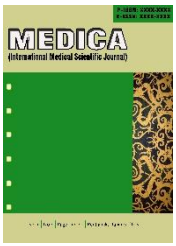
MEDICA

(International Medical Scientific Journal)
Vol.8, No.4, April 2026, pp. 232 – 241
ISSN 2622-660X (Online), ISSN 2622-6596 (Print)
https://journal.ahmareduc.or.id/index.php/medica



Factors Associated with Work Related Accidents Among Welding Shop Workers

Wiwiek Mulyani[1]✉, Pedro William Arthur Lamag[1], Akbar Ilham Pamungkas[1]

[1] Department of Sanitation, Politeknik Kesehatan Kemenkes Jayapura, Jayapura, Papua, Indonesia

Info Article

Article History:
Received:
25 February 2026
Accepted:
29 April 2026
Published:
30 April 2026

Keywords:
Accident
Worker
Welding Shop

Abstract

Occupational accidents remain a major issue in the informal industrial sector, particularly in welding workshops where workers are exposed to various occupational hazards. Data from BPJS Employment, Jayapura Branch, reported an increase in occupational accident cases in Jayapura Regency from 288 cases in 2019 to 329 cases in 2020. This study aimed to analyze factors associated with occupational accidents among welding workers in Waibu District, Jayapura Regency. This study used an analytic observational design with a cross-sectional approach. The research was conducted in eight welding workshops in Waibu District, involving 36 welding workers selected through total sampling. Data were collected using a structured questionnaire. The independent variables included age, education level, knowledge, and length of employment, while the dependent variable was the occurrence of occupational accidents. Data were analyzed using univariate and bivariate analyses with the Chi-square test. The results showed that among the 36 respondents, 50.0% were aged ≥35 years, 66.7% had a low educational level (elementary to junior high school), 50.0% had poor knowledge, and 66.7% had worked for less than five years. Bivariate analysis revealed no significant association between age (p = 0.469) and length of employment (p = 0.124) with occupational accidents. However, education level (p = 0.020) and knowledge (p = 0.030) were significantly associated with occupational accidents among welding workers. In conclusion, education level and occupational safety knowledge were significantly associated with occupational accidents among welding workers in Waibu District, while age and length of employment were not associated. Improving workers' knowledge through occupational safety and health education and training is recommended to reduce the risk of workplace accidents.

Corresponding Author:
✉ Wiwiek Mulyani
Department of Sanitation, Politeknik Kesehatan Kemenkes Jayapura, Jayapura, Papua, Indonesia
Email: mulyani@gmail.com

1. INTRODUCTION

Occupational accidents remain a major public health and occupational safety issue in both formal and informal work sectors and continue to have substantial impacts on workers, employers, and surrounding communities (Adei, Agyemang-Duah, & Mensah, 2022; Lee, & Di Ruggiero, 2022; Shams, 2024; Widowati et al., 2024; Ronconi, Anchorena, & Paz, 2025). Occupational accidents can lead to physical injury, disability, decreased productivity, economic losses, and even death. These incidents are generally influenced by two major factors, namely unsafe human behavior and unsafe working environments (Nastiti & Dian, 2021). Human factors are recognized as the dominant contributor to workplace accidents, with previous studies reporting that approximately 80–85% of accidents are associated with negligence, lack of awareness, or unsafe actions performed by workers and other personnel involved in industrial processes. Such unsafe actions may originate from designers, engineers, supervisors, machine operators, contractors, or maintenance workers, indicating that occupational safety is strongly influenced by human behavior and knowledge.

One occupational group with a high risk of workplace accidents is welding workers. Welding activities involve direct exposure to multiple hazards, including high temperatures, electrical current, ultraviolet (UV) radiation, sparks, toxic fumes, excessive noise, and sharp metal materials. In developing countries, the demand for welders continues to increase due to rapid industrialization and urbanization, resulting in a greater number of workers being exposed to occupational hazards. However, many welding workers still have limited understanding of occupational safety procedures and the appropriate use of personal protective equipment (PPE), while some employers fail to provide adequate safety facilities (Endriastuty & Adawia, 2018). According to the World Health Organization (WHO), Occupational Health and Safety (OHS) aims to maintain and improve workers' physical, mental, and social well-being. In the welding sector, inadequate knowledge and unsafe work practices may increase the risk of burns, electric shocks, eye injuries, respiratory disorders, and metal fume fever. Therefore, improving worker awareness and safety behavior is essential to reducing occupational accidents among welders.

Several studies have identified multiple hazards associated with welding activities, including electric shock, explosions, fire, toxic gas exposure, optical hazards, and unsafe work environments (Ekefre, Ekanem, & Ikpe, 2024; Murugan, & Sathiya, 2024). Electric shock may occur due to direct contact with uninsulated electrical equipment, while welding sparks and hot slag can trigger fires and explosions, particularly in poorly managed workplaces (Nastiti & Munawir, 2021). Globally, occupational accidents remain a significant concern. According to the International Labour Organization (ILO), approximately 2.78 million workers die annually due to occupational accidents and work-related diseases, while around 374 million workers experience non-fatal occupational accidents each year (Zurriya, Thamrin, & Ikhtiar, 2019). In Indonesia, data from BPJS Ketenagakerjaan showed that occupational accident cases increased from 123,040 cases in 2017 to 234,270 cases in 2021, indicating a continuous upward trend. Most accidents occur in high-risk sectors such as construction and metalwork industries, including welding workshops. These findings demonstrate that occupational accidents among welders remain an important occupational health problem requiring further investigation.

Previous studies have reported a high prevalence of occupational accidents among welding workers. Zahara (2018) found that 53.3% of welders in Medan District had experienced workplace accidents, including electric shocks, falls, and contact with hazardous materials. Similarly, Tanjung et al. (2022) reported that 54.5% of welding

workers experienced occupational accidents, with significant associations identified between accidents and factors such as age, education, length of employment, knowledge, work attitude, PPE use, and work environment. Although several studies have examined occupational accidents among welders, most research has focused on industrial areas in western Indonesia and has primarily emphasized behavioral and environmental factors separately. Limited studies have specifically explored the relationship between worker characteristics such as age, education, knowledge, and length of employment with occupational accidents among informal welding workers in eastern Indonesia, particularly in Jayapura Regency. This condition represents an important research gap because differences in educational background, occupational safety awareness, and workplace conditions may influence accident patterns among workers in different regions. The novelty of this study lies in its focus on welding workshop workers in Waibu District, Jayapura Regency, an area that has received limited attention in occupational health research, while simultaneously analyzing multiple individual factors associated with occupational accidents in the informal welding sector.

Based on a preliminary survey conducted on March 20, 2023, data obtained from the Department of Industry and Trade showed that there were eight welding workshops in Waibu District with a total of 32 workers. Several workers reported having experienced occupational accidents, including exposure to welding sparks, electric shocks, abrasions, and cuts during metal-cutting activities. If these conditions persist, workers may develop welding-related health problems such as conjunctivitis, burns, asthma, bronchitis, emphysema, and metal fume fever. Considering the increasing number of occupational accidents and the limited evidence regarding accident-related factors among welding workers in Waibu District, this study aimed to analyze the factors associated with occupational accidents among welding workshop workers in Waibu District, Jayapura Regency.

2. METHOD

This study employed a quantitative analytic observational design using a cross-sectional approach. A cross-sectional study is conducted to identify the relationship between risk factors and outcomes through observation or data collection at a single point in time (Notoatmodjo, 2018). In this design, all variables were measured simultaneously without any follow-up period. This study also obtained ethical approval from the Health Research Ethics Committee of the Health Polytechnic of the Ministry of Health Jayapura with ethical clearance number 222/KEPK-J/V/2023.

The study was conducted from April to May 2023 in Waibu District, Jayapura Regency. The research sites included eight welding workshops operating within the district. The study population consisted of all welding workers employed in these workshops. A total of 36 respondents participated in the study, and the sampling technique used was total sampling, in which all eligible workers were included as study participants. Data were collected using a structured questionnaire as the primary research instrument. The independent variables examined in this study were age, education level, knowledge, and length of employment, while the dependent variable was the occurrence of occupational accidents among welding workers.

Data analysis was performed using univariate and bivariate analyses. Univariate analysis was used to describe the characteristics of respondents and the distribution of each variable in the form of frequencies and percentages. Bivariate analysis was conducted to determine the association between independent variables and occupational

accidents using the Chi-square test. Statistical significance was determined at a 95% confidence level (α = 0.05), and a p-value ≤ 0.05 was considered statistically significant.

3. RESULTS AND DISCUSSION

Table 1. Frequency Distribution of Respondents by Age, Education Level, Knowledge Level, and Length of Service of Welding Shop Workers in Waibu District

Variable	Category	Frequency (n)	Percentage (%)
Age	≥ 35 years	18	50.0
	< 35 years	18	50.0
Education Level	Low	24	66.7
	High	12	33.3
Knowledge Level	Poor	18	50.0
	Good	18	50.0
Length of Employment	≤ 5 years (Short)	24	66.7
	> 5 years (Long)	12	33.3

Based on Table 1, of the 36 respondents included in the study, half of the respondents were categorized as younger workers (n = 18; 50%), while the remaining half were categorized as older workers (n = 18; 50%). In terms of education level, the majority of respondents had a low level of education, accounting for 24 individuals (66.7%), whereas 12 respondents (33.3%) had a higher level of education. Regarding knowledge level, the distribution was equal, with 18 respondents (50%) categorized as having poor knowledge and 18 respondents (50%) as having good knowledge. With respect to length of employment, most respondents had a shorter duration of work experience, with 24 individuals (66.7%) classified as having a short working period, while 12 respondents (33.3%) had longer work experience.

Table 2. Distribution of Occupational Accident Experience and Types of Occupational Accidents Among Welding Workers in Waibu District (n = 36).

Variable	Category	Frequency (n)	Percentage (%)
Occupational Accident Experience	Ever experienced	25	69.4
	Never experienced	11	30.6
	Total	36	100.0
Types of Occupational Accidents*	Electric shock	11	30.6
	Exposure to welding sparks	10	27.8
	Cuts/abrasions	5	13.9
	Slipping	2	5.6
	Hit by falling objects	2	5.6
	Falls	1	2.8
	Injuries from sharp objects	1	2.8
	Total multiple responses	32	88.9

**Multiple responses were allowed.*

Based on Table 2, the majority of respondents (69.4%) reported having experienced occupational accidents, while 30.6% had never experienced workplace accidents. This

finding indicates that occupational accidents are relatively common among welding workers in Waibu District and reflect the presence of considerable occupational hazards in welding activities.

The most frequently reported types of occupational accidents were electric shocks (30.6%) and exposure to welding sparks (27.8%), followed by cuts or abrasions (13.9%). Other accidents included slipping (5.6%), being struck by falling objects (5.6%), falls (2.8%), and injuries caused by sharp objects (2.8%). The total percentage of accident types exceeded 100% because several respondents experienced more than one type of occupational accident.

These findings suggest that welding workers are exposed to multiple workplace hazards, particularly electrical, thermal, and mechanical risks. Therefore, strengthening occupational safety practices, improving compliance with personal protective equipment (PPE) use, and enhancing workplace hazard control are essential to reduce the occurrence of occupational accidents among welding workers.

Table 3. Association Between Respondent Characteristics and Occupational Accidents Among Welding Workers in Waibu District (n = 36).

Variable	Category	Experienced Accident n (%)	No Accident n (%)	Total n (%)	p-value
Age	≥ 35 years	11 (61.1)	7 (38.9)	18 (100)	0.469
	< 35 years	14 (77.8)	4 (22.2)	18 (100)	
Education Level	Low	20 (83.3)	4 (16.7)	24 (100)	0.020*
	High	5 (41.7)	7 (58.3)	12 (100)	
Knowledge Level	Poor	16 (88.9)	2 (11.1)	18 (100)	0.030*
	Good	9 (50.0)	9 (50.0)	18 (100)	
Length of Employment	≤ 5 years (Short)	19 (79.2)	5 (20.8)	24 (100)	0.124
	> 5 years (Long)	6 (50.0)	6 (50.0)	12 (100)	
	Total	25 (69.4)	11 (30.6)	36 (100)	

**Statistically significant at p ≤ 0.05.*

Based on Table 3, respondents aged <35 years had a higher proportion of occupational accidents (77.8%) compared to respondents aged ≥35 years (61.1%). However, the Chi-square test showed no statistically significant association between age and occupational accidents (p = 0.469), indicating that age was not a significant factor associated with workplace accidents among welding workers in this study.

In terms of education level, respondents with low educational attainment were more likely to experience occupational accidents (83.3%) compared to those with higher education (41.7%). The Chi-square analysis demonstrated a statistically significant association between education level and occupational accidents (p = 0.020), suggesting that workers with lower education levels had a greater risk of workplace accidents.

Similarly, respondents with poor knowledge showed a substantially higher proportion of occupational accidents (88.9%) than respondents with good knowledge (50.0%). Statistical analysis revealed a significant association between knowledge level and occupational accidents (p = 0.030). This finding indicates that inadequate knowledge

regarding occupational safety may increase the likelihood of accidents among welding workers.

Regarding length of employment, workers with shorter work experience (≤5 years) experienced more occupational accidents (79.2%) compared to workers with longer work experience (>5 years) (50.0%). Nevertheless, the Chi-square test indicated that the association between length of employment and occupational accidents was not statistically significant ($p = 0.124$). Therefore, length of employment was not identified as a significant determinant of occupational accidents in this study. Overall, the findings suggest that education level and knowledge were significant factors associated with occupational accidents, whereas age and length of employment were not significantly associated.

The findings of this study revealed that the prevalence of occupational accidents among welding workers in Waibu District, Jayapura Regency, was relatively high, with 69.4% of respondents reporting having experienced workplace accidents. The most frequently reported accident was electric shock, followed by exposure to welding sparks and cuts or abrasions. Although the majority of these accidents were non-fatal, the high prevalence indicates that welding workers remain highly exposed to occupational hazards associated with electrical, thermal, and mechanical risks. This condition reflects inadequate occupational safety practices and highlights the urgent need for strengthening workplace safety measures, particularly in the informal welding sector.

The results showed that age was not significantly associated with occupational accidents among welding workers ($p > 0.05$), even though younger workers experienced a higher proportion of accidents compared to older workers. This finding suggests that occupational accidents cannot be explained solely by age differences. Younger workers may be more vulnerable due to limited work experience, lack of hazard awareness, and unsafe work practices, whereas older workers may face risks related to fatigue, declining physical capacity, and prolonged exposure to occupational hazards. Therefore, both age groups possess different risk characteristics that may contribute to workplace accidents. This finding is consistent with the study conducted by Mudasir et al. (2022), which also reported no significant relationship between age and occupational accidents.

In contrast, education level was found to have a statistically significant association with occupational accidents ($p < 0.05$). Workers with lower educational attainment were more likely to experience occupational accidents than those with higher levels of education. Educational background may influence an individual's ability to understand occupational safety procedures, recognize workplace hazards, and apply preventive measures during work activities. Workers with limited educational attainment may have difficulties understanding safety instructions, standard operating procedures, and the importance of using personal protective equipment (PPE) consistently. This finding is in line with previous research conducted by Tanjung et al. (2022), which demonstrated a significant relationship between education level and occupational accidents. Moreover, this result supports the theory proposed by Triwibowo & Puspihandani (2013) and is reinforced by recent studies (Hong et al., 2023; Zeng, Zhong, & Naz, 2023; Islam et al., 2025), which emphasize that education plays an important role in shaping safety behavior, improving risk perception, and increasing compliance with occupational safety regulations.

Knowledge level was also significantly associated with occupational accidents ($p < 0.05$). Workers with poor occupational safety knowledge experienced more workplace accidents compared to workers with good knowledge. This finding indicates that knowledge regarding occupational safety and health (OSH) is a critical factor in preventing accidents in welding activities. Adequate knowledge enables workers to identify potential

hazards, follow safe working procedures, and use PPE appropriately during welding processes. Conversely, limited knowledge may increase unsafe behavior and reduce awareness of workplace risks. This result is consistent with the findings of Nastiti & Munawir (2021), who reported that improved safety knowledge contributes to safer work practices and reduces the risk of occupational accidents. Therefore, regular occupational safety training and health education programs are essential to improve workers' awareness and promote safer behavior in welding workshops.

Although workers with shorter job tenure (<5 years) reported a higher proportion of occupational accidents, this study found no statistically significant relationship between length of employment and occupational accidents ($p > 0.05$). This finding suggests that longer work experience does not necessarily guarantee safer working behavior. Workers with longer employment duration may become overly confident or less compliant with safety procedures, while newer workers may lack sufficient practical skills and experience in hazard management. In addition, occupational accidents may also be influenced by other factors such as workplace supervision, availability of PPE, work environment conditions, and compliance with occupational safety standards. Previous studies have similarly reported that the use of PPE and adherence to safety protocols are more influential in preventing accidents than work experience alone (Boakye et al., 2022; Millington, Chilcott, & Williams, 2022; Al-Bayati et al., 2023; Khoshakhlagh et al., 2024; Lohiniva et al., 2025).

Overall, this study demonstrates that education level and occupational safety knowledge are important determinants of occupational accidents among welding workers in Waibu District, while age and length of employment were not significantly associated with accident occurrence. These findings emphasize the importance of strengthening occupational safety education, providing regular training programs, improving workers' safety awareness, and promoting consistent use of PPE to reduce occupational accidents in welding workshops.

This study has several limitations. First, the cross-sectional design only describes associations between variables and cannot establish causal relationships. Second, the relatively small sample size and focus on welding workshops in a single district may limit the generalizability of the findings to other settings or industrial sectors. Third, data collection relied on self-reported questionnaires, which may introduce recall bias and reporting bias among respondents. In addition, this study did not assess other potential factors related to occupational accidents, such as workplace environmental conditions, safety supervision, work attitudes, and compliance with PPE use, which may also influence accident occurrence. Future studies are recommended to involve larger samples, include additional occupational safety variables, and apply longitudinal designs to obtain a more comprehensive understanding of factors associated with occupational accidents among welding workers.

4. CONCLUSION

Based on the results of this study, it can be concluded that the majority of welding workers in Waibu District, Jayapura Regency, were older workers, had low educational attainment, insufficient occupational safety knowledge, and relatively short work experience. The findings also showed that educational level and knowledge were significantly associated with the occurrence of occupational accidents, whereas age and length of employment were not significantly associated with workplace accidents among welding workers. These results indicate that workers with lower levels of education and

inadequate occupational safety knowledge are more likely to experience occupational accidents.

The findings of this study imply that improving workers' educational and knowledge-related aspects is essential in reducing occupational accidents in welding workshops. Occupational safety and health (OSH) training, regular safety education programs, and increased awareness regarding the proper use of personal protective equipment (PPE) should be prioritized by workshop owners and related stakeholders. Strengthening workplace safety culture and supervision may also contribute to minimizing unsafe work practices and reducing accident risks among welding workers.

Future studies are recommended to involve larger sample sizes and broader study locations to improve the generalizability of the findings. Further research should also examine additional factors associated with occupational accidents, such as work environment conditions, safety supervision, worker attitudes, compliance with PPE use, workload, and occupational stress. Moreover, longitudinal or cohort study designs are recommended to better identify causal relationships between occupational risk factors and workplace accidents among welding workers.

REFERENCES

Adei, D., Agyemang-Duah, W., & Mensah, A. A. (2022). Demographic and socio-economic factors associated with exposure to occupational injuries and diseases among informal sector workers in Kumasi metropolis, Ghana. *Journal of Public Health,* 30(9), 2191-2199. Retrieved from https://doi.org/10.1007/s10389-021-01492-3

Al-Bayati, A. J., Rener, A. T., Listello, M. P., & Mohamed, M. (2023). PPE non-compliance among construction workers: An assessment of contributing factors utilizing fuzzy theory. *Journal of safety research,* 85, 242-253. https://doi.org/10.1016/j.jsr.2023.02.008

Boakye, M. K., Adanu, S. K., Coffie, G. H., Adzivor, E. K., & Ayimah, J. C. (2022). Building construction artisans' level of access to personal protective equipment (PPE) and the perceived barriers and motivating factors of adherence to its use. *Journal of Environmental and Public Health,* 2022(1), 4870731. https://doi.org/10.1155/2022/4870731

Ekefre, A., Ekanem, I. I., & Ikpe, A. E. (2024). Physical survey on the health hazards of welding activities on welding operators in Uyo, Nigeria. *Ibom medical journal*, 17(2), 302-312. https://doi.org/10.61386/imj.v7i2.441

Endriastuty, Y., & Adawia, P. R. (2018). Analisa Hubungan Antara Tingkat Pendidikan, Pengetahuan Tentang K3 Terhadap Budaya K3 Pada Perusahaan Manufaktur [Analysis of the Relationship Between Educational Level and Knowledge of Occupational Safety and Health and Occupational Safety and Health Culture in Manufacturing Companies]. *Jurnal Ecodemica,* 2(2), 193–201. Retrieved from https://ejournal.bsi.ac.id/ejurnal/index.php/ecodemica/article/view/4014

Hong, W. C. H., Chi, C., Liu, J., Zhang, Y., Lei, V. N. L., & Xu, X. (2023). The influence of social education level on cybersecurity awareness and behaviour: a comparative study of university students and working graduates. *Education and information technologies*, 28(1), 439-470. https://doi.org/10.1007/s10639-022-11121-5

Islam, K. S., Hossain, A., Khan, M. R., & Islam, M. T. (2025). The Role Of Age In Shaping Risk-Taking Behaviors And Safety Awareness In The Manufacturing Sector. *American Journal of Advanced Technology and Engineering Solutions*, 1(01), 98-121. https://doi.org/10.63125/sq8jta62

Khoshakhlagh, A. H., Malakoutikhah, M., Park, J., Kodnoueieh, M. D., Boroujeni, Z. R., Bahrami, M., & Ramezani, F. (2024). Assessing personal protective equipment usage and its correlation with knowledge, attitudes, performance, and safety culture among workers in small and medium-sized enterprises. *BMC Public Health*, 24(1), 1987. https://doi.org/10.1186/s12889-024-19517-3

Lee, J., & Di Ruggiero, E. (2022). How does informal employment affect health and health equity? Emerging gaps in research from a scoping review and modified e-Delphi survey. *International Journal for Equity in Health,* 21(1), 87. https://doi.org/10.1186/s12939-022-01684-7

Lohiniva, A. L., Lehtinen, J. M., Arifulla, D., Ollgren, J., Nuorti, P., & Lyytikäinen, O. (2025). Factors influencing healthcare workers' compliance with personal protective equipment guidelines in long-term care during the COVID-19 pandemic—A theory-based mixed-methods study. *Plos one*, 20(4), e0321851. https://doi.org/10.1371/journal.pone.0321851

Millington, T. I., Chilcott, R. P., & Williams, J. (2022). Experiences of personal protective equipment and reasons for non-compliance. *Journal of Paramedic Practice*, 14(10), 411-418. https://doi.org/10.12968/jpar.2022.14.10.411

Mudasir, A., Medyati, N., & Irjayanti, A. (2022). Faktor yang Berhubungan dengan Kecelakaan Kerja pada Pekerja Bengkel Las di Distrik Abepura Kota Jayapura [Factors Associated with Workplace Accidents Among Welding Shop Workers in the Abepura District of Jayapura City]. *Jurnal Kesehatan Andalas,* 11(3), 158-163. https://doi.org/10.25077/jka.v11i3.2094

Murugan, S. S., & Sathiya, P. (2024). Analysis of welding hazards from an occupational safety perspective. *Vietnam journal of science, technology and engineering,* 66(3), 63-74.

Nastiti, D., & Munawir, M. (2021). Hubungan Pengetahuan dan Waktu Kerja Terhadap Kecelakaan Kerja Pada Pekerja Bengkel Las di Kecamatan Warunggunung [The Relationship Between Knowledge and Working Hours and Workplace Accidents Among Welding Shop Workers in Warunggunung Subdistrict]. *Jurnal Medika Sains,* 1(1), 8-18.

Notoadmojo, S. (2018). *Metodologi Penelitian Kesehatan [Health Research Methodology]*. Jakarta: Rineka Cipta.

Ronconi, L., Anchorena, J., & Paz, J. (2025). The incidence and severe consequences of occupational injuries among informal workers in a developing country. International *Journal of Occupational Safety and Ergonomics,* 31(2), 560-567. https://doi.org/10.1080/10803548.2025.2454152

Shams, N. (2024). The Burden of Occupational Hazards on Informal Workers: A Global Perspective. *International journal of medical and health sciences archives*, 3(02), 72-87. Retrieved from https://ijmhsa.com/index.php/IJMHSA/article/view/26

Tanjung, R., Syaputri, D., Rusli, M., Sinaga, J., Manalu, S. M., Bambang, T. T., & Lubis, A. Z. (2022). Analisis Faktor Kecelakaan Kerja pada Pekerja Usaha Bengkel Las [Analysis of Factors Contributing to Workplace Accidents Among Welding Shop Workers]. *Formosa Journal of Science and Technology,* 1(5), 435–446.

Triwibowo, C., & Pusphandandani, M.E. (2013). *Kesehatan Lingkungan dan K3.* Yogyakarta: Nuha Medika.

Widowati, E., Wahyuningsih, A. S., Seftyono, C., Sulistyani, U. N. L., Kurniawan, M., Dwijaningtyas, S., ... & Rahayu, O. (2024). Analysis of Occupational Accidents in Various Informal Sectors in Indonesia. *Unnes Journal of Public Health,* 13(2), 50-56.

Zeng, Z., Zhong, W., & Naz, S. (2023). Can environmental knowledge and risk perception make a difference? The role of environmental concern and pro-environmental behavior in fostering sustainable consumption behavior. *Sustainability,* 15(6), 4791. https://doi.org/10.3390/su15064791