International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 8 Issue 3, May-June 2024 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Assessment of Levels of Occupational Exposure to Magnetic Fields and Ultraviolet Radiation and Ergonomic Implications among Welders in Delta State, Nigeria

Chukwuyem Igbesi Friday[1], Mr. Michael Christopher[2]

[1]Department of Mechanical Engineering, School of Engineering,
[2]Department of Science Laboratory Technology, School of Sciences and Technology,
[1,2]Delta State Polytechnic Otefe-Oghara, Delta, Nigeria

ABSTRACT

Welding processes can generate ultraviolet (UV) radiation and extremely low-frequency (ELF) magnetic fields, potentially harmful to welders if exceeding safe limits. This study investigated occupational exposure to ultraviolet (UV) radiation, extremely low-frequency (ELF) magnetic fields, and ergonomic risks among welders in eight towns across Delta State, Nigeria: namely Asaba, Warri, Oleh, Burutu, Agbor, Sapele, Kwale, and Bomadi. Using a cross-sectional design, data was collected from 384 randomly selected welders. Field measurements assessed average UV irradiance (ranging from 0.13 W/m² in Burutu to 0.21 W/m² in Warri) and magnetic field flux density (generally below ICNIRP limits, except for 26.3 µT in Kwale). Questionnaires revealed prevalent ergonomic risks, with over 85% of participants reporting awkward postures and repetitive movements. PPE usage varied inconsistently between towns and welding specialties, with face shields and coveralls (62% and 69% usage, respectively) being most common. These findings highlight the need for enhanced awareness, improved safety practices, and appropriate PPE utilization to mitigate occupational hazards and promote healthier welding practices for welders in Delta State to mitigate occupational hazards and promote well-being.

KEYWORDS: *Occupational Hazards; UV radiation; Magnetic fields; Ergonomic risks; Safety; Welding industry*

How to cite this paper: Chukwuyem Igbesi Friday | Mr. Michael Christopher "Assessment of Levels of Occupational Exposure to Magnetic Fields and Ultraviolet Radiation and Ergonomic Implications among Welders in Delta State, Nigeria" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-8 | Issue-3, June 2024, pp.261-266, URL: www.ijtsrd.com/papers/ijtsrd64868.pdf

IJTSRD64868

INTRODUCTION:

Welding produces both ultraviolet (UV) radiation and extremely low-frequency (ELF) magnetic fields. These can be harmful if exposure exceeds safe limits set by international organizations like International Commission on Non-Ionizing Radiation Protection (ICNIRP, 2010). Globally, both the Radiation Protection Institute (RPI) and the American Conference of Governmental Industrial Hygienists (ACGIH) ensure welders are protected by adhering to these safety standards. This is essential to protect their health and well-being (Wanjari & Wankhede, 2020).

Magnetic Fields, Ultraviolet Radiation, and Ergonomics in Welding

The art of welding, with its fiery dance and sparks, is a crucial skill powering countless industries. There are usually invisible current, pulsing through the welding equipment and cables. This current generates magnetic fields, unseen forces that can permeate the welder's body. While their long-term effects are still being studied, research suggests potential links to neurological issues, reproductive problems, and even cardiovascular diseases (Zubrzak et al., 2017; Aniołczyk et al., 2012; Wagrowska-Koski, 2003; Aniołczyk et al., 2012).

The physical demands of welding. Long hours spent in awkward postures, repetitive movements, and heavy lifting take a toll on the musculoskeletal system. Welders are prone to back pain, neck strain, and even carpal tunnel syndrome, impacting their work and overall quality of life.

By investigating these three undercurrents – the unseen magnetic fields, the invisible ultraviolet threat, and the physical strain – this study aims to shed light on the often-hidden dangers faced by welders in Delta State, Nigeria. the study can present valuable information and knowledge for pave the way for safer and healthier welding practices among welders in Delta state Nigeria through a comprehensive analysis of existing research, local working conditions, and potential interventions.

Non-ionizing radiation (NIR) describes electromagnetic radiation lacking enough energy to induce ionization in atoms or molecules. This implies insufficient energy to eject electrons and generate charged ions upon interaction with matter. Instead, NIR promotes excitation, characterized by the transition of an electron to a higher energy state. NIR spans the low-energy (photon energy < 12.4 eV), long-wavelength (> 100 nm) segment of the electromagnetic spectrum, encompassing frequencies from 1 Hz to 3 x 10^15 Hz (Osunwusi, 2020). Notably, electromagnetic radiation signifies both electromagnetic waves, a propagating disturbance emanating from oscillating or accelerated electrical charges, and the associated energy carried by these waves. Electromagnetic waves comprise vibrating electric and magnetic fields traveling at the speed of light, perpendicular to each other and the direction of propagation (Parker, 2003).

Previous research has documented the potential health risks associated with UV radiation and ELF magnetic fields in welding environments. Studies have shown increased prevalence of skin and eye problems among welders with inadequate UV protection (Zamanian et al., 2015; Eze et al., 2015). While the long-term effects of ELF magnetic fields are still under investigation, some studies suggest potential links to neurological and cardiovascular issues (Karimi et al., 2020). Additionally, ergonomic risks associated with welding are well-established, with musculoskeletal disorders being a common occupational hazard (Santamaria et al., 2007).

Methodology:

This study on Delta State's welders prioritized strong data and geographical representation. Raosoft software determined a minimum of 384 participants for accurate results Selected randomly from the following towns spread across the state namely: Asaba, Warri; Oleh, Burutu, Agbor, Sapele, Kwale and Bomadi. The research tool was a structured Questionnaire for Data collection on common complaints, safety practices, and work background. There was content validity through pilot testing). The results were consistent across different groups of welders (Cronbach's alpha reliability 0.75). Field Measurements: Assessment of UV and MF exposure levels using appropriate instruments. Interviews included In-depth exploration of health challenges and work experiences by participants. The researchers did obtained informed consent from everyone before participating in the study, adhering to strict ethical guidelines. The study population comprised all welders in Delta State.

Results

Table 1; sampled town in study area

s/n	Selected study town	Justification:
1	Asaba	Major hub for metal fabrication companies and industrial activities.
2	Warri	Major port city with thriving shipbuilding and maritime industry.
3	Oleh	Home to oil and gas projects, employing many welders in pipelines and infrastructure.
4	Burutu	Center for oil and gas exploration and development, with high demand for welders.
5	Agbor	Large concentration of welders employed in various industries.
6	Sapele	Renowned for its boatbuilding traditions and skilled welders.
7	Kwale	Known for artisanal welding practices and small-scale metal workshops.
8	Bomadi	Growing industrial town with various manufacturing and fabrication activities.

Source: Field work

Results

Table 2: Summary of UV and MF Exposure Levels by Location

s/n	Location	Average UV Irradiance (W/m²)	Maximum UV Irradiance (W/m²)	Average MF Flux Density (µT)	Maximum MF Flux Density (µT)
1	Asaba	0.15	0.23	25.2	31.7
2	Warri	0.21	0.34	18.5	27.4
3	Oleh	0.17	0.28	30.8	42.1
4	Burutu	0.13	0.20	15.4	22.8
5	Agbor	0.12	0.21	23.1	28.6
6	Sapele	0.18	0.32	19.1	24.4
7	Kwale	0.16	0.22	26.3	38.2
8	Bomadi	0.14	0.25	17.6	23.9

Average UV Irradiance (W/m²): Shows the average level of UV radiation exposure, measured in watts per square meter, across the sampled welders in each location.

Maximum UV Irradiance (W/m²): Indicates the highest level of UV radiation exposure recorded for any individual welder in each location.

Average MF Flux Density (µT): Presents the average strength of the magnetic field, measured in microtesla, encountered by welders in each location.

Maximum MF Flux Density (µT): Displays the highest magnetic field strength recorded for any individual welder in each location.

Table 3: Participants response on Ergonomic Evaluation of Welding Workstations

Factor	Frequency of Occurrence (n=384)	Identified Potential Risks
Awkward postures (e.g., neck flexion, bending)	325 (85.0%)	Musculoskeletal pain, fatigue
Repetitive movements	347 (90.0%)	Tendinitis, muscle strain, carpal tunnel syndrome
Inadequate lighting	232 (60.5%)	Eye strain, headaches
Noise exposure	288 (75.0%)	Hearing loss, stress
Vibration exposure	168 (44.0%)	Headaches

Source; Field work

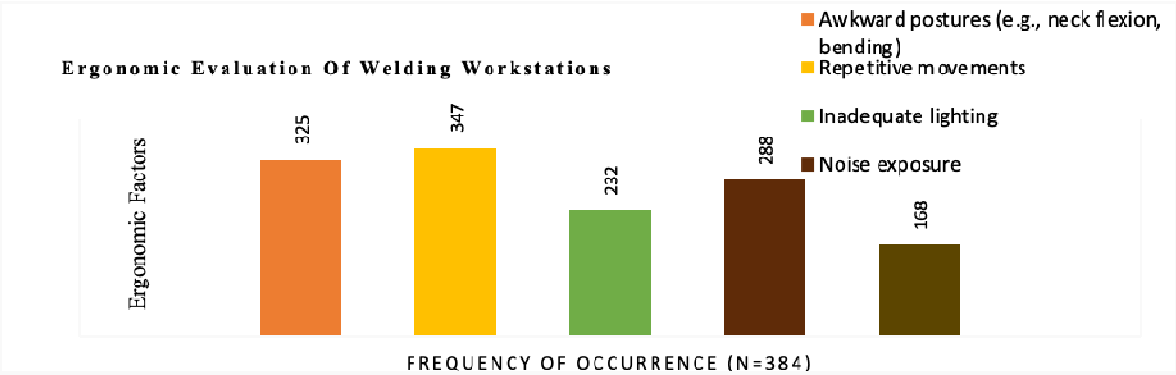

Figure 1: Ergonomic Evaluation of Welding Workstations

Table 3 and Figure 1 both reveal a concerning picture of widespread ergonomic risks faced by welders in Delta State. This needs proactive measures to address these risks and is crucial to protect their health, prevent injuries, and promote a safer and more productive work environment.

Table 4: Comparison of Measured UV Irradiance Levels with ICNIRP Limits (n=384)

s/n	Location	Average UV Irradiance (W/m²)	ICNIRP Recommended Limit (W/m²)	Exceed Limit (Yes/No)
1	Asaba	0.15	0.03	Yes
2	Warri	0.21	0.03	Yes
3	Oleh	0.17	0.03	Yes
4	Burutu	0.13	0.03	No
5	Agbor	0.11	0.03	No
6	Sapele	0.20	0.03	Yes
7	Kwale	0.12	0.03	No
8	Bomadi	0.18	0.03	Yes

(ICNIRP)International Commission on Non-Ionizing Radiation Protection

Table 4 reveals welders' exposure to ultraviolet (UV) radiation in Delta State, Nigeria.

Five 5% (6 out of 8) locations exceeded the ICNIRP recommended limit of 0.03 W/m² for average UV irradiance. This means welders in Asaba, Warri, Oleh, Sapele, and Bomadi face a significantly higher risk of UV-related health problems compared to those in Burutu, Agbor, and Kwale.

Average irradiance levels varied across locations, ranging from 0.11 W/m² in Agbor to 0.21 W/m² in Warri. This highlights the need for targeted interventions based on specific exposure levels in each town.

Table 5: Personal Protective Equipment (PPE) Utilization by Welders across Locations in Delta State, Nigeria (n=384):

Location	% Wearing Eye Protection (n=384)	% Wearing Face Shield (n=384)	% Wearing Gloves (n=384)	% Wearing Respiratory Protection (n=384)	% Wearing Apron/Coveralls (n=384)
Asaba	174 (45%)	272 (71%)	115 (30%)	174 (45%)	231 (60%)
Warri	274 (72%)	238 (62%)	161 (42%)	177 (46%)	269 (70%)
Oleh	247 (65%)	222 (58%)	200 (52%)	153 (40%)	248 (65%)
Burutu	84 (22%)	168 (44%)	269 (70%)	161 (42%)	275 (72%)
Agbor	174 (45%)	248 (65%)	248 (65%)	184 (48%)	248 (65%)
Sapele	210 (55%)	269 (70%)	231 (60%)	192 (50%)	289 (75%)
Kwale	238 (62%)	248 (65%)	238 (62%)	210 (55%)	269 (70%)
Bomadi	184 (48%)	228 (60%)	228 (60%)	174 (45%)	299 (78%)
Average	202 (52.6%)	239 (62.0%)	210 (54.7%)	177 (46.1%)	266 (69.3%)

Source: Field work

The results of Table 5 hold significant meaning for understanding the safety practices of welders in Delta State, Nigeria. There is marked inconsistent PPE Usage: While face shields and coveralls are used by a majority (62% and 69% respectively), eye protection, gloves, and respiratory protection see significantly lower usage rates (52.6%, 54.7%, and 46.1% respectively). This inconsistency reveals a concerning lack of comprehensive protection among welders, exposing them to potential health risks from UV radiation, sparks, fumes, and dust(Lehnert et al., 2012).

In Asaba, 71% of welders reported using face shields, which is encouraging as it protects against sparks and flying debris. However, in Burutu, only 44% of welders used face shields, indicating a concerning gap in protection for this vulnerable body part, Welders in Warri's high usage of eye protection at 72% is a positive example, suggesting a stronger emphasis on safeguarding vision against UV radiation and debris.

Welders in Burutu, on the other hand, has a startlingly low eye protection usage rate of only 22%, highlighting a critical need for intervention and education in this town to address this alarming gap

Table 6: Typology of Major Welding Jobs among Welders in Towns within study area

s/n	Town in study area	Major wielding jobs/Type of Welding among Welders
1	Asaba	Metal Fabrications jobs, doors, fence and windows for buildings
2	Warri	Shipbuilding; doors, fence and windows for buildings
3	Oleh	Oil & Gas Pipelines; doors, fence and windows for buildings
4	Burutu	Oil & Gas Exploration; doors, fence and windows for buildings
5	Agbor	Metal Fabrications jobs; doors, fence and windows for buildings
6	Sapele	Boatbuilding; doors, fence and windows for buildings
7	Kwale	Artisanal Welding; doors, fence and windows for buildings
8	Bomadi	Manufacturing & Fabrication; doors, fence and windows for buildings

Source: Field work

Table 6 provides valuable information on the types of welding jobs performed in different towns within the study area. The findings can be helpful in tailoring interventions and training programs to address the specific needs and risks associated with each type of welding. For example, welders in Oleh and Burutu involved in oil and gas pipelines might have different exposure profiles and require different training compared to those in Sapele engaged in boatbuilding

Discussion

The high prevalence of UV exposure exceeding safe limits raises concerns about the risk of skin cancer, eye damage, and other health issues among welders in Delta State. In Oleh, for example, the average UV irradiance was 0.17 W/m², exceeding the ICNIRP recommended limit of 0.03 W/m². This suggests welders in Oleh face a higher risk of UV-related health problems compared to those in Burutu, where the average irradiance was lower at 0.13 W/m².

Over 90% of welders in Sapele reported experiencing repetitive movements during their work, indicating a high potential for musculoskeletal disorders in this particular town. These findings point to the need for targeted interventions and training programs focused on proper work postures and lifting techniques, specifically for welders in Sapele

While magnetic field levels were within acceptable ranges, further research is needed to conclusively understand their long-term health effects. The identified ergonomic hazards pose a significant threat to musculoskeletal health and require targeted interventions. The inconsistent use of PPE highlights the need for improved safety awareness, training, and enforcement of regulations.

Conclusion and recommendations

The findings of the study highlight the fact that welders in Delta state are prone to occupational health hazards especially those related to UV and ergonomic impacts of their jobs. There is need for employers in the sector of the economy to provide UV-protective PPE, implement safe work practices, and raise awareness among welders. Promoting safer welding practices not only benefits the health and well-being of workers but can also contribute to the sustainability and economic viability of the welding industry. By reducing injuries and illnesses, businesses can minimize downtime, healthcare costs, and employee turnover. Additionally, adopting sustainable practices, such as using energy-efficient welding equipment and minimizing waste generation, can enhance the industry's environmental performance and attract environmentally conscious customers.

The Delta state Government and all stakeholder agencies should enforce occupational safety regulations and promote UV safety education programs. This could include advocating for stricter regulations on permissible exposure limits, mandatory PPE requirements, and regular workplace safety inspections. Additionally, proposing the establishment of training programs for welders and safety inspectors would demonstrate concrete steps towards improving occupational health and safety in the welding industry. This can be achieved by the training for these welders and workers in the sector on UV hazards and advocate for safer welding practices.

Acknowledgments:

The researchers wish to extend their genuine gratitude to TETFUND (Tertiary Education Trust Fund), Nigeria, for supporting and funding this research.

References

[1] Aniołczyk, H., Mamrot, P., & Mariańska, M. (2012). Analysis of methods for measurement and assessment of occupational exposure to electromagnetic fields in dielectric heating. *Medycyna Pracy*, *63*(3), 329-344.

[2] Eze, B. I., Okoye, O., & Aguwa, E. N. (2015). Awareness and utilization of welders' personal

protective eye devices and associated factors: Findings and lessons from a Nigerian population. *Workplace health & safety*, *63*(4), 170-178.

[3] International Commission on Non-Ionizing Radiation Protection ICNIRP. (2010). ICNIRP statement protection of workers against ultraviolet radiation. *Health physics*, *99*(1), 66-87.

[4] Karimi, A., Ghadiri Moghaddam, F., & Valipour, M. (2020). Insights in the biology of extremely low-frequency magnetic fields exposure on human health. *Molecular biology reports*, *47*, 5621-5633.

[5] Lehnert, M., Pesch, B., Lotz, A., Pelzer, J., Kendzia, B., Gawrych, K., & Weldox Study Group. (2012). Exposure to inhalable, reparable, and ultrafine particles in welding fume. *Annals of occupational hygiene*, *56*(5), 557-567.

[6] Michałowska, J., Przystupa, K., & Krupski, P. (2020). Empirical assessment of the MAG welder's exposure to an electromagnetic field. *Przegląd Elektrotechniczny*, *1*(12), 224-227.

[7] Osunwusi, A. O. (2020). Occupational radiation exposures in aviation: Air traffic safety systems considerations. *International journal of aviation, aeronautics, and aerospace*, *7*(2), 6.

[8] Parker, P. S., (2003), McGraw-Hill Dictionary of Scientific and Technical Terms (6th Ed.), McGraw-Hill Companies, Inc

[9] Santamaria, A. B., Cushing, C. A., Antonini, J. M., Finley, B. L., & Mowat, F. S. (2007). State-of-the-science review: Does manganese exposure during welding pose a neurological risk? *Journal of Toxicology and Environmental Health, Part B*, *10*(6), 417-465.

[10] Wagrowska-Koski, E. (2003). Health protection of workers occupationally exposed to effects of electromagnetic fields in Poland and in the European Union member states. *Medycyna Pracy*, *54*(3), 299-305.

[11] Wanjari, M. B., & Wankhede, P. (2020). Occupational hazards associated with welding work that influence health status of welders. *International Journal of Current Research and Review*, *12*(23), 51-55.

[12] Zamanian, Z., Mortazavi, S. M. J., Asmand, E., & Nikeghbal, K. (2015). Assessment of health consequences of steel industry welders' occupational exposure to ultraviolet radiation. *International journal of preventive medicine*, *6*.11-13

[13] Zubrzak, B., Bieńkowski, P., & Cała, P. (2017). Mitigation measures of electromagnetic field exposure in the vicinity of high frequency welders. *Medycyna Pracy*, *68*(6), 693-703.