ORIGINAL ARTICLE

Impact of occupational health and safety education intervention on the knowledge, attitudes, and practices among palm oil plantation workers in Indonesia

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ABSTRACT

Palm oil plantation workers are exposed to various occupational hazards—physical, chemical, and biological—that can lead to accidents and long-term health issues. This study evaluated the effectiveness of a tailored Occupational Health and Safety (OHS) training program in improving knowledge, attitudes, and practices among workers in a plantation in South Kalimantan, Indonesia. A total of 120 workers participated, divided equally into an intervention group (n = 60) and a control group (n = 60). The intervention involved 15 small-group sessions covering eight key OHS topics, delivered by trained cadres using printed and digital modules. A mixed-methods approach with an intervention and cross-sectional design was employed. Due to non-normal data distribution, the Wilcoxon signed-rank test was used to compare pre- and post-intervention scores. Statistically significant improvements were observed in the intervention group, with knowledge scores increasing from 55.47 to 71.60, attitudes from 61.87 to 68.13, and practices from 17.90 to 21.87 ($p = 0.000$). The proportion of workers with good knowledge rose from 5.8% to 83.8% ($p < 0.001$; OR = 84.6; 95% CI: 22.3–320.8), while poor attitudes dropped from 80% to 20% ($p < 0.001$; OR = 10.0; 95% CI: 4.2–23.8). Good safety practices also increased to 76.5% ($p < 0.001$; OR = 4.9; 95% CI: 2.0–12.3). In contrast, no significant improvements were observed in the control group ($p > 0.05$). These findings demonstrate the effectiveness of a context-specific OHS training program in enhancing safety-related behaviors among plantation workers. The study also emphasizes the importance of inclusive implementation strategies, particularly for contract workers and those with limited experience, to ensure equitable benefits. Future research should explore the long-term sustainability of these improvements and investigate organizational factors that may influence the success of OHS interventions.

Keywords:
occupational health and safety, education, palm oil plantation, workers

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INTRODUCTION

The oil palm (*Elaeis guineensis*), a member of the Arecaceae family, is a vital commodity that is primarily produced in Malaysia, Indonesia, and Nigeria.[1] Indonesia is the world's leading producer and exporter of palm oil. The plantation sector, which is integral to this industry, relies on a substantial and diverse workforce owing to the various skill-intensive activities involved. However, the expansion of this labor force has also introduced significant challenges, particularly heightened risks and hazards in the workplace.[2] Globally, the palm oil industry employs over a million workers, many of whom are exposed to a broad range of occupational hazards.[3]

Occupational Health and Safety (OHS) is a critical framework to ensure worker safety and productivity, particularly in high-risk industries. Inadequate implementation of OHS measures often leads to workplace accidents and work-related illnesses.[4] OHS initiatives aim to minimize or eliminate these risks by implementing preventive controls, fostering a safer work environment, and promoting the physical and mental resilience of workers. Effective OHS practices not only protect workers from fatal and non-fatal accidents but also enhance their work capacity and overall health, thereby contributing to a safer and more efficient workplace.[5]

Education on OHS is an essential strategy for improving workplace safety and health. It cultivates a culture of prevention and responsibility, while equipping workers with the skills to identify and manage workplace hazards. By fostering awareness and proactive safety practices, OHS education reduces accidents and supports the development of resilient and sustainable work environments.[6] Based on previous findings, implementing educational interventions based on behavioral theories, such as the PRECEDE–PROCEED model, can lead to significant improvements in OHS practices.[7] Moreover, encouraging the transmission of OHS knowledge through educational programs can reportedly help retain and disseminate critical safety information.[8,9]

In palm oil plantations, workers face a multitude of occupational hazards, including heat exposure, physically demanding tasks, hazardous chemicals, and risks associated with heavy machinery. Those with limited education are particularly vulnerable, which increases their susceptibility to injuries and chronic health issues. Addressing risks such as exposure to chemicals, falls, and fires is essential for improving OHS practices. However, OHS in this sector is often perceived as an expense rather than a necessary investment[10]. Plantation workers face risks such as musculoskeletal injuries from repetitive tasks, psychosocial stress from heavy workloads, and infections such as malaria and leptospirosis. Poor training and lack of protective gear heighten chemical exposure risks, especially to pesticides like paraquat, while ergonomic issues like neck and back pain add to the physical strain.[1–3,11] Several hazards may arise during palm oil processing that jeopardize worker safety: (1) slips, thorn injuries, or crushing from palm fruits during sorting; (2) fall risks in the elevated (2 m) and often slippery boiling area; and (3) potential rope-related injuries during fruit-bunch separation.[13]

Research on OHS education among palm oil plantation workers is limited, yet crucial owing to the numerous hazards that these workers face. The palm oil industry, particularly in countries like Indonesia and Malaysia, employs a vast workforce exposed to various occupational risks, including musculoskeletal disorders, injuries, and exposure to hazardous chemicals such as pesticides. Previous studies have highlighted the critical need for regular and comprehensive OHS

education. Such programs enhance workers' understanding of safety protocols, hazard identification, and the proper use of personal protective equipment (PPE), all of which are vital for minimizing workplace risks and fostering a culture of safety. Targeted training in ergonomics, emergency preparedness, and PPE usage has been shown to improve worker competence and create safer and more sustainable plantation environments.[12,13]

While OHS education has been shown to improve safety outcomes in various industries, there is limited evidence regarding its effectiveness in palm oil plantations, particularly in Indonesia. Although OHS training has improved safety outcomes in other industries, its effect on knowledge, attitudes, and practices in palm oil plantations remains underexplored. This gap highlights the need to evaluate OHS interventions tailored for this high-risk environment. To fill this gap, this study aimed to evaluate the impact of OHS education on improving the knowledge, attitudes, and practices among palm oil plantation workers.

METHODS

Participants and procedure

This study, developed by researchers at Universitas Indonesia, was conducted between February and August 2024. Workers from two palm oil plantation companies based in South Kalimantan, Indonesia were recruited as participants and allocated to the intervention or control group. All participants were informed of the purpose of the study and provided written informed consent.

Participants were selected using a non-probability quota sampling technique. Individuals from each unit were included to ensure representation across working units with different job descriptions. However, the participants were not randomly selected within each unit. This approach allows for broad representation across job functions while acknowledging the limitations inherent in non-random sampling methods.

The inclusion criteria were as follows: (1) workers of the palm oil plantation with at least 6 months of employment, (2) able to communicate well both in oral and written form, and (3) willing to participate in the study. Sixty workers were recruited for the intervention group, and 60 workers were recruited for the control group. No workers dropped out during the study period. Finally, the analysis included 60 participants (37 male and 23 female workers) in the intervention group and 60 (37 male and 23 female workers) in the control group (Figure 1).

After the intervention procedures, a cross-sectional design was employed. The chi-squared test was used to test the significance of the associations between the tailored OHS training intervention and the level of knowledge, attitudes, and practices among workers in both groups.

This study was approved by the Research Ethics Committee of the Faculty of Public Health, Universitas Indonesia (ethical approval No: Ket-106/UN2. F10. D11/PPM.00.02/2024).

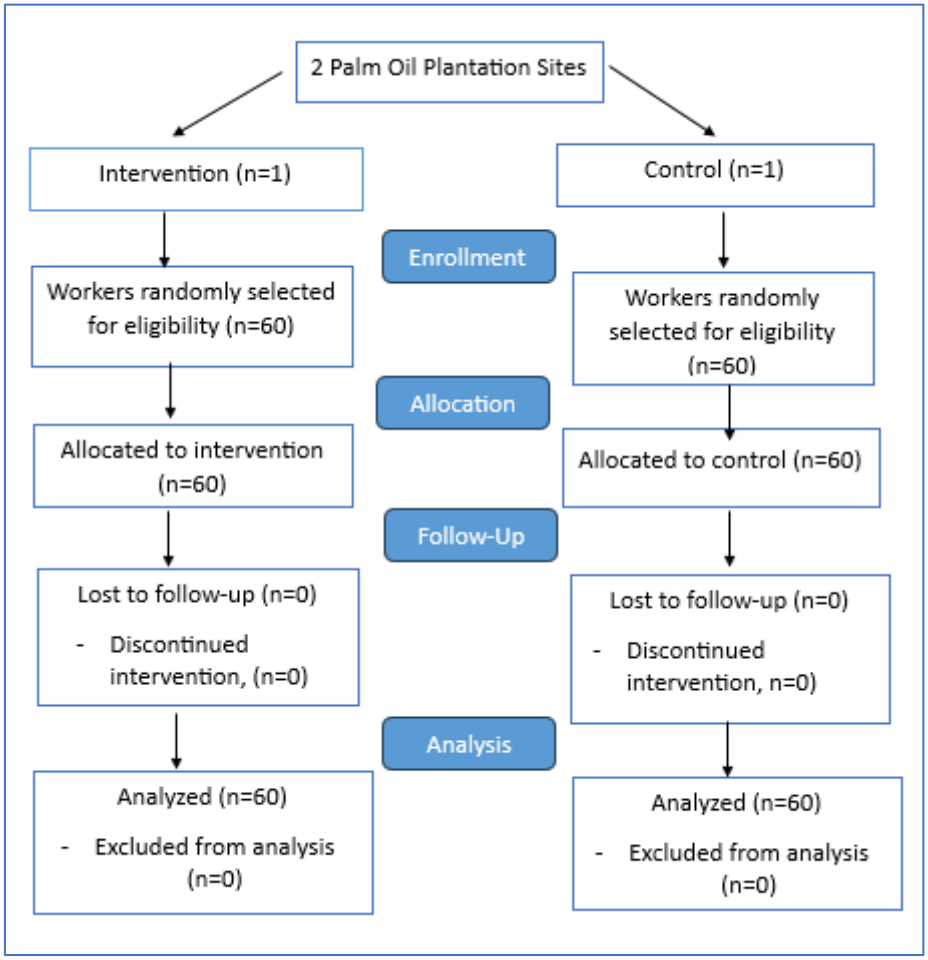

Figure 1. Consolidated Standards of Reporting Trials (CONSORT) Diagram

Intervention

Workers in palm oil plantations in the intervention group were given educational modules on occupational safety and health in digital (e-book) and printed formats. In contrast, the control group received the conventional OHS program routinely provided by palm oil companies without a tailored intervention that was specifically designed and delivered to the intervention group (Figure 2).

The module contained eight topics of learning material on 34 pages, which included: (1) the legal basis and policies of occupational safety and health in Indonesia, (2) occupational safety and health at work in oil palm plantations, (3) a healthy working environment, (4) good posture and ergonomics at work, (5) balanced nutrition for workers in oil palm plantations, (6) use of personal protective equipment at work, and (7) media promotion of occupational safety and health.

The development of the modules was guided by a comprehensive review of relevant literature and existing training materials, including those from the Ministry of Education and Culture of Indonesia and the International Labor Organization (ILO). Based on this review, a framework for the module content was established. Next, a needs assessment was then conducted through qualitative methods, including interviews and direct observations involving workers, company management, and peer educators. This process helped to identify the specific risks, work routines, and contextual factors relevant to palm oil plantation settings. The draft modules were subsequently developed and subjected to expert review, which included feedback from health and safety

professionals as well as plantation workers themselves, through material validation and acceptability testing. The module has been reviewed and rated by several stakeholders and experts regarding the feasibility of content, relevance of material, presentation of content, and language by the head of the local health office, head of the local labor office, head of the local agriculture office, labor inspectors, heads of labor unions, and doctors in palm oil plantations. The module was deemed fit and appropriate for use. The module was also tested for acceptability by the head of the health office, head of the labor office, head of the agriculture office, labor inspectors, head of the labor union, doctors on palm oil plantations, and representatives of palm oil plantation workers, and obtained an assessment that the module was deemed acceptable and appropriate in terms of learnability, memorability, efficiency, user satisfaction, and usability.

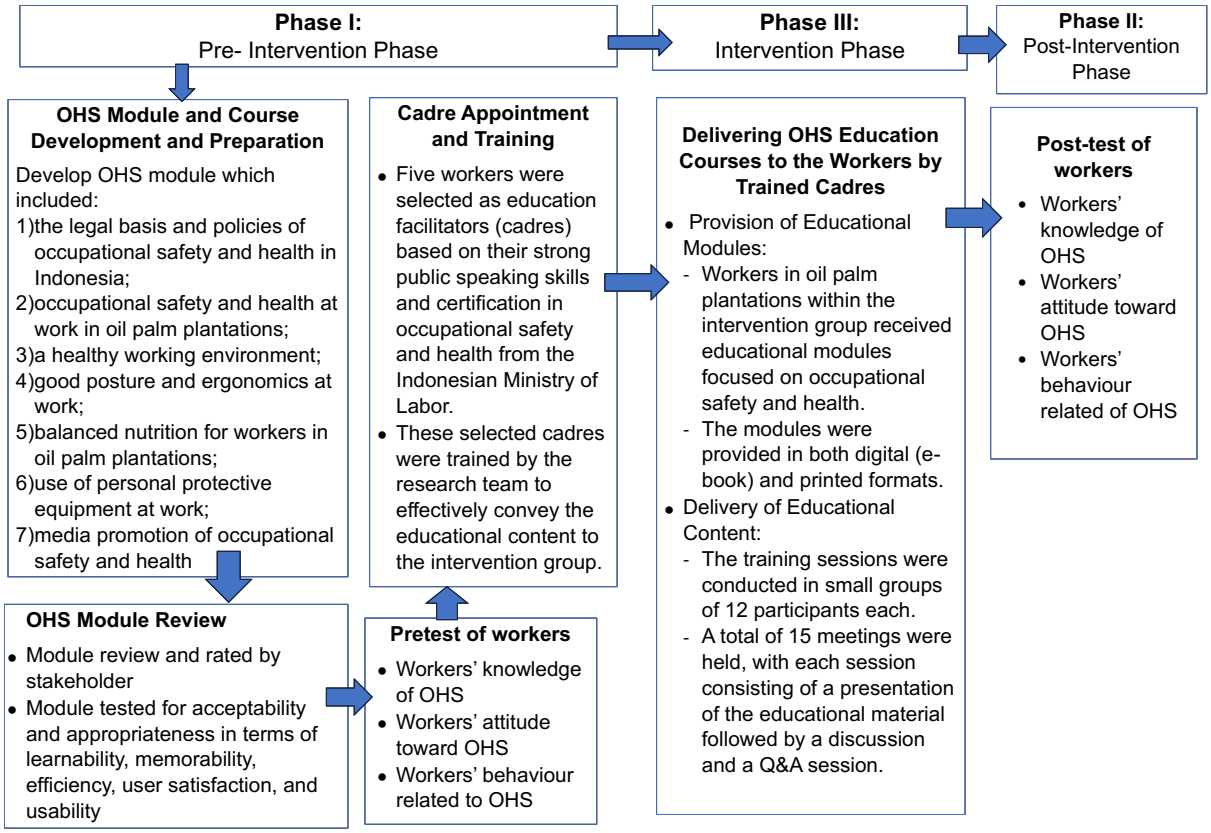

Figure 2. Diagrammatic presentation of the quasi-experimental study design

Researchers appointed five cadres with the criteria of being oil palm plantation workers who have good public speaking skills and occupational safety and health expert certification issued by the Indonesian Ministry of Labor. They were then trained by the research team as cadres who provided education and conveyed the contents of this module to the intervention group. The module was delivered by cadres in a small forum of 12 people each in 15 meetings, with a session for delivering educational material on the module and ending with a discussion and question-and-answer session.

Measures

Workers' knowledge, attitudes, and behaviors toward occupational safety and health were measured using a self-

administered questionnaire before and immediately after the intervention. Prior to the main study, a pilot study was conducted to assess instrument reliability. This pilot study involved 30 palm oil plantation workers, and demonstrated that the instrument was reliable for measuring knowledge, attitudes, and practices, with an overall Cronbach's alpha of 0.796.

The questionnaire contained demographic information, including age, sex, highest education level, job title, tenure, and employment status. Knowledge related to occupational safety and health was measured through 24 questions with the answer options "true," "false," and "don't know." The questions were about eight topics from the learning materials in the module. Attitudes related to occupational safety and health were measured using 22 questions with the answer options "strongly agree," "agree," "disagree," and "strongly disagree." The questions reflected the workers' attitudes related to the eight topics of the learning materials in the module. Behavior related to occupational safety and health among oil palm plantation workers was measured through 11 questions on a questionnaire about the application of occupational safety and health behavior in oil palm plantations contained in the module, with the answer options "never," "sometimes / rarely," and "always."

Statistical Analysis

Descriptive statistics are reported as mean (standard deviation) for continuous variables and frequency (percentage) for categorical variables. The Wilcoxon signed-rank test was used to compare two related samples or repeated measurements of the same subjects, because the data did not meet the normality assumption required for the paired sample t-test. The chi-square test was employed to evaluate the statistical significance of the associations between the tailored OHS training intervention and the levels of knowledge, attitude, and practice among workers in both the intervention and control groups. Data analysis was performed using SPSS version 25 (IBM, Armonk, NY, USA).

RESULTS

Table 1 presents an overview of the demographic and employment characteristics of the intervention and control groups. Notably, most participants in both groups were between 31 and 40 years old, and the intervention group had a higher proportion of participants with junior high school education (36.7%) than the control group (31.7%). Additionally, the working period shows that the control group predominantly has less than 5 years of work experience (91.7%), while the intervention group has more experienced participants (33.3% with 5–10 years and 40% with 10–20 years). These differences are crucial to understanding the context in which the results are framed.

Table 1. Characteristics of participants based on demographic, employment, and work-related variables

Variable	Group				Total	
	Intervention		Control			
	n	%	n	%	n	%
Age						
≤30 years	9	15.0	23	38.3	32	26.7
31–40 years	23	38.3	16	26.7	39	32.5
41–50 years	17	28.3	20	33.3	37	30.8
>50 years	11	18.3	1	1.7	12	10.0
Sex						
Male	37	61.7	37	61.7	37	61.7
Female	23	38.3	23	38.3	23	38.3
Educational background						
None	0	0.0	3	5.0	3	2.5
Not finished elementary school	3	5.0	1	1.7	4	3.3
Elementary school	33	55.0	22	36.7	55	45.8
Junior high school	22	36.7	19	31.7	41	34.2
Senior high school	2	3.3	15	25.0	17	14.2
Working period						
<5 years	15	25.0	55	91.7	70	58.4
5–10 years	20	33.3	5	8.3	25	20.8
10–20 years	24	40.0	0	0.0	24	20.0
>20 years	1	1.7	0	0.0	1	0.8

The results of the Wilcoxon test (Table 2) show that the intervention group experienced significant improvements in all three variables related to OHS. Knowledge scores increased from 55.47 to 71.60 ($p = 0.000$), attitude scores rose from 61.87 to 68.13 ($p = 0.000$), and practice scores improved from 17.90 to 21.87 ($p = 0.000$), demonstrating the strong positive impact of the intervention. In contrast, the control group showed more modest improvements: knowledge scores increased from 56.30 to 57.37 ($p = 0.007$), attitude scores rose from 51.72 to 53.72 ($p = 0.003$), and practice scores slightly improved from 21.53 to 21.85 ($p = 0.016$). These findings highlight that, while the control group showed some significant changes, the intervention group exhibited much more pronounced and meaningful improvements, emphasizing the effectiveness of the intervention in enhancing OHS outcomes.

Table 2. Knowledge, attitude, and practice scores between intervention and control groups (pretest and post-test)

Variable	Group	*Pretest*		*Post-test*		p-value[#]
		Mean	SD	*Mean*	SD	
Knowledge	Intervention	55.47	4.455	71.60	0.588	0.000[*]
	Control	56.30	5.631	57.37	5.483	0.007[*]
Attitude	Intervention	61.87	4.312	68.13	2.151	0.000[*]
	Control	51.72	4.730	53.72	3.320	0.003[*]
Practice	Intervention	17.90	1.714	21.87	1.567	0.000[*]
	Control	21.53	2.038	21.85	1.783	0.016[*]

M, mean; SD, standard deviation

Meanwhile, Table 3 demonstrates the correlation between the tailored OHS training intervention and improvements in knowledge, attitudes, and practices among palm oil plantation workers in the intervention group. Following the intervention, the proportion of workers with poor knowledge decreased substantially from 94.2% to 5.8%, while those with good knowledge increased to 83.8% ($p < 0.001$; odds ratio [OR] = 84.6; 95% confidence interval [CI]: 22.3–320.8). Comparable improvements were observed in attitude, with the percentage of poor attitudes declining from 80% to 20% ($p < 0.001$; OR = 10.0; 95% CI: 4.2–23.8), and in practice, where poor practices decreased from 60% to 39.5%, and good practices rose to 76.5% ($p < 0.001$; OR = 4.9; 95% CI: 2.0–12.3). In contrast, the control group exhibited no statistically significant changes across any of the knowledge, attitudes, and practices, with all p-values exceeding 0.05, and ORs indicating minimal to no effects. These findings underscore the effectiveness of a context-specific OHS training program in significantly enhancing plantation workers' occupational health and safety knowledge, attitudes, and practices.

DISCUSSION

The results of the Wilcoxon test (Table 2) underscored the effectiveness of the intervention in enhancing OHS-related knowledge, attitudes, and practices within the intervention group. The significant increases in knowledge scores (from 55.47 to 71.60), attitude scores (from 61.87 to 68.13), and practice scores (from 17.90 to 21.87) not only demonstrate the intervention's impact but also suggest that the training or programs implemented were well received and effectively tailored to address the needs of this group. The p-values (all $p = 0.000$) further indicate a high level of statistical significance, reinforcing the robustness of the findings. By contrast, while the control group showed statistically significant improvements across all three variables, the magnitude of these changes was considerably smaller. For instance, the knowledge score increased by only 1.07 points (from 56.30 to 57.37), the attitude score by 2 points (from 51.72 to 53.72), and the practice score by 0.32 points (from 21.53 to 21.85). These modest gains suggest that external factors such as routine workplace activities or general awareness programs may have played a role in the observed changes. However, the results of the cross-sectional study (Table 3)

highlight significant improvements in knowledge, attitudes, and practices among workers who received tailored OHS training, with marked reductions in poor outcomes and strong statistical significance across all measures. Good knowledge increased to 83.8%, with significant improvements in attitudes (poor attitudes dropped to 20%) and practices (good practices rose to 76.5%) (all $p < 0.001$). These results confirmed the effectiveness of a context-specific OHS intervention in enhancing workplace safety behavior, whereas the control group showed no significant change.

Table 3. Correlation between OHS tailored training intervention and knowledge, attitude, and practice in the intervention and control groups

Variable	Intervention Group				p-value	OR	95% CI OR	Control Group				p-value	OR	95% CI OR
	Pretest		Post test					Pretest		Post test				
	n	%	n	%				n	%	n	%			
Knowledge														
Poor	49	94.2	3	5.8	**<0.001***	84.6	22.3–320.8	49	53.3	43	46.7	0.281	1.7	0.7–4.2
Good	11	16.2	57	83.8				11	39.3	17	60.7			
Attitude														
Poor	40	80	10	20	**<0.001***	10.0	4.2–23.8	34	49.3	35	50.7	1.000	0.9	0.5–1.9
Good	20	28.6	50	71.4				26	51	25	49			
Practice														
Poor	52	60	34	39.5	**<0.001***	4.9	2.0–12.3	20	54.1	17	45.9	0.693	1.3	0.6–2.8
Good	8	23.5	26	76.5				40	48.2	43	51.8			

OHS, Occupational Health and Safety; OR, odds ratio; CI, confidence interval

This finding aligns with previous research showing that tailored OHS training programs significantly improve workers' knowledge, attitudes, and behaviors. For instance, training that includes practical, job-specific content delivered by qualified trainers tends to be more effective[14]. Similarly, tailored OHS training programs have been shown to significantly improve workers' knowledge, attitudes, and behaviors across various sectors. Personalized safety interventions that consider cognitive-related factors such as personality traits and psychological needs have demonstrated a persistent positive effect on construction workers' safe behaviors by enhancing cognitive-based competence and safety motivation.[10] In terms of OHS knowledge improvement, the findings from this study were aligned with those of a previous study involving young workers who underwent training programs grounded in Total Worker Health® principles, which demonstrated a substantial improvement in young workers' understanding of workplace hazards and safety protocols, with knowledge retention evident for up to three months following the training.[15] Regarding improvements in workers' attitudes toward OHS, this finding is in accordance with a previous study that revealed that tailored education programs have been found to positively influence workers' attitudes and beliefs towards OHS, which is critical for fostering a safety culture in the workplace.[16,17] Concerning the improvement of OHS practices, it was found that tailored interventions have the potential to yield considerable advancements in employees' safety-related behaviors and perceptions. Empirical research has demonstrated that interventions specifically designed to align with particular occupational demands and administered in small-group settings can augment adherence to safety protocols and reduce the incidence of workplace injuries.[18,19] A previous study on coal mining workers also revealed that safety education intervention is a key factor affecting workers' safety performance.[20]

A notable limitation of this study was the use of nonrandom sampling in the selection of participants. Since the participants were not randomly selected, there is a potential for selection bias, which may limit the generalizability of the findings. The sample may not fully represent the broader population, and as a result, caution should be exercised when interpreting the results beyond the specific context or group studied. Future research employing randomized sampling techniques would be valuable to confirm the robustness and external validity of the present findings. Another limitation is that owing to the relatively small sample size employed in this study, the robustness of our results was somewhat limited across the different model specifications. Specifically, although the outcomes were sensitive to variations in the analytical approach, the core conclusions remained consistent regardless of the specific model used. This suggests that despite potential limitations associated with the sample size, the general findings of the study are stable across different methodological frameworks. These findings have practical implications for workplace safety and health policies. Significant improvements observed in the intervention group highlight the importance of investing in structured interventions to enhance OHS outcomes. These interventions should prioritize knowledge dissemination, attitude shifts, and practical training, as all three dimensions are interrelated and critical for fostering a safe culture. Future research should explore the long-term sustainability of these improvements and examine how factors such as organizational culture, leadership support, and worker engagement influence the success of OHS interventions. By doing

so, organizations can develop more inclusive and impactful strategies to promote occupational safety and health for all employees.

RECOMMENDATIONS

The findings of this study have important implications beyond the individual plantation level, highlighting the need for broader policy reforms and the establishment of industry-wide standards to improve OHS in the palm oil sector. The significant improvements observed through the tailored OHS intervention highlight the potential for scalable, context-specific training programs to address longstanding safety challenges in the industry. Given the hazardous nature of palm oil plantation work and the high proportion of vulnerable workers—such as contract laborers and those with limited education—there is a critical need for national and regional policies that mandate regular, inclusive, and practical OHS training as a standard component of workplace operations. Regulatory bodies and industry stakeholders should consider integrating such interventions into certification schemes and compliance frameworks to ensure worker safety as a core performance indicator. Furthermore, developing standardized training modules and requiring companies to invest in internal OHS cadres can help institutionalize safety culture across plantations, contributing to more sustainable and socially responsible industry practices.

AUTHOR CONTRIBUTIONS

Conceptualization: Jayadi YD, Modjo R, Lestari, F, Tejamaya M, Prasetyo S, and Fikawati S. Data curation: Jayadi YD and Noor IH. Methodology: Jayadi YD, Sugiarti, Astono S, Mayawati H. Project administration: Noor IH. Writing – original draft: Jayadi YD and Sulistiyorini D. Writing – review & editing: Sulistiyorini D.

ETHICAL CONSIDERATION

This study was approved by the Research Ethics Committee of the Faculty of Public Health, Universitas Indonesia with protocol number: Ket-106/UN2.F10.D11/PPM.00.02/2024. The approval date was 27 March 2024.

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CONFLICT OF INTEREST

The authors affirm that there are no conflicts of interest related to the content, analysis, or findings presented in this paper.

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