

Occupational eye health and productivity loss: The impact of photokeratitis among electric welders in Gowa, Indonesia

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ABSTRACT

Occupational eye disorders, particularly photokeratitis, have received limited attention in developing regions, despite their significant impact on worker productivity. This study aimed to assess the relationship between photokeratitis symptoms and work productivity among electric welders in Gowa Regency, Indonesia. Employing an observational design with a cross-sectional approach, data were collected from 63 electric welders across 14 welding workshops in Samata Subdistrict, Somba Opu District. The presence of photokeratitis symptoms and productivity levels were assessed through structured interviews and categorized accordingly. Statistical analysis using the chi-square test ($\alpha=0.05$) revealed that 75.0% of respondents with photokeratitis symptoms were less productive, while only 25.0% remained productive. Conversely, among those without symptoms, 87.0% were productive, and 13.0% were less productive. The association between photokeratitis and productivity was statistically significant ($p=0.001$; $OR=20.000$). These findings underscore the critical role of occupational eye health in sustaining productivity in rural industrial settings. Public health interventions, including the promotion of personal protective equipment and workplace safety education, are imperative to mitigate productivity loss among welders.

ABSTRAK

Gangguan mata akibat kerja, khususnya photokeratitis, masih kurang mendapat perhatian di negara berkembang, padahal dampaknya cukup signifikan terhadap produktivitas pekerja. Penelitian ini bertujuan untuk menilai hubungan antara gejala fotokeratitis dan produktivitas kerja pada tukang las listrik di Kabupaten Gowa, Indonesia. Menggunakan desain observasional dengan pendekatan cross-sectional, data dikumpulkan dari 63 pekerja las listrik di 14 bengkel las di Kecamatan Samata, Kabupaten Somba Opu. Keberadaan gejala fotokeratitis dan tingkat produktivitas dinilai melalui wawancara terstruktur dan dikategorikan. Analisis statistik menggunakan uji chi-square ($\alpha = 0,05$) menunjukkan bahwa 75,0% responden dengan gejala photokeratitis kurang produktif, sementara hanya 25,0% yang tetap produktif. Sebaliknya, di antara mereka yang tidak memiliki gejala, 87,0% produktif, dan 13,0% kurang produktif. Hubungan antara fotokeratitis dan produktivitas secara statistik signifikan ($p=0,001$; $OR=20,000$). Temuan ini menggarisbawahi peran penting kesehatan mata kerja dalam mempertahankan produktivitas di lingkungan industri pedesaan. Intervensi kesehatan masyarakat, termasuk promosi alat pelindung diri dan pendidikan keselamatan di tempat kerja, sangat penting untuk mengurangi hilangnya produktivitas di antara para tukang las.

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INTRODUCTION

The shift from traditional agrarian livelihoods to rapidly growing industrial sectors in Indonesia has introduced a range of occupational health hazards, particularly in informal work settings. One critical yet often overlooked hazard is occupational eye disorders, which are increasingly prevalent in industries such as welding. According to the Ministry of Health of the Republic of Indonesia (2013), occupational eye diseases, including those resulting from specific job exposures (PMAK and PMAHK), are emerging as significant public health concerns. Given that 60% of the national workforce operates in the informal sector (Kemenkes RI, 2015), safeguarding workers' eye health is an essential part of addressing nearly half of Indonesia's overall health issues.

Global data echo these concerns. The U.S. Bureau of Labor Statistics (BLS) reported that approximately 37% of all head injuries leading to work absence in 2018 occurred in men, with eye injuries constituting a substantial proportion. Studies in Asia, including those by Yu et al. (2004) and subsequent research in Taiwan, highlight that photokeratitis — commonly caused by welding — is the most frequent type of eye injury in industrial settings. This condition severely affects worker concentration and leads to lost workdays and decreased productivity. The evidence suggests a strong correlation between insufficient eye protection and elevated risk of injury, particularly among informal workers such as welders.

Despite growing awareness of occupational hazards in welding, the specific relationship between photokeratitis symptoms and productivity loss among informal sector workers remains underexplored. In Indonesia, there is limited empirical research linking occupational eye injuries with measurable productivity outcomes. Yet, studies such as those by Kumah et al. (2011) and Wahyuni (2013) emphasize the significance of exposure duration and use of personal protective equipment (PPE) in preventing eye injuries like photokeratitis. Addressing this research gap requires targeted studies to assess how photokeratitis affects work performance in welding environments, particularly in underserved rural settings.

Research consistently underscores the effectiveness of PPE in reducing the incidence of eye injuries among welders. For example, the study by Okuno et al. (2001) demonstrates that consistent use of properly rated eye protection significantly lowers the risk of photokeratokonjunctivitis, a condition closely related to photokeratitis. Furthermore, findings from the Society of Japan Welding Engineering (JWES, 1980) revealed that although 86% of welding workers had experienced eye discomfort consistent with photokeratitis, consistent use of eye protection minimized recurrent symptoms. Similarly, Ari Sigit P (2008) found that the risk factors for photoelectric conjunctivitis included duration of exposure, employment length, and type of electrode used, indicating that modifying these variables could mitigate ocular damage.

Moreover, research conducted by ICNIRP (2007) and Wahyuni (2013) links prolonged exposure to ultraviolet radiation from arc welding to increased prevalence of photokeratitis. These studies advocate for systemic interventions such as regulatory enforcement of safety protocols, regular health check-ups, and education on occupational hazards. Implementing these measures in informal industries, particularly through community-based outreach and local government initiatives, could substantially reduce the burden of eye-related occupational illnesses.

Despite the abundance of global evidence on photokeratitis, most existing research focuses on formal industrial settings and often overlooks informal workshops prevalent in rural Indonesia. Localized data remain scarce, particularly regarding the functional impact of photokeratitis on work productivity. While studies such as those by Nur Najmi Laila (2017) and Kumah et al. (2011) provide insight into symptom prevalence, they fall short of linking these symptoms to quantifiable productivity outcomes. Additionally, much of the existing literature emphasizes risk identification without evaluating the real-world occupational consequences in community-based settings.

This study addresses these gaps by investigating the relationship between photokeratitis symptoms and productivity among electric welders in Samata Subdistrict, Gowa Regency, where informal welding businesses are common. By examining both health symptoms and productivity outcomes, this research offers novel insights into the occupational health dynamics of rural, informal

labor sectors. The objective of this study is to determine the association between photokeratitis symptoms and work productivity, thereby informing targeted public health interventions to protect and promote eye health among informal workers.

Figure 1
Data collection process



METHODS

This study employed an observational analytic design with a cross-sectional approach to examine the relationship between photokeratitis symptoms and work productivity among electric welders. The study was conducted in Kelurahan Samata, Somba Opu Subdistrict, Gowa Regency, South Sulawesi, Indonesia. The research period encompassed preparatory activities, data collection, and analysis within the timeframe of 2024.

The target population consisted of all electric welding workers operating in the area, totaling 40 individuals employed across 14 informal welding workshops. A total sampling technique was applied, whereby all eligible workers were included as study respondents, thus eliminating the need for sampling error consideration. Inclusion criteria were defined as individuals actively engaged in electric welding work, with a minimum work duration of six months, and who voluntarily consented to participate in the study.

Table 1
Distribution of respondents

Characteristic	Frequency (n = 63)	Percentage (%)
Age		
High Risk	25	39.7
Low Risk	38	60.3
Education Level		
Low Education	44	69.8
Higher Education	19	30.2
Work Duration		
Long	29	46
Short	34	54
Work Tenure Eligibility		
Does Not Meet Requirements	16	25.4
Meets Requirements	47	74.6
Use of PPE		
Not Using	46	73
Using	17	27
Productivity		
Not Productive	33	52.4
Productive	30	47.6
Photokeratitis		
Symptomatic	40	73
Asymptomatic	23	27

Table 2
Factors associated with photokeratitis symptoms

Variable	Photokeratitis Symptoms				Total	P-Value	OR
	Exposed	%	Not Exposed	%			
Age							
High Risk	19	76.00	6	24.00	25	0.16	2.563
Low Risk	21	55.30	17	44.70	38		
Education							
Low Education	30	68.20	14	31.80	44	0.373	1.929
Higher Education	10	52.60	9	47.40	19		
Work Duration							
Long	20	69.00	9	31.00	29	0.568	1.556
Short	20	58.80	24	41.20	34		
Work Eligibility							
Does Not Meet Criteria	3	18.80	13	81.30	16	0.001	0.062
Meets Criteria	37	78.70	10	21.30	47		
Use of PPE							
Not Using	34	73.90	12	26.10	46	0.011	5.194
Using	6	35.30	11	64.70	17		
Photokeratitis							
Symptomatic	30	75.00	10	25.00	40	0.001	20.000
Asymptomatic	3	13.00	20	87.00	23		

Data collection was performed using a structured questionnaire comprising demographic information, exposure history, symptoms indicative of photokeratitis, and self-reported productivity measures (See [Figure 1](#)). The primary independent variable was the presence of photokeratitis symptoms, while the dependent variable was categorized productivity (productive vs. less productive).

Quantitative data analysis was conducted using SPSS version 25. Descriptive statistics were used to present demographic characteristics and frequency distributions. The chi-square test ($\alpha = 0.05$) was applied to assess the association between photokeratitis symptoms and productivity. The odds ratio (OR) was calculated to determine the strength of the association.

Data presentation included frequency tables and cross-tabulations to illustrate the distribution and relationship between variables. All procedures adhered to ethical standards, and informed consent was obtained from all participants prior to data collection. The study ensured confidentiality and voluntary participation, with no personal identifiers recorded in the dataset.

RESULTS AND DISCUSSION

[Table 1](#) presents the distribution of 63 welding workers in Samata Village based on various individual and occupational characteristics. The majority of respondents (60.3%) were classified in the low-risk age group, while 39.7% were in the high-risk category. Educational attainment shows that a significant portion (69.8%) had a low level of education. More than half of the participants (54.0%) were relatively new to their jobs, while 46.0% had a longer work duration.

In terms of compliance with work tenure requirements, 74.6% of the workers met the criteria, whereas 25.4% did not. Alarming, only 27.0% of the respondents used personal protective equipment (PPE), while 73.0% reported not using it. Productivity was slightly higher among those categorized as not productive (52.4%) compared to productive workers (47.6%). Finally, the prevalence of photokeratitis symptoms was high, affecting 73.0% of respondents, which suggests potential gaps in occupational safety and the need for stronger preventive measures in this working environment.

[Table 2](#) displays the results of the bivariate analysis examining factors associated with photokeratitis symptoms among welding workers in Samata Village. Among the variables tested, work eligibility, use of personal protective equipment (PPE), and presence of photokeratitis symptoms

showed statistically significant associations ($p < 0.05$). Workers who met the minimum work eligibility criteria had a significantly higher risk of photokeratitis (OR = 0.062; $p = 0.001$), while those who did not use PPE were over five times more likely to develop symptoms compared to those who used PPE (OR = 5.194; $p = 0.011$).

The strongest association was found with the presence of photokeratitis symptoms (OR = 20.000; $p = 0.001$), indicating a very high likelihood of experiencing symptoms among those classified as exposed. Variables such as age, education level, and work duration did not show statistically significant relationships. These findings underscore the critical role of PPE usage and compliance with work standards in preventing occupational eye disorders among welders.

The results of this study revealed no significant association between age and symptoms of photokeratitis among welding workers in Samata Village, as determined through Chi-Square cross-tabulation analysis. Although a larger proportion of respondents were aged ≥ 40 years, age did not appear to influence the occurrence of photokeratitis symptoms. This finding is inconsistent with studies by Bifessa (2024) and Priyanto (2016), which indicated a correlation between age and ocular health disorders, but aligns with Suherni (2023), who suggested that recovery capacity may counterbalance age-related risk. Likewise, no statistically significant association was found between educational level and photokeratitis symptoms. The majority of respondents had educational attainment below senior high school, yet this did not affect symptom occurrence. Although previous studies (Masrurin, 2006; Karini et al., 2023) emphasized the role of education in occupational health awareness, the results here support Ramdan (2017) and indicate that knowledge alone may be insufficient without behavioral reinforcement and structured safety practices.

Regarding work duration, the study found no relationship between years of employment and photokeratitis, although there was a significant association with daily working hours, particularly for those exceeding 8 hours per day. Despite this, exposure intensity and frequency during welding tasks may better explain symptom occurrence than total work time, as observed by Suherni (2023) and Masrurin (2006). Similarly, there was no significant association between PPE usage and symptoms of photokeratitis. Although a portion of respondents reported using PPE, it was often limited to basic dark glasses, which are inadequate against UV rays and metal debris. This is consistent with previous findings (Masrurin, 2006) but contradicts those of Yuda (2018), who found that proper PPE significantly reduces photokeratitis risk. The discrepancy likely stems from differences in the type, quality, and consistent usage of PPE. Lastly, the study confirmed a strong link between photokeratitis symptoms and decreased work productivity. Symptoms such as blurred vision and eye irritation negatively affected workers' focus and performance. This observation aligns with studies by Suherdin et al. (2023), Halijah et al. (2022), and Putri and Nugroho (2022), who emphasize the importance of occupational health management, including PPE enforcement and workload regulation, to ensure both worker health and productivity in welding environments.

CONCLUSION

This study confirms a significant association between photokeratitis symptoms and reduced work productivity among electric welding workers in Samata Village, Gowa Regency. Despite no statistically significant relationships being observed with age, education level, and work duration, the findings reveal that failure to meet work eligibility standards and the absence of personal protective equipment (PPE) are strongly correlated with the occurrence of photokeratitis. Moreover, the majority of workers experiencing photokeratitis were also classified as less productive, indicating the substantial impact of ocular health on occupational performance. The high prevalence of photokeratitis, limited use of PPE, and considerable proportion of workers failing to meet safety standards reflect critical deficiencies in occupational health management within the informal sector. These results underscore the necessity of strengthening health and safety regulations, particularly in rural and informal industries where systemic oversight is often limited.

This research contributes to the growing body of literature on occupational eye health by offering context-specific evidence from a rural Indonesian setting. Future studies should explore the long-term effects of photokeratitis on visual function and productivity, as well as assess the

effectiveness of intervention programs designed to improve PPE compliance and occupational safety awareness. Addressing these gaps is essential for promoting worker health, safety, and sustainable productivity in informal industrial environments.

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