



HEALTH EFFECTS OF WELDING FUMES AND ULTRAVIOLET RADIATION, USE OF PERSONAL PROTECTIVE EQUIPMENT (PPE) AMONG PRODUCTION WELDERS

BY

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Abstract

This paper determined the knowledge of welders on health effect of welding fumes and use of PPE during welding processes and their successful control strategies. This cross-sectional study was carried out among self-employed electric-arc welders, their journeymen, and apprentices with at least three months working experience in Akoko South-West, Akoko South-East, and Akoko North-West Local Government Area of Ondo State. The study adopted a survey research design. The study used structured questionnaire as an Instrument for data collection to elicit the opinions from the respondents. The instrument was validated. The responses to the items were based on a four-point scale, with numerical value of 4, 3, 2, and 1. Descriptive statistics was used to analyze the data collected from the study for answering the research question. The population of this study comprised all 200 Welders, journeymen, and apprentices of more than three months experience. There was no sampling; an entire population of 200 was used. The findings of the study showed that the respondents agreed that use of Personal Protective Equipment (PPE) among production welders is imperative for good health. Based on findings and discussion, conclusions were drawn and recommendations made, among was that the use of face-mask, nose mask, and other personal protective equipment in the workshop should be made compulsory.

Key Words: Electric-Arc Welding, Welding Fumes, Ultraviolet Radiation, Health, Strategies

Introduction

Welding has enabled manufacturers to construct airplanes, ships, automobiles, earthmoving equipment, and industrial machines, as well as repair them, for the benefit of humanity. Welding is the process of connecting metals together to produce a permanent (homogeneous) connection by heating them to a certain temperature, with or without the addition of filler metal. Welding is one of the most used industrial procedures for permanently attaching metallic components (Monireh Khadem et al., 2022). There are more than fifty (50) distinct welding procedures used in both small and large-scale companies. Electric arc welding and oxy-fuel gas welding are the most widely utilized welding methods in industry (Vimesh-Jani and Mazumumda, 2024). Electric-arc welding is extensively used on both small and big scales, producing fumes and Ultraviolet (UV) rays where production takes place. According to Azian et al. (2022), fumes are solid particles that come from welding consumables, the base metal, and any coatings on the base metal. The vapors can pose major health risks not just to electric-arc welders, but also to anyone in the surroundings. According to Jerome (2024), the welding process releases numerous pollutants at a

high enough rate to induce both short and long-term health impacts if not regulated adequately.

Welders are usually exposed to a range of airborne contaminants that arise from the welding process and other welder tasks in the workplace. The quantity and concentration of fumes and UV radiation vary according on the welding procedure used. Shielded Metal Arc Welding (SMAW) is the most widely used welding method nowadays (Rahul et al, 2020). They also said that the welding arc generates a significant amount of ultraviolet (UV) radiation into the working environment, posing radiation dangers owing to continual exposure. The health effects were identical to those caused by exposure to the Sun's natural UV radiation. However, unlike the latter, the UV released during welding has serious health consequences because to the short distance between the source and receiver. According to Syed et al. (2019), the main sources of exposure are breathing fumes from welding, heating, or cutting galvanized metal. On the other hand, it involves several health hazards, primarily due to the exposure to hazardous fumes and gases. Ines et al. (2020) stated that it can produce dangerous fumes that may be hazardous to the welder's health. The fume contains high



levels of toxic gases such as carbon monoxide and nitrogen oxides that are formed during electric arc welding.

Welding fumes and gases are produced by the base materials being welded or the filler material that is used, coatings and paints on the metals being welded or the coat covering the electrode, shielding gases supplied from the cylinder, chemical reactions caused by the action of ultraviolet radiation from the arc or heat, process and consumables used, and air contaminants (Adewoye et al 2023). According to Monireh et al. (2024), the principal components of welding radiations are metal oxides formed when oxygen in the air comes into contact with vaporized metals. Furthermore, in the arc welding process, the presence of additional flux coating on the electrode causes increased radiation of fumes and gases, posing a major hazard to the welder's health. According to Sjogren et al. (1994) and Eki et al. (2020), welding fumes are a complex mixture of metallic oxides, fluorides, and silicates formed by the evaporation and subsequent condensation of hot metal vapors during welding. Welders who inhale these fumes may be at risk since these gases have a significant impact on lung function and can induce severe acute respiratory disease as well as chronic diseases such as lung cancer. Full-time welders may experience respiratory consequences such as bronchitis, siderosis, asthma, and an increased risk of lung cancer. Welders are more likely to develop pulmonary infections, which are more severe, last longer, and occur more frequently. Also, Bamidele, et al (2023) discovered that the long-term effect is not particularly evident, but there is a strong probability that these decreases could culminate in the development of respiratory impairments. There has been a rise in the rising cases of welding-related disorders in Nigeria (Isah, et al,2020). It has been observed that persistent exposure to exceptionally high quantities of zinc oxide fumes or dust for more than six months might cause dermatitis, boils, conjunctivitis, and gastrointestinal problems. However, some of these reports indicated that exposure to other chemicals was likely. Hence, if your job is taking care of others, your first task is taking care of yourself. It is critical to protect welders from welding fume exposure and ultraviolet radiation.

According to Adewoye et al. (2023), the most successful ways for controlling welders' exposure to welding smoke, depending on the practicality of implementation, include process enclosure, local exhaust ventilation, general dilution ventilation, and the use of personal protective equipment. During electric welding procedures, operators must wear safety goggles, hand gloves, welding helmets, face masks or respirators, and safety boots. The addition of reactive material to metal in arc welding, as well as electrode replacement, alters the smoke and harmful radiation produced during welding. According to Kobayashi (2018), 95% of the emissions during arc welding came from the welding consumables. To limit exposure to welding fumes and UV radiation, craftspeople should use Personal Protective Equipment (PPE) (Ojo et al, 2020). Therefore, prevention of Metal Fume Fever (MFF) in workers who are at risk (such as welders) involves avoidance of direct contact with potentially

toxic fumes, improved engineering controls (exhaust ventilation systems), personal protective equipment (respirators), and workers' education regarding the features of the syndrome itself (Syed et al., 2019). Wearing protective gloves along with clothing that covers the arms and forearms down to the gloves is a good way to guard against UVR exposure while arc welding.

Theoretically, theories of situational awareness are used to this study since awareness in general indicates, knowledgeable being conscious, attentive, educated alert.

Awareness is the state in which a subject is aware of some information when that knowledge is readily available to influence a variety of behavioral behaviors. Situational awareness is the invariant in the agent-environment system that creates the momentary information and behavior needed to achieve the goals set by an arbiter of performance in the environment (Smith & Hancock, 2020). According to Gilson (2020), the notion of situational awareness was identified during World War I by Oswald Boelke, who understood "the importance of gaining an awareness of the enemy before the enemy gained a similar awareness, and devised methods for accomplishing this." Woods (2018) argues that in order for humans to maintain a sufficient knowledge of system status, they must watch the progression of events as they unfold gradually. Over the last 50 years, the spectrum of difficulties that human factors practitioners face has expanded. Practitioners must deal with human performance in physical or perceptual activities, as well as increasingly complicated cognitive demands. As technology advanced, many sophisticated, dynamic systems were built that tested people' ability to make effective, timely decisions when operating these systems. The operator's situation awareness (SA) will be shown as a critical concept on which decision-making and performance in such systems depend. (Endsley, 2020)

Health and safety in welding are critical issues that must be addressed globally. According to Christopher (2020), welding demands close observation, and many workers will put their heads wherever they need to see the work. This may include putting the head in the plume (Harris et al., 2005). As a result, it is critical to be aware of the situation in the welding workshop, particularly with the electric arc welding process, which produces fumes and ultraviolet rays that pose a health risk to the welder and others in the surroundings. The purpose of the study is to determine the awareness of welders on the health implications of welding fumes and ultraviolet radiation, as well as occupational safety measures among electric-arc welders.

Purpose of the Study

The purpose of this research is to determine:

1. the causes of welding fumes and ultraviolet radiation in welding process.
2. the awareness of health effects of welding fumes and ultraviolet radiation to welders.
3. the for preventing welder from effects of welding flume and ultraviolet radiation exposure.

Research Questions

The following research questions guided the research.

1. What are the causes of welding fumes and ultraviolet radiation in welding process?
2. What are the health effects of welding fumes and ultraviolet radiation to welders?
3. What are the strategies for preventing welder from effects of welding flume and ultraviolet radiation exposure?

Research Hypothesis

H₀: There is no significant relationship between the use of Personal Protective Equipment (PPE) and the awareness of the health effects of welding fumes and ultraviolet (UV) radiation among welders.

Methodology

The three local government areas in Akoko, in Ondo State were used. For the electric-arc welders in Akoko South-West is divided into five zones namely Oke-Oka, Iworo/Ayeye-Oka, Akungba, Supare, and Ayegunle/Oba. Akoko South-East is divided into three zones namely Isua, Ipe/Epinmi, and Ifira/Sosan. Akoko North-West is divided into five zones namely Arigidi, Ugbe, Alapata-Ikare, Igbede-Ikare, and Ogbagi. The study population was self-employed electric-arc welders, their journeymen, and apprentices in all the registered workshops in Akoko South-West, Akoko South-East, and Akoko North-West. The instrument of data collection was self-structured questionnaire. Pre-test of the questionnaire was done in Okeagbe, Ondo state which is about 8 kilometres from Arigidi-Akoko. The questionnaire was administered by the researcher and two trained research assistants. The total number of respondents (Welders, journeymen, and apprentices of more than three months experience) obtained from the 84 randomly selected workshops were 200. The population of this study comprised all 200 Welders, journeymen, and apprentices of more than three months experience. There was no sampling; an entire population of 200 was used. The Instrument for data collection in this study was a structured questionnaire. The instrument was validated. The responses to the items were based on a four-point scale, with numerical value of 4, 3, 2, and 1. Descriptive statistics was used to analyze the data collected from the study for answering the research question. Scoring system was used for assessing the awareness of the respondents on health effects of welding fumes and ultraviolet radiation, use of personal protective equipment (PPE) among production welders.

RESULTS

Research Question 1: What are causes of welding fumes and ultraviolet in welding process?

Table 1: Mean and Standard Deviation of responses on causes of welding fumes and ultraviolet radiation in welding process.

S/N	Causes of Welding Fumes and ultraviolet in	Mean X	Standar	Remarks
1	welding process.		Deviat ion	
1	Consumable materials	3.18	0.71	Strongly Agree
2	Work piece	3.30	0.82	Strongly Agree
3	Compounds decomposition in the flux coating	3.11	0.60	Strongly Agree
4	Core Decomposition	3.33	0.63	Strongly Agree
5	Decomposition through oxidation	3.18	0.71	Strongly Agree
6	Decomposition through dissociation.	3.30	0.82	Strongly Agree
7	Nuisance dusts	3.11	0.60	Strongly Agree

S/ N	Strategies of Preventing Health Hazards of Welding Fumes	Mean X	Standar Deviation	Remarks
1	Faces shield/mask	3.41	0.68	Strongly Aware
2	Well ventilated areas	3.18	0.88	Strongly Agree
3	Local exhausts	3.21	0.89	Strongly Agree
4	Vent hood	3.25	0.66	Strongly Agree
5	Gun-mounted exhausts ventilation	3.18	0.71	Strongly Agree
6	Evaluation of the	3.30	0.82	Strongly

The data presented in table 1 revealed that the 7 causes of welding fumes and ultraviolet in welding process have their mean value ranged from 3.11 to 3.30. This indicated that the mean value of each item was above the cut-off point of 2.50, showing that all the causes of welding fumes and ultraviolet in welding process were agreed on by Welders, journeymen, and apprentices on prior awareness of health effects of welding fumes and ultraviolet radiation, use of personal protective equipment (PPE). The table also showed that the standard deviations (SD) of the items are within the range of 0.60-0.82.

Research Question 2: What are the health effects of welding fumes and ultraviolet radiation to welders?

Table 2: Mean and Standard Deviation of responses on health effects of welding fumes and ultraviolet radiation to welders.

S/ N	Strategies of Preventing Health Hazards of Welding Fumes	Mean X	Standar Deviation	Remarks
1	Faces shield/mask	3.41	0.68	Strongly Aware
2	Well ventilated areas	3.18	0.88	Strongly Agree
3	Local exhausts	3.21	0.89	Strongly Agree
4	Vent hood	3.25	0.66	Strongly Agree
5	Gun-mounted exhausts ventilation	3.18	0.71	Strongly Agree
6	Evaluation of the	3.30	0.82	Strongly

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	work situation			Agree
7	Knowledge of materials and its hazard	3.10	0.60	Strongly Agree
8	Field location portable hoods	3.33	0.63	Strongly Agree
9	Dust nose cover	3.25	0.64	Strongly Agree

The data presented in table 3 revealed that the 9 Strategies of Preventing Health Hazards of Welding Fumes have their mean value ranged from 3.10 to 3.41. This indicated that the mean value of each item was above the cut-off point of 2.50 showing that all the Strategies of Preventing Health Hazards of Welding Fumes and ultraviolet radiation exposure were agreed on by Welders, journeymen, and apprentices on prior awareness of health effects of welding fumes and ultraviolet radiation, use of personal protective equipment (PPE). The table also showed that the standard deviations (SD) of the items are within the range of 0.60-0.89.

Hypothesis

There is no significant relationship between the use of Personal Protective Equipment (PPE) and the awareness of the health effects of welding fumes and ultraviolet (UV) radiation among welders.

Group	N	X	S D	D F	r-cal	r-tab	P-Value	Decision
Personal Protective Equipment (PPE)	200	3.26	.723	198	0.25	0.139	< 0.05	Rejected
health effects of welding fumes and ultraviolet (UV) radiation among welders	200	3.27	.731					

The hypothesis test aimed to examine the relationship between the use of Personal Protective Equipment (PPE) and the awareness of the health effects of welding fumes and ultraviolet (UV) radiation among welders. With 200 participants, the mean scores for PPE use and awareness of

health effects were 3.26 (SD = 0.723) and 3.27 (SD = 0.731) respectively. The Pearson correlation coefficient (r-cal) was calculated to be 0.25, exceeding the critical value (r-tab) of 0.139 at a significance level of less than 0.05. Consequently, the null hypothesis was rejected, indicating a significant positive relationship between PPE use and awareness of health effects among welders. This suggests that increased use of PPE is associated with greater awareness of the health risks posed by welding fumes and UV radiation.

DISCUSSION

The paper conducts a thorough evaluation of the current research on health risks associated with the welding process and its control techniques. Welding has significant health risks, including exposure to hazardous fumes and ultraviolet radiations, which can cause respiratory diseases, skin cancer, and metal fume fever. Dixon et al. (2024) found that UV radiation exposure can cause DNA alterations in welders over time.

The majority of respondents were aware of the health risks associated with welding fumes and UV radiation. This is most likely owing to the fact that the majority of respondents are graduates of technical colleges, and secondary school leavers were taught about the work dangers connected with arc welding in basic technology classes. Apprentices, journeymen, and their masters all received official training for the vocation, thus they had the opportunity to learn about the health concerns related with their work as well as feasible safeguards to be taken in the practice of their vocation.

This finding is consistent with findings from a related study conducted in Northern Nigeria and Benin City, Nigeria, which found that the majority of welders were aware that their jobs were hazardous to their health, despite the fact that the majority of respondents interviewed received their training through apprenticeship (Isah and Okojie, 2020; Sabitu et al., 2019). However, the study did not measure the amount of comprehension or knowledge of the health risks associated with welding. Welders who are unaware of the potential hazards of welding may use safety devices improperly, even if they have them.

Most of the respondents in the survey were aware of the usage of welding shields/eye goggles and nose masks as a form of protection against fume and UV radiation dangers, which might explain the observed high use of welding shields/eye goggles among respondents. This conclusion is greater than that of previous studies conducted in Northern Nigeria by Sabitu et al. (2019) and Adewoye et al. (2023), as well as in Benin City Nigeria by Isah and Okojie (2020), in which welders reported using eye-goggles or a face mask. As a result, welders will experience less ocular injuries if they wear eye goggles at all times when welding.

However, this conclusion is consistent with a research conducted by Omolase in Owo, South Western Ondo State, Nigeria, which found that the majority of welders utilized eye goggles on occasion. According to Omolase and Mahmood (2020), welders who do not wear eye goggles routinely



expose themselves to ocular dangers. As a result, the study concluded that fumes and UV radiations were the most serious health risks associated with welding operations.

CONCLUSION

The results reveal that welding fumes are harmful to welders and others around them. This research also examines the welding profession, which is extremely hazardous; few welders and people who work in the welding industry are aware of all of the risks. Welders and others in the welding proximity are vulnerable to welding dangers because they are unaware of them. To reduce arc welding dangers, this paper recommends several safety precautions for both the welder and others nearby.

RECOMMENDATIONS

Following the results of the Findings, the following recommendations were made:

1. Welders should imbibe the culture of using respiratory protection equipment to protect themselves from welding fumes and also reduce the period of exposure to welding fumes.
2. Apprentices, journeymen, and their masters should be enlightened on the health effects of welding fumes and the methods to minimize exposure to the fumes.
3. The use of face masks, nose masks, and other personal protective equipment in the workshop should be made compulsory.

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