

THE EFFECT OF ULTRAVIOLET RADIATION INTENSITY ON EYE DISORDERS AMONG WELDERS IN MEDAN MAIMUN DISTRICT, MEDAN CITY IN 2024

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Abstract

Welding is a high-risk occupation that can lead to eye disorders, posing significant hazards to workers. One of the primary dangers is exposure to ultraviolet (UV) radiation generated during the welding process. UV radiation emitted during welding activities can harm not only welders but also other workers in close proximity to the welding area. This study aimed to analyze the influence of ultraviolet (UV) radiation exposure

on eye disorders among welders in Medan Maimun District, Medan City. This quantitative study used an observational analytic method with a cross-sectional study design. The research was conducted in Medan Maimun District, an area with the highest number of welding businesses in Medan City. The study took place from August 2024 to December 2024. The study population included all 85 welding businesses in the district, with a sample size of 25 welding businesses and 94 welders, selected based on inclusion criteria. The sampling technique employed cluster sampling for welding businesses and total sampling for welders. Data collection involved interviews, observations, and measurements of UV radiation intensity conducted by technicians from the Occupational Safety and Health Center (Balai K3) in Medan City. Data analysis was conducted in two stages: univariate analysis and bivariate analysis using simple logistic regression tests at a 95% confidence level ($\alpha=0.05$). The results revealed a significant influence of UV radiation intensity on eye disorders among welders in Medan City ($\text{ExpB}=0.783$; $p\text{-value}=0.001$). Recommendations include encouraging welders to use standard eye protection equipment such as spectacles, goggles, and welding masks to reduce UV radiation exposure.

Keywords: Eye disorders, ultraviolet radiation, welders

Introduction

Eye disorders are a prevalent health problem in society. These conditions are characterized by a decline in the eye's ability to see objects clearly (Setiyaji & Nasution, 2019; Sundawa et al., 2020). Eye health issues range from mild to severe, including vision impairment and blindness (Putra et al., 2022).

According to the International Labour Organization (ILO, 2023), 2.2 billion people globally experience vision impairment. The primary causes of severe vision impairment include undiagnosed refractive errors affecting 161 million people, glaucoma (8 million), cataracts (100 million), age-related macular degeneration (8 million), and diabetic retinopathy (4 million).

The rapid industrial growth in Indonesia is reflected in data from the Central Bureau of Statistics, which recorded 80.24 million people (59.31%) working in the informal sector and 55.06 million people (40.69%) in the formal sector in 2022 (Badan Pusat Statistik, 2022). By 2023, the



Central Bureau of Statistics reported that the total working population in Indonesia reached 138.63 million people (Badan Pusat Statistik, 2023). Indonesia ranks third globally in the prevalence of vision impairment, following India and China (Rokom, 2024). Data from the Bureau of Labor Statistics (BLS, 2023) indicate that eye disorders among workers accounted for 1,790 cases, with welders, solderers, and metal cutters experiencing 1,390 cases of eye complaints caused by radiation exposure and welding sparks.

The welding industry is a rapidly growing segment within the informal industrial sector. Welding is defined as the process of joining two or more metal pieces using thermal energy (Yantony & Parekke, 2023). Various hazards arise during welding, including dust, electric shocks, light and radiation, heat radiation, risks of explosions and fires, and welding sparks (Harahap et al., 2017). Among these, radiation exposure and welding sparks pose the greatest health risks to welders (Ristanti et al., 2023).

Welders are exposed to occupational hazards that can negatively impact their health, particularly their eyes. One significant hazard is the radiation and intense light emitted during the welding process. Welding generates a radiation spectrum with wavelengths ranging from 200 to 1400 nm, which includes ultraviolet (UV) light (100–400 nm), visible light (400–700 nm), and infrared radiation (700–1400 nm) (Yantony & Parekke, 2023).

Among these, UV-B radiation is the most detrimental to human eyes. Ultraviolet-B radiation is largely absorbed by the cornea, with a small fraction reaching the lens, potentially causing eye disorders. Welders rank highest in the proportion of workers experiencing eye disorders. Frequent exposure to high-intensity light significantly impacts the ocular system, posing severe risks to welders' eye health (Masrurin et al., 2017).

The hazards associated with welding processes include exposure to ultraviolet (UV) radiation, which can lead to eye disorders such as eyelid swelling, blurred vision, corneal damage, and even blindness. The effects of UV radiation are significantly more harmful than those of visible light. Although UV rays are easily absorbed, they have a profound impact on chemical reactions within the body (Wirawan et al., 2023).

According to the Minister of Manpower Regulation of the Republic of Indonesia No. 5 of 2018 concerning Occupational Safety and Health in the Work Environment, the permissible exposure limit for UV radiation over an 8-hour workday is 0.0001 mW/cm². If this threshold is exceeded, various control measures must be implemented. Workplaces involved in welding must provide personal protective equipment (PPE) such as welding goggles, face shields, and welding helmets to prevent direct exposure to UV radiation emitted by welding tools (Khusaini & Setyawan, 2024).

Welders who do not use specialized welding goggles face a significantly higher risk of UV radiation exposure during welding activities. Failure to consistently wear protective goggles exposes welders' eyes to direct UV radiation, increasing the likelihood of severe eye damage (Syahrizal, 2021).

Medan Maimun is one of the districts in Medan City, North Sumatra Province. It comprises six sub-districts: Kampung Baru, Sei Mati, Suka Raja, Jati, Hamdan, and Aur. The total population



of Medan Maimun is 41,092 people, with a significant portion of the residents operating welding workshops as their primary livelihood.

The work life of welders is closely linked to sources of radiation, with UV radiation from welding processes being a major contributor to eye disorders. In small-scale welding workshops in Medan Maimun, oral agreements dictate work targets and deadlines, compelling welders to meet agreed-upon timelines with their clients. This operational setup places additional strain on workers. Given the absence of formal written contracts and the demanding work targets, there is a pressing need to study the eye health impacts on welders in small-scale workshops. This research aims to analyze the effect of ultraviolet radiation intensity on eye disorders among welders in Medan City in 2024.

Methods

This quantitative study employed an observational analytic approach with a cross-sectional design and was conducted in Medan Maimun District, Medan City, from August to December 2024. The population included all 85 welding businesses in the district, with a sample comprising 25 welding businesses and 94 welders. Sampling was conducted in two stages: first, cluster sampling was applied to select 30% of the welding businesses, and second, total sampling was used to include all 94 welders. Sampling was based on inclusion and exclusion criteria, where inclusion criteria for welding businesses required at least three welders and operation for a minimum of five days per week, while exclusion criteria excluded businesses with fewer than three welders. For welders, inclusion criteria involved active participation in welding for at least five days per week, no routine use of eye medications, and willingness to provide informed consent, while exclusion criteria involved a history of serious eye diseases, recent acute eye injuries, or inability to participate in data collection.

Data collection was conducted through interviews, observations, and UV radiation intensity measurements by technicians from the Occupational Safety and Health Center (Balai K3) in Medan City. The dependent variable was eye disorders among welders, measured on an ordinal scale, while the independent variable was the intensity of UV radiation, also measured on an ordinal scale. Data analysis included three steps: univariate analysis, bivariate analysis using independent t-tests and chi-square tests, and multivariate analysis using multiple logistic regression at a = 95% significance level ($\alpha=0.05$).

The principal researcher obtained an ethical approval certificate from the Health Research Ethics Committee of Universitas Prima Indonesia (No: 050/KEPK/UNPRI/XII/2024). Additionally, permission was sought from the academic administration of the university and relevant authorities prior to data collection, ensuring informed consent was obtained from respondents before distributing the questionnaires.



Results

Characteristics of Welders in Medan Maimun District

The frequency distribution of the characteristics of welders in Medan Maimun District, Medan City, is presented in the table below:

Table 1. Frequency Distribution of Welder Characteristics in Medan Maimun District, Medan City

Welder Characteristics	n	%
Age		
< 35 years	51	54.3
> 35 years	43	45.7
Working Hours per Day		
< 8 hours	34	36.2
> 8 hours	60	63.8
Years of Work Experience		
< 10 years	50	53.2
> 10 years	44	46.8
Use of Eye Protection		
Does not use eye protection	56	59.6
Uses eye protection	38	40.4

Based on Table 1, the frequency distribution of welder characteristics in Medan Maimun District shows that 51 welders (54.3%) are under 35 years old, while 43 welders (45.7%) are over 35 years old. Regarding working hours, 34 welders (36.2%) work less than 8 hours a day, and 60 welders (63.8%) work more than 8 hours a day. Regarding years of experience, 50 welders (53.2%) have less than 10 years of experience, and 44 welders (46.8%) have more than 10 years of experience. As for the use of eye protection, 56 welders (59.6%) do not use eye protection, while 38 welders (40.4%) use it.

Eye Disorders Among Welders in Medan Maimun District

The frequency distribution of eye disorders among welders in Medan Maimun District is presented in the table below:

Table 2. Eye Disorders Among Welders in Medan Maimun District, Medan City

Eye Disorders Among Welders	n	%
Experiencing	33	35.1
Not Experiencing	61	64.9
Total	94	100.0



Based on Table 2, the frequency distribution of eye disorders among welders in Medan Maimun District shows that 33 welders (35.1%) experience eye disorders, while 61 welders (64.9%) do not experience eye disorders.

Welders in Medan Maimun District, Medan City, who experienced eye disorders in the last three months. The frequency distribution of eye disorders experienced by welders in the last three months is presented as follows:

Table 3. Frequency Distribution of Eye Disorders Experienced in the Last Three Months

Eye Disorders Experienced	n	%
> 2 times	21	22.3
< 2 times	12	12.8
Total	33	100.0

Based on Table 3, the frequency distribution of eye disorders experienced by welders in the last three months shows that 21 welders (22.3%) experienced eye disorders more than twice, and 12 welders (12.8%) experienced eye disorders fewer than two times.

Welders in Medan Maimun District who continue working despite experiencing eye disorders. The frequency distribution of welders who continue working despite experiencing eye disorders is presented as follows:

Table 4. Frequency Distribution of Welders Who Continue Working Despite Eye Disorders

Continue Working	n	%
Yes	28	29.8
No	5	5.3
Total	33	100.0

Based on Table 4, the frequency distribution shows that 28 welders (29.8%) continue working despite experiencing eye disorders, while 5 welders (5.3%) do not work when experiencing eye disorders.

Ultraviolet Radiation Exposure Intensity in Welders in Medan Maimun District

The descriptive analysis of ultraviolet radiation exposure intensity in welders in Medan Maimun District, Medan City is presented in the following table:

Table 5. Descriptive Analysis of Ultraviolet Radiation Exposure Intensity in Welders

Ultraviolet Radiation Exposure Intensity (mw/cm ²)	Min	Max	Mean	SD
	0.00105	0.29221	0.02439	0.039786



Based on Table 5, the descriptive analysis of ultraviolet radiation exposure intensity in welders in Medan Maimun District, Medan City reveals that the average ultraviolet radiation exposure intensity in the welders' eyes is 0.02439 mw/cm², with a standard deviation of 0.03978 mw/cm². The lowest recorded ultraviolet radiation exposure intensity is 0.00105 mw/cm², while the highest recorded intensity is 0.29221 mw/cm².

The Effect of Ultraviolet Radiation Intensity on Eye Disorders in Welders in Medan Maimun District, Medan City

Since ultraviolet radiation exposure intensity is measured on a ratio scale and eye disorders in welders are measured on an ordinal scale, the analysis used was simple logistic regression. The effect of ultraviolet radiation intensity on eye disorders in welders in Medan Maimun District, Medan City is as follows:

Table 6. The Effect of Ultraviolet Radiation Intensity on Eye Disorders in Welders in Medan Maimun District, Medan City in 2024

Variable	<i>Beta</i>	<i>Exp.B</i>	Confidence Interval (95% CI for <i>Exp.B</i>)		<i>Pvalue</i>
			Lower	Upper	
Ultraviolet Radiation Intensity	-0.245	0.783	0.705	0.870	0.001

Based on the results in Table 5, the analysis of the effect of ultraviolet radiation intensity on eye disorders in welders in Medan Maimun District, Medan City shows an *ExpB* value of 0.783. This indicates that 78.3% of the intensity of ultraviolet radiation influences eye disorders in welders in Medan Maimun District, Medan City. The statistical test yielded a p-value of 0.001, which can be concluded to indicate a significant effect between radiation intensity and eye disorders in Medan Maimun District, Medan City.

Discussion

Welding work can cause health problems for individuals in the welding environment, as they are exposed to several hazards, such as smoke, dust, and the most significant hazard radiation exposure, which leads to eye disorders in welders (Kosasih et al., 2022).

The results of this study indicate that 33 welders (86.2%) in Medan Maimun District, Medan City, experience eye disorders, with the majority using electric welding machines. The most common eye complaints reported by welders during their work were glare, experienced by 31 welders (33.0%). After working, the most common complaints included excessive tearing, experienced by 31 welders (33.0%), and blurred vision, also reported by 31 welders (33.0%).

According to the welders in Medan Maimun District, some of the complaints were not noticed until after the workday. While working, they felt symptoms such as having something foreign in their eyes, often described as "sandy eyes." The most severe experience reported by



welders was swelling of the eyelids, making it extremely difficult to open them, often accompanied by an intense stinging sensation.

The findings of this study are consistent with the research by Khusaini & Setyawan (2024), which states that the most common eye complaints among welders in Jagakarsa District in 2024 were the sensation of having foreign objects in their eyes (like sand), tearing, and blurred vision.

According to Saputri (2024), the direct effects of welding on the eyes of welders include complaints such as pain in the eyes after exposure to welding light. This pain is caused by the eyes' muscles being strained while trying to cope with the intensity of the welding light that exceeds the eyes' tolerance, resulting in fatigue. Other symptoms include watery eyes, stinging, swelling, the sensation of having something foreign (like sand), glare, a burning sensation, reduced sharpness, and, in the least severe cases, swollen eyelids and blurred vision.

Welding sparks, which occur rapidly, produce high light intensity, causing the eyes to adapt quickly and strongly to the bright light. When the welding machine is moved away from the welding material, the sparks initially present dissipate, causing the light intensity to decrease rapidly and return to the initial ambient light level (Husein, 2022).

The results of this study indicate that the average intensity of radiation exposure to the eyes of welders in Medan Maimun District, Medan City, is 0.02439 mw/cm², with the lowest radiation intensity being 0.00105 mw/cm² and the highest reaching 0.29221 mw/cm². During this process, the heat generated by the welding creates high light intensity at a specific point, leading to a significant contrast between the object being focused on by the welder and the surrounding environment.

The high radiation intensity is caused by the UV radiation intensity during welding, which depends on the available capacity of the welding machine. However, if the current used in the welding process is low, the welding intensity will also be lower. To ensure that the electric welding intensity is not too high, welders must adjust the intensity level depending on the type of work (Khusaini & Setyawan, 2024).

The light intensity produced by the welding process has poor luminance distribution properties. High light intensity can lead to glare, influenced by the high luminance, the size of the light source, the observer's position relative to the light source, and the contrast between the center of the visual field and the surrounding environment. Additionally, this condition can affect people in the vicinity of the welding process, not just the welder.

The results of this study indicate that there is an effect of radiation intensity on eye disorders among welders in Medan Maimun District, Medan City, where the intensity of ultraviolet (UV) radiation from the welding process contributes to eye disorders in welders.

The intensity of welding light is extremely high because the light produced comes from the welding sparks, which are concentrated at the welding point. The light intensity generated from welding can vary depending on the type of welding machine, the welding task, and the type of metal being welded. The variability in welding light intensity is related to the occurrence of eye disorders in welders.



These findings are consistent with the study by Setiawan (2016), which states that there is a relationship between welding light intensity and eye fatigue in welders. This is due to the high quantity of light intensity, which originates from a single point, causing a light contrast with the surrounding environment. The light contrast that welders focus on leads to eye fatigue.

The stronger the light intensity exposed during work, especially when workers are required to focus on the task, the longer the photochemical process in the retina. A prolonged photochemical process in the retina requires a longer recovery time for the macula as well. When compared to exposure to lower light intensity, higher light intensity results in a longer recovery time for the macula.

The occurrence of eye disorders among welders in Medan Maimun District, Medan City, is an inevitable issue. However, short-term and long-term measures are needed to minimize the incidence of eye disorders and the intensity of UV radiation, ultimately improving work productivity.

Conclusion and Recommendation

Based on the results of the study, it can be concluded that 33 welders (35.1%) in Medan Maimun District, Medan City, experienced eye disorders. Among these, 21 welders (22.3%) experienced eye disorders more than twice in the last three months, while 12 welders (12.8%) experienced eye disorders less than twice. Additionally, 28 welders (29.8%) continued to work despite experiencing eye disorders, while 5 welders (5.3%) refrained from working when experiencing eye disorders. The average intensity of ultraviolet (UV) radiation exposure to the eyes of welders in Medan Maimun District was 0.02439 mw/cm², with the lowest recorded exposure at 0.00105 mw/cm² and the highest at 0.29221 mw/cm². Statistical analysis revealed a p-value of 0.001, indicating a significant effect of radiation intensity on eye disorders in Medan Maimun District, Medan City.

The following recommendations are made: Welders are encouraged to use eye protection equipment that meets safety standards, such as spectacles, goggles, and welding masks, to reduce the intensity of ultraviolet (UV) radiation. Welding business owners are advised to implement clear Standard Operating Procedures (SOPs) for the workshop area and to monitor workers who fail to comply with the proper use of eye protection.

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