocular health. Non-compliance with established protocol for welding have devastating impact on the ocular health.

List of Abbreviations:

Intense Ultraviolet (UV),
Infrared Radiation (IR)
World Health Organization (WHO)
Local Government Area (LGA)
Personal Protective Equipment (PPE)

INTRODUCTION:

Exposure to high-intensity light, especially in occupational settings, can have adverse effects on ocular health. Workers in certain professions, such as welders, are particularly vulnerable due to their frequent and prolonged exposure to intense ultraviolet (UV) and infrared radiation (IR) generated during the welding process. Welders are exposed to intense UV radiation, primarily generated by the electric arc produced during welding. The cornea and the lens of the eye are the primary sites affected by UV exposure. Acute exposure to high levels of UV radiation can lead to photokeratitis (welder's flash), a painful condition similar to sunburn of the cornea. Prolonged exposure can result in chronic conditions like cataracts and pterygium, characterized by the growth of abnormal tissue on the conjunctiva (Behar-Cohen *et al*, 2014*)*.

In addition to UV radiation, welders are also exposed to significant levels of IR radiation. IR radiation can cause thermal damage to ocular tissues, leading to conditions such as welder's maculopathy and retinal damage. Welder's maculopathy, also known as "arc eye," is a condition characterized by damage to the macula, resulting in blurred vision, color vision abnormalities, and central scotomas. The intense light and heat generated during welding can also affect the ocular surface. Welders often experience symptoms such as dryness, foreign body sensation, redness, and itching of the eyes. These symptoms may be indicative of ocular surface disorders, including dry eye syndrome and conjunctivitis. The heat produced during welding can evaporate the tear film, leading to tear film instability and increased ocular surface dryness (Sliney, 2016).

The occupation of welding is associated with numerous occupational hazards, including potential risks to visual health. Welders are consistently exposed to intense light, ultraviolet radiation, hazardous fumes and particles, which may lead to various ophthalmic

challenges. Understanding the impact of these challenges is crucial for developing appropriate preventive measures and ensuring the well-being of welders in Nigeria in particular and worldwide.

According to the World Health Organization (WHO), approximately 285 million people worldwide are visually impaired, and 39 million of them are blind. It is estimated that 80% of all visual impairments can be prevented or cured, highlighting the importance of identifying high-risk groups such as welders (World Health Organization, 2023). While the global statistics provide an overall understanding of the prevalence and burden of ophthalmic challenges, it is essential to examine the specific situation in Anambra State, Nigeria.

In Nigeria, visual impairment is a prevalent public health issue. According to a study published in the Nigerian Journal of Ophthalmology, the prevalence of blindness in Nigeria is approximately 4.2%, and the major causes include cataracts, glaucoma, and refractive errors (Kyari *et al,* 2009). However, specific data regarding the prevalence and impact of ophthalmic challenges among welders in Nigeria is scarce.

Anambra State, Nigeria, is home to a significant population of welders who work in various industries, including construction, fabrication, and automotive repair. These professionals routinely work with high-intensity welding arcs that emit intense ultraviolet visible light potential sparks and debris. These emissions, when inadequately controlled or protected against, have the potential to cause serious ophthalmic challenges. Prolonged and repeated exposure to such conditions can lead to ocular health risks, such as photokeratitis, welder's flash, and cataracts. These conditions can result in temporary or permanent vision impairment and reduce the quality of life for welders.

Despite the well-documented health hazards associated with welding, a substantial number of welders in Anambra State do not have access to or do not consistently use appropriate protective gear, such as welding helmets with auto-darkening filters, safety goggles, and face shields. The absence of such equipment or inconsistent usage exacerbates the risk of ophthalmic challenges among this occupational group. Many welders in Anambra State may not be fully aware of the potential ophthalmic risks associated with their profession. The lack of awareness and education about the importance of eye protection and regular eye check-ups might contribute to higher prevalence rates of ophthalmic conditions in this population. Ophthalmic challenges can have long-term socioeconomic consequences for welders and their families. Impaired vision affects not only the welder's ability to work but also their overall quality of life and independence. In Anambra State, where welders play a vital role in the local economy, addressing these challenges is essential for the well-being of the affected individuals and the community as a whole.

Aim

The aim of this study was to investigate the ophthalmic challenges faced by individuals, specifically welders, who are exposed to high-intensity light in both urban and rural areas of Anambra State, Nigeria.

Specific Objectives

The specific objectives of the study were as follows:

i. To determine the types of ophthalmic conditions, such as cataracts, pterygium, and retinal damage, among welders exposed to high-intensity light in urban and rural areas of Anambra State, Nigeria.
ii. To compare the severity of ophthalmic challenges between welders in urban and rural areas, considering factors such as work environment, safety practices, and protective equipment usage.
iii. Assess the frequency and duration of exposure to high-intensity light among welders in urban and rural areas.

Research Questions

i. What are the common ophthalmic conditions among welders exposed to high-intensity light in urban and rural areas of Anambra State?
ii. How frequently and for what duration are welders exposed to high-intensity light in urban and rural areas of Anambra State?
iii. Are there differences in the severity of ophthalmic challenges between welders in urban and rural areas of Anambra State?

Research Hypothesis

Null Hypothesis (H0): There is no significant association between high intensity light and the occurrence of ophthalmic challenges among welders in Anambra State.

Alternative Hypothesis (Ha): There is a significant association between high intensity light and the occurrence of ophthalmic challenges among welders in Anambra State.

METHODS;

Study Area;

Anambra State is a Nigerian state, located in the South-Eastern part of the country. The state is bounded by Delta state to the west, Imo state to the south, Enugu to the east and Kogi state to the North. It lies approximately between latitude 6°07'N and 7°53'N and longitude 6°37'E and 7°53'E. As of the most recent available data,

Anambra State has a population of over 5 million people (City facts, 2019). The state has experienced steady population growth, with a significant urbanization trend in recent years. The major ethnic groups in Anambra State are the Igbo's.

Anambra State's economy is predominantly driven by agriculture, commerce, and industry. Agriculture plays a crucial role, with the state known for the cultivation of crops such as yam, cassava, rice, and vegetables. The state has a thriving commercial sector, with markets and trading activities contributing to its economic growth. Anambra State also has a significant industrial presence, including manufacturing and construction sectors.

The welding industry holds substantial importance in Anambra State, contributing to economic development and employment opportunities. Welding activities are prevalent in various sectors, including construction, fabrication, repairs, and maintenance. Notable welding centers, workshops, and industrial areas can be found in cities like Onitsha, Nnewi, Awka,etc.

Anambra State recognizes the importance of occupational health and safety and has instituted measures to ensure workers' well-being (Okofia and Onyeaso, 2023). Occupational health regulations and guidelines exist to address workplace safety and protect workers from occupational hazards. The welding industry is subject to specific regulations and guidelines related to safety practices, equipment usage, and risk mitigation (Safety Culture, 2024).

Within the welding industry, workers are exposed to various occupational health challenges, including those related to high-intensity light exposure. Ophthalmic challenges, such as cataracts, photokeratitis, and retinal damage, are significant concerns for welders due to their exposure to welding arcs and intense light (Saurman. 2023).

Anambra State was selected as the study area due to its prominent welding industry and the potential prevalence of ophthalmic challenges among welders. The unique characteristics of the welding sector in Anambra State, including the presence of notable industrial areas and workshops, make it an ideal location to investigate the impact of high-intensity light exposure on ocular health.

The Study Areas: Determination of Sample Size

This study was conducted in the three Senatorial Zones in Anambra state. Two local government areas (LGA) were randomly selected from each Senatorial Zone. Two Towns were randomly selected from each LGA. Multistage sampling technique was used to select the study areas and respondents. Multistage sampling technique refers to sampling plan where the sampling is carried out in stages using smaller and smaller sampling units at each stage. Selection was done in stages between one to four. The population was divided into 1st stage units by simple random sampling. Each selected first stage was subdivided into second stage units and a sample was selected. The procedures continued until the participants were reached at stage four.

Simple random sampling technique refers to a sampling plan where every unit has an equal chance or probability of being selected. It is a sampling method where every participant is chosen entirely by chance and sampling frame must be available. Simple random sampling is the most straightforward method of probability sampling. It allows for calculation of sampling error and reduces selection bias.

Anambra North Senatorial Zone is made up of seven Local Government Areas,

Namely; Anambra East, Anambra West, Ayamelum, Ogbaru, Onitsha North, Onitsha South and Oyi. A combination of multistage and simple random sampling techniques was used to select the study areas and respondents.

First Stage; The researcher wrote down the names of the seven Local Government Areas in Anambra North Senatorial Zone on different piece of papers, folded and mixed them together in a box. The researcher then blind folded his assistant who picked out two pieces of papers, which were Anambra East and Onitsha South Local Government Areas.

Second Stage; Anambra East is made up of eleven Towns; Aguleri, Enugwu Aguleri, Eziagulu Out Aguleri, Ikem Ivite Nando, Igbariam, Umuoba Anam, Nando, Umueri, and Nsugbe. The name of each Town was written down on a separate piece of paper, folded and mixed together in a box and the researcher then blind folded his assistant who picked out Igbariam as a Rural area.

Third Stage; Igbariam community is made up of Eight villages; Aniekwem, Eziafor, Eziama, Ivite, Ogugu – Etiti, Ubaru, Umuchem and Urualor.. The name of each village was written on a piece of paper, folded and mixed together in a box and the researcher then blind folded his assistant who picked out one piece of paper and got Ivite village.

Stage Four; There are seven welding workshops in Ivite Village. The researcher wrote down each name of the workshops on a separate piece of paper, folded and mixed them together in a box and the researcher then blind folded his assistant who picked out five pieces of papers representing the participants.

This same sampling technique was used to select all the study locations and subjects studied in this study.

From Anambra South Senatorial Zone, Aguata and Nnewi North LGAs were randomly selected. In Aguata LGA, Uga and Ekwulobia were randomly selected. The study was conducted in welding Workshops close to Oye Uga Market. In Ekwulobia, the study was conducted in welding Workshops in Umuchi and Nkono respectively.

In Nnewi North LGA, Uruagu Community was randomly selected. In Uruagu Town, the study was conducted in Welding Workshops in Okponueze and Nkwo Nnewi.

In Anambra Central Senatorial Zone, Awka North and Awka South LGAs were randomly selected.

In Awka North LGA, Mgbakwu and Isu -Aniocha were selected. In Mgbakwu, the study was conducted in welding Workshops in Amankpu community. In Isu-Aniocha, the study was conducted in welding Workshops in Umuleri.

In Awka South LGA, Mbaukwu and Amawbia Town were randomly selected. In Mbaukwu, the study was conducted in welding Workshops close to Unizik Prescience Study Centre. In Amawbia, the study was conducted along Umueze Road.

Study Design

The study consisted of three hundred (300) welders from the three senatorial district in Anambra State. A well-structured and pre-tested questionnaire was used to obtain data on the socio-demographic characteristics, history of eye injury, welding types, and the use of personal protective equipment during welding activities. The test for pterygium was done by physical examination according to the directions given by the optometrist. Visual acuity was assessed using a Snellen chart placed at a standardized distance of 10 meters.

Pterygium Test: The test for pterygium was done by physical examination according to the directions given by the optometrist. Pterygium appears as a raised, triangular or wedge-shaped growth on the conjunctiva, which may extend onto the cornea. It often has a fleshy appearance and can vary in size. An examination of each participant's eyes was performed to assess for the presence of pterygium based on its characteristic appearance. Diagnosis of pterygium was confirmed based on established clinical criteria.

Visual Acuity Test: Visual acuity was assessed using a Snellen chart placed at a standardized distance of 10 meters. Participants read aloud lines of letters until unable to do so accurately. Visual acuity was recorded as a Snellen fraction.

Sample Size

The sample size was calculated based on the prevalence of eye injuries among welders in Anambra state, (26%).

$$n = \frac{z^2 P(1-P)}{E^2}$$

Where:

n is the required sample size.
Z is the Z-score corresponding to the desired confidence level. For a 95% confidence level, Z is typically 1.96.
p is the estimated prevalence level (expressed as a decimal).
E is the margin of error (expressed as a decimal).
Where Z = 1.96, P = 26 % approximately 0.26,

$$n = \frac{(1.96)^2 0.26(1-0.26)}{0.05^2}$$

$$n = \frac{3.8416\ x\ 0.26\ x\ 0.74}{0.0025}$$

$$n = \frac{0.7391}{0.0025}$$

n = 295.6.

So, the estimated sample size would be approximately 296 for a prevalence value of 26%, assuming a 95% confidence level and a margin of error of 5%.
Thus, applying the 10% attrition.

296 x 10/100

Appropriately = 30
Therefore: 296 + 30 = 326
Therefore, the sample size is 326.

Data Collection

A pretested semi structured questionnaire was used to obtain information on the socio-demographic characteristics, history of eye injury, welding types, and the use of personal protective equipment during welding activities. Data were collected through one on one interviews. This process was conducted in either English language or the local language of participants (Igbo). Eligible participants were asked to give informed consent in writing before participating in the study.

Data were collected during working hours. Interviews were conducted in a safe area at the site away from any distractions.

Inclusion Criteria

i. Welders were included if they used welding sets which includes

- Electrode welding Machine
- Gas Welding Machines

ii. Welders between the range of 15 – 50 years

iii. Welders who were resident in Anambra

Exclusion Criteria

i. Welders with any eye defect
ii. Welders with a previous medical history of eye injury or defect.

iii. Welders who are Diabetic
iv. Welders who are severely hypertensive.

Ethical Consideration

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Basic Medical Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli Campus.

Data Analysis and Management

Questionnaires from the field work were coded and checked for consistency before passing on for data entry. Microsoft Excel 2019 was used for data entry. The data was then exported to IBM SPSS version 19 for analysis. Primary analysis for the study was the visual acuity of the welders and the proportion of welders suffering from pterygium.

Secondary endpoint analysis was focused on age, sex, educational level, number of working years, welding type, and the use of eye personal protective equipment (PPE) (independent variables). A proprietor welder in this study was defined as the owner of a welding shop who supervises other welders in the same establishment and has the most experience on the job. Descriptive statistics was used for continuous and categorical variables. The criterion for statistical significance was $P \leq 0.05$.

RESULTS

Table I: Age Distribution Amongst Participants

Age	Frequency	Percentage
15-18	42	14.0
19-21	75	25.0
21-24	81	27.0
25-29	54	18.0
≥ 30	48	16.0
Total	300	100

Table II: Sex Distribution Amongst Participants

Sex	Frequency	Percent
Male	300	100.0

Table III: Education Level Amongst Participants

Level of Education	Frequency	Percentage
FSLC	51	17.0
HND	3	1.0
JSSCE	54	18.0
SSCE	192	64.0
Total	300	100.0

Table IV: Years of Experience amongst Welders

Years of experience	Frequency	Percentage
1	39	13.0
2	81	27.0
3	66	22.0
4	33	11.0
5	18	6.0
6	12	4.0
7	9	3.0
8	6	2.0
9	6	2.0
≥10	30	10.0
Total	300	100.0

Table V: Level of Welders

Level	Frequency	Percentage
Apprentice	246	82.0
Proprietor	54	18.0
Total	300	100.0

Table VI: Type of Welding Set Used

Welding Set	Frequency	Percentage
Electrode	258	86.0
Oxyacetylene	42	14.0
Total	300	100.0

Table VII: Average Work Hours a Day

Number of Hours	Frequency	Percentage
8	48	16.0
10	150	50.0
12	102	34.0
Total	300	100.0

Table VIII: Use of Protective Equipment Amongst Welders

Use Protective equipment	Frequency	Percentage
Yes (Always)	237	79.0
Yes (Sometimes)	63	21.0
No	0	0
Total	300	100.0

Table IX: This table represents the distribution of visual acuity among the welders, with the frequency and percentage of individuals falling into each category.

Visual Acuity	Frequency	Percentage (%)
20/20	84	28.0
20/20-2	3	1.0
20/25	24	8.0
20/25-1	3	1.0
20/32	96	32.0
20/32-1	9	3.0
20/40	54	18.0
20/50	15	5.0
20/50-1	3	1.0
20/63	3	1.0
20/80	6	2.0
Total	300	100

Table X: The table represents the count of welders who have a certain level of visual acuity after a specific number of years in the profession. The data suggests a trend where visual acuity declines with an increase in the number of years spent welding.

	Years of Experience as a Welder									
Visual Acuity	1	2	3	4	5	6	7	8	9	≥10
20/20	24	21	12	12	3	9	0	0	0	3
20/20_2	0	0	0	0	0	0	0	0	0	3
20/25	0	0	9	3	3	3	0	0	0	6
20/25-1	0	3	0	0	0	0	0	0	0	0
20/32	12	27	27	12	6	0	3	6	0	3
20/32-1	0	6	0	0	0	0	0	0	0	3
20/40	0	18	3	6	6	0	6	0	6	9
20/50	3	6	6	0	0	0	0	0	0	0
20/50-1	0	0	0	0	0	0	0	0	0	3
20/63	0	0	3	0	0	0	0	0	0	0
20/80	0	0	6	0	0	0	0	0	0	0

DISCUSSION

This study aimed to evaluate the impact of high-intensity light on welders in Anambra State. It was found that nearly half of the welders had sustained eye injuries. The result of this study is consistent with the report of Douglas and Ayakoro, (2018), which stated 43.4% prevalence of ocular injuries among welders in Yenagoa, Bayelsa State, Nigeria. The result is also in line with the findings of Karl *et al* (2020) which found the prevalence of reported eye injury among welders in Accra to be 47.9%. This is also similar to the results obtained in a study conducted in Nigeria by Ihekaire *et al*, (2017) who found the prevalence of eye injury among welders to be 48%. However, this is inconsistent with the report of Nwala *et al*, (2014), which recorded 84.5% prevalence of eye injuries in Nigeria , 75% by Ganesh *et al*, (2014) in India, and 61% by Sithole *et* al, (2009) in South Africa. Nwala *et al*, (2014) attributed the high prevalence to increasing industrialization, and Sithole *et al*, (2009) attributed their observation to poor knowledge on the adverse effects of welding activities. The prevalence of eye injuries reported in our study could be attributed to the low use of eye PPE. These injuries could have significant socioeconomic implications for their families, communities, and the nation, particularly if they are severe or permanent, thereby affecting the welder's ability to earn an income. The study also revealed that electric arc welding (electrode welding) is the predominant type of welding used by welders in Anambra, accounting for 86%. This trend aligns with other research indicating that arc welding is more commonly used than oxyacetylene or gas welding (Adu, 2016). The preference for arc welding in these studies is likely due to its cost-effectiveness, availability, and ease of use. Among electric welders, 32% experienced eye injuries, compared to only 2% of gas welders. This supports findings by Nwala *et al,* (2014), which identified electric welding as more hazardous, likely due to the

higher ultraviolet light emissions and brighter flame associated with it (Davies, 2010).

The majority of welders were aged between 21-24 years (27%), followed by those between 19-21 years (25%). These age groups also had the highest incidence of pterygium (21% and 24%, respectively), similar to a study in Edo State, Nigeria, which reported that the age group most affected by ocular injury is 21-30 years (Okeigbemen *et al*, 2012). This trend may be attributed to the fact that these are the most active years of life, with individuals often engaged in various vocations.

The prevalence of ophthalmic issues due to high-intensity welding light did not depend on location (urban or rural), as the rates of pterygium were 18% and 16%, respectively. Table 4.10 illustrates the visual acuity of welders according to their years of experience. Welders with only 1 or 2 years of experience generally had normal visual acuity (20/20). However, visual acuity declined with increased years of welding, with welders having 6-10 years of experience exhibiting various levels of abnormal visual acuity. This suggests that prolonged exposure to UV rays from welding light significantly affects visual acuity over time.

Most welders claimed to use PPE frequently, but monitoring revealed that some rarely used PPE or did not use it properly. Reasons for non-use of PPE included reduced productivity, inconvenience, excessive heat, forgetfulness, short task duration, perceived low risk, and time constraints. These reasons are similar to those reported by Lombardi *et al*. (2009). Another factor could be limited knowledge about the importance of PPE. The observed PPE usage patterns among welders in this study indicate an increased risk of eye injuries, as unsafe occupational practices such as non-use of PPE are widely associated with injuries (Ogundipe *et al*. 2018). This finding underscores the need for government agencies responsible for Occupational Health and Safety to enforce mandatory PPE use, ensuring welders prioritize personal safety. Enforcement should be accompanied by positive reinforcement from supervisors and colleagues to sustain PPE use. Involving all stakeholders, including workers, in designing safety procedures and task execution can also improve acceptance and compliance.

The study also found that gas welders (oxyacetylene) were less likely to suffer eye injuries compared to electric/arc welders (electrode). Previous research has indicated that electric/arc welding is more hazardous than gas welding (Vecchia *et al*, 2007). Electric welding involves the use of voltage and generates high temperatures, which can cause life-threatening injuries. Continuous exposure to this type of welding can lead to arc eye, a condition where ultraviolet light inflames the cornea or burns the retina (Cary and Helzer, 2005). This may explain why gas welders had a lower incidence of welding-related eye injuries.

CONCLUSION

In conclusion, the dominance of electric arc welding and its correlation with higher eye injury rates underscores the importance of tailored safety protocols. The study highlights age-specific vulnerabilities, particularly among the 19-24 age groups, and a progressive decline in visual acuity with years of welding experience. Non-compliance with personal protective equipment (PPE) and identified barriers necessitate government intervention for enforcement and collaborative efforts to ensure the ocular health and overall well-being of welders.

Competing Interests

There is no conflict of interest.

Authors' Contributions

MO; wrote the study design, WC; analysed the data generated from the study, JC and SI ; wrote the introduction of the study, CV and OF; wrote the literature review, SC, EO and NI discussed the results.

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