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Original Article

Occupational safety and health education for reducing workplace accidents in oil palm plantations

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ABSTRACT

Introduction: The plantation sector is ranked third in occupational accidents in Indonesia by 2022 (17.3%), with cases rising by 18–20% annually. A major contributing factor is workers' limited knowledge of Occupational Safety and Health (OSH). This study evaluates the effectiveness of module-based OSH education and cadre formation in improving workers' knowledge, attitudes, and behaviors, as well as in reducing occupational accidents and diseases among workers.

Methods: This research was conducted over six months, from February to August 2024, in palm oil companies located in Central Kalimantan and South Kalimantan Provinces, Indonesia. A quasi-experimental method was employed using purposive sampling. A total of 60 respondents were recruited based on predetermined inclusion criteria. The sample size was determined through statistical calculations at a 95% confidence level.

Results: The intervention resulted in a significant improvement in OSH indicators. The proportion of workers with good OSH knowledge increased from 41.67% to 80.00% ($p < 0.001$), positive OSH attitudes rose from 46.67% to 61.67% ($p < 0.001$), and good OSH practices improved from 41.67% to 66.67% ($p < 0.001$). The incidence of occupational accidents declined markedly from 66.7% to 10.0%, and the incidence of reported occupational diseases decreased from 43.3% to 33.3%.

Conclusion: Module-based OSH education and cadre empowerment effectively enhance OSH knowledge, attitudes, and behaviors while reducing occupational accidents and diseases in oil palm plantations. This model offers a sustainable and scalable approach to improving workplace safety and health, which other plantation sectors can adopt to support long-term occupational health improvements.

Keywords: Accident, Education, Occupational Safety and Health, Palm oil

Introduction

Work-related accidents and occupational diseases are prevalent across various industrial sectors, including oil palm plantations.[1] These incidents do not occur randomly but are driven by specific risk factors that must be identified and analyzed to facilitate corrective and preventive measures.[2] The oil palm industry has a higher occupational accident rate than many other sectors,

highlighting the critical need for stringent occupational safety and health (OSH) practices. Common occupational hazards in the oil palm industry include thorn injuries, musculoskeletal disorders, chemical exposure, inhalation of palm flower dust, falling fruit or fronds, puncture wounds, psychosocial disorders, and occupational diseases such as malaria and leptospirosis, with potential exposure to paraquat and other pesticides.[3] According to the Indonesian National OSH Profile Data Report, the agriculture and plantation sector accounts for 17.3% of all occupational accidents, ranking as the third-highest contributor to workplace injuries in Indonesia.[4] Additionally, data from the Employment Social Security Organizing Agency indicate that over the past five years, the oil palm plantation industry has recorded 3,266 cases of occupational accidents, with an increasing trend of 18–20% annually.[5]

Studies conducted across Malaysia, Costa Rica, Ghana, Indonesia, Myanmar, Papua New Guinea, and Cameroon have demonstrated that occupational accidents in oil palm plantations are primarily linked to the manual harvesting process, which often lacks well-defined standard operating procedures (SOPs) for OSH. Moreover, limited worker knowledge about plantation environmental conditions, including poor sanitation, slippery and oil-contaminated work areas, and high exposure to disease vectors such as mosquitoes and rodents, further exacerbates the risk of occupational diseases in this sector.[3]

Research in Thailand revealed that 78% of oil palm plantation workers experience musculoskeletal disorders within their first year of employment.[6] A key factor contributing to this issue is the lack of company-provided education and training on the application of OSH-aligned SOPs. Previous research found a significant relationship between worker knowledge levels and the occurrence of work accidents on oil palm plantations, making it essential to address these issues.[7] Consistent with a previous study among batik knife artisans, which demonstrated that knowledge of OSH principles and attitudes toward personal protective equipment (PPE) use have a direct correlation with workplace accidents.[8] Furthermore, research conducted among automotive workshop workers reported that workers with higher OSH knowledge levels have a lower risk of workplace injuries.[9]

A strong foundation in OSH knowledge enhances workers' attitudes, behaviors, and awareness, leading to better compliance with workplace safety protocols.[10,11] Individuals with higher knowledge levels are more capable of making informed decisions and taking appropriate actions to protect themselves from occupational hazards.[12] Moreover, education (both formal and non-formal) is a crucial determinant of OSH awareness, as individuals with higher education levels generally have broader insights and deeper understandings of workplace safety principles.[13,14]

To address these challenges, this study develops an OSH education-based intervention aimed at enhancing workers' knowledge, attitudes, and practices in applying OSH principles. Additionally, this intervention integrates nutritional improvements as a preventive strategy to mitigate occupational accidents and diseases within Indonesia's oil palm plantation sector.

Methods

This study was conducted in a multinational oil palm plantation company in Indonesia, located in Central Kalimantan Province. The company, established in 1995, manages 16,950 km² of plantation land and employs 1,744 workers. It oversees the entire oil palm production chain, from land clearing to refined oil palm production, with primary products including Fresh Fruit Bunches (FFB), Crude Palm Oil (CPO), Palm Kernel Oil (PKO), and Palm Kernels.

A quasi-experimental design with an educational intervention targeting oil palm plantation workers was employed. Quasi-experimental research involves treatment, effect measurement, and experimental units. Still, it lacks random assignment, which makes comparisons to infer treatment effects difficult.[15] A pre-test and post-test design assessed changes in workers'

knowledge, attitudes, and practices before and after the intervention.

The study involved 60 respondents, and the sample size was determined using Levy & Lemeshow's Sample Size software (Hypothesis Test for Two Population Proportions, 95% confidence level).[16] This calculation guaranteed sufficient statistical power to detect significant differences between the groups of interest. Participants were selected using purposive sampling from oil palm plantation workers (permanent or contract) who have been employed for more than 6 months, are literate, and are actively working during the data collection period.

The OSH education program, which spanned six months, comprised two main components: cadre training and worker education. The company appointed five OSH education cadres in collaboration with the local District Health Office. The cadre recruitment process was structured, and all selected cadres received comprehensive Training of Trainers (ToT) delivered by researchers and OSH experts through online and in-person sessions. The cadres received incentives in the form of training facilities, modules, free uniforms, and transportation reimbursement.

The cadre training consisted of five sessions, each lasting 2–3 hours, conducted over three months. The training covered core OSH principles and strategies. The training content included workplace safety, hazard identification and risk prevention, the proper use of personal protective equipment (PPE), and the prevention of occupational diseases. The program utilized the Occupational Safety and Health Education Module for Oil Palm Plantation Workers, developed by researchers in 2024. This module is based on an extensive literature review and regulatory guidelines from the Ministry of Education, the Ministry of Manpower, the Ministry of Health, and the International Labour Organization (ILO). The module covers the following topics: Legal basis for OSH; General OSH information; Healthy environment; Body positioning during work; Worker nutrition and reproductive health; Use of PPE; OSH promotion Media; and Work instructions for harvest workers. The module is officially registered as a copyrighted work with the Ministry of Law and Human Rights of the Republic of Indonesia (registration number EC00202480359, dated August 9, 2024).

Following training, the OSH cadres conducted educational sessions for plantation workers twice per month for six months. Each session lasted two to three hours. The sessions employed interactive methods, including discussions, demonstrations, and case studies, that were relevant to the oil palm plantation sector.

Program effectiveness was assessed using a self-administered questionnaire at the beginning (baseline) and end (post-test) of the study. The questionnaire was pre-piloted with 30 plantation workers, yielding good internal consistency (Cronbach's α = 0.796). It included demographic information (age, gender, education level, job description, length of service, employment status, history of occupational accidents and diseases, and workplace environment factors). OSH knowledge was assessed using multiple-choice questions (true/false/do not know) based on the module key topics. OSH attitudes were evaluated using a Likert scale (strongly agree/agree/ disagree/strongly disagree), assessing perceptions on OSH's importance and implementation. OSH compliance behaviors were measured based on self-reported adherence (never/sometimes/ rarely/always), aligned with behavioral recommendations in the education module.

All participants were provided with detailed information about the study, and written informed consent was obtained before enrollment. The study was approved by the Research Ethics Committee of the Faculty of Public Health, University of Indonesia (Approval No. 106/UN2.F10.D11/PPM.00.02/2024), ensuring compliance with ethical research guidelines.

Descriptive statistics were reported as mean with standard deviation (SD) for continuous variables and frequency (percentage) for categorical

variables. Given the data's non-normal distribution, the Wilcoxon signed-rank test was applied for pre- and post-intervention measurements. All statistical analyses were conducted using IBM SPSS Statistics version 25.

Results

Table 1 presents the distribution of respondents. The most significant proportion of workers (38.3%) falls within the 31–40 age group, with male workers comprising 61.7% of the sample. More than half (55%) have completed elementary school as their highest level of education. The majority (51.7%) were employed as harvesters, making it the most common job role. Additionally, 98.3% (n = 59) were fieldworkers with permanent employment status. Regarding length of service, 40% of workers have been employed for 10–20 years.

Table 1. Demographic profile of survey participants

Variables	Number (Percentage)
Age (years)	
≤ 30	9 (15)
31-40	23 (38.3)
41-50	17 (28.3)
> 50	11 (18.3)
Gender	
Male	37 (61.7)
Female	23 (38.3)
Education	
Incomplete elementary school	3 (5)
Elementary school	33 (55)
Junior high school	22 (36.7)
High school	2 (3.3)
Job desk	
Nursery	2 (3.3)
Harvester	31 (51.7)
Maintenance	5 (8.3)
Others	22 (26.7)
Employee Type	
Fieldworker	59 (98.3)
Office worker	1 (1.7)
Employee Status	
Contract Employee	1 (1.7)
Permanent Employees	59 (98.3)
Length of Service	
Less than 5 Years	15 (25)
5-10 Years	20 (33.3)
10-20 Years	24 (40)
More than 20 Years	1 (1.7)

Table 2 displays the changes in occupational safety and health (OSH) knowledge, attitudes, and behaviors among oil palm plantation workers after the intervention. All comparisons were analyzed using the Wilcoxon signed-rank test. The proportion of workers with high OSH knowledge increased from 41.67% to 80% ($p < 0.001$). Similarly, the proportion of workers with a positive attitude towards OSH rose from 46.67% to 61.67% ($p < 0.001$), and the proportion of workers exhibiting compliant OSH behavior improved from 41.67% to 66.67% ($p < 0.001$). These results indicate a statistically significant enhancement across all measured aspects.

Table 3 presents the changes in mean scores of OSH knowledge, attitude, and behavior before and after the intervention. OSH knowledge showed the highest increase, rising from 55.47 to 71.60, followed by OSH attitude (61.87 to 68.13) and OSH behavior (17.90 to 21.87). All improvements were statistically significant.

The intervention also contributed to a reduction in occupational accidents and diseases (Table 4). Initially, 66.7% of workers reported experiencing work accidents. This number decreased to 10% after six months, while the proportion of workers with no accident history increased to 90%. Similarly, the prevalence of occupational diseases declined from 43.3% to 33.3%, indicating an overall improvement in workers' health and safety conditions.

Table 2. Knowledge, attitude, and OSH behavior of participants

Variables	Pre-test	Post-test	P-value
	n (%)	n (%)	
Knowledge			
High	25 (41.67)	48 (80)	<0.001
Low	35 (58.33)	12 (20)	
Attitude			
Positive	28 (46.67)	37 (61.67)	<0.001
Negative	32 (53.33)	23 (45.1)	
Behavior			
Compliant	25 (41.67)	40 (66.67)	<0.001
Not compliant	35 (58.33)	20 (33.33)	

Table 3. Comparison of OSH knowledge, attitude, and behavior scores among participants

Variables	Pre-test		Post-test		*P*-value
	Mean	SD	Mean	SD	
OSH Knowledge	55.47	4.45	71.60	0.59	<0.001
OSH Attitude	61.87	4.31	68.13	2.15	<0.001
OSH Behavior	17.90	1.71	21.87	1.57	<0.001

Discussion

This study demonstrated that OSH education-based interventions, which include an OSH education module and mentoring by OSH education cadres, effectively enhanced the OSH knowledge, attitudes, and behaviors of oil palm workers. Significant improvements were observed across all three aspects, with the most substantial increase in knowledge scores after the intervention.

The OSH education intervention aimed to enhance workers' understanding, attitudes, and safe practices in the workplace. The OSH education module was systematically developed to allow independent learning, while the involvement of OSH cadres ensured effective and sustainable information dissemination. Education and counselling efforts are well-established strategies to increase knowledge, awareness, and behavioral change. These activities provide individuals or groups with the necessary information, knowledge, and skills to develop appropriate attitudes and behaviors.[13]

Table 4. Occupational accidents and work-related diseases among participants

Variables	Pre-test n (%)	Post-test n (%)
Work accident history		
Yes	40 (66.7)	6 (10)
No	20 (33.3)	54 (90)
Worker's disease		
Yes	26 (43.3)	20 (33.3)
No	34 (56.7)	40 (66.6)

According to Lawrence Green's health behavior theory, knowledge serves as a predisposing factor influencing health behavior.[13] Behaviors rooted in understanding and awareness are more likely to be sustained than those driven solely by instructions or regulations.[17,18] In this study, OSH education cadres played a crucial role in facilitating behavioral changes by delivering regular education sessions and improving workers' understanding of safe and healthy work practices through OSH guidelines.

This finding aligns with research in the agricultural sector, which has demonstrated that cadre empowerment through training, including lectures, discussions, and demonstrations on the use of personal protective equipment and ergonomic postures, led to a significant improvement in participants' post-test scores.[19] The demonstration method, in particular, fosters critical thinking and allows individuals to practice actions under real working conditions.[20]

Further supporting these findings, studies in various locations in Indonesia have shown that educational interventions using lecture and discussion methods are more effective in improving knowledge, attitudes, and practical skills compared to other methods.[21,22] Promotive and preventive efforts aimed at behavioral change are crucial to reducing the risk of occupational accidents and diseases, ultimately improving workers' overall health and safety.[23,24] The optimization of OSH skills in agricultural settings requires collaboration among multiple stakeholders, including government authorities, local organizations, health professionals, and OSH cadres.[25]

OSH Education Cadres serve as key facilitators in community empowerment initiatives, bridging the gap between health professionals, companies, government entities, and workers. They play an active role as motivators and instructors, promoting awareness and implementation of OSH practices among oil palm plantation workers. Moreover, these cadres assist in assessing workers' health and safety conditions, ensuring continuous improvements in workplace safety standards.

The use of structured educational modules in this intervention further reinforced its effectiveness. Modules designed specifically for workers provide practical guidance that can be accessed at any time, supporting continuous learning and reinforcing behavioral changes. These results align with findings from the mining industry, which reported that field safety officers exhibited significant improvements in knowledge, attitudes, and safety practices after exposure to an OSH risk module for underground mining.[26]

The six-month intervention resulted in a significant reduction in occupational accidents and work-related illnesses among oil palm plantation workers. This outcome highlights the effectiveness of the OSH intervention program in enhancing workers' awareness of workplace safety. Additionally, the decline in work-related illnesses indicates an improved understanding of occupational health, which in turn reduces exposure to occupational hazards.

These findings align with previous studies in palm oil mills, which emphasized that well-implemented OSH programs enhance workplace safety, productivity, and overall worker well-being.[27] An adequate occupational safety and health management system integrates management, labor, workplace conditions, and the work environment to prevent accidents and occupational diseases, fostering a safer, more efficient, and more productive workplace.

Similarly, other research found that improved workplace conditions and adherence to safety protocols significantly reduce accident risks in oil palm plantations.[28] Key factors such as cleanliness, comfort, and adherence to safety procedures contribute to a safer work environment. Effective OSH management benefits not only workers but also companies and economies by minimizing direct and indirect costs associated with workplace incidents.

These findings reinforce the importance of a promotive and preventive approach in OSH

management for plantation workers. Strengthening OSH competencies requires collaborative efforts from companies, government agencies, and health professionals.[25] OSH education cadres play a critical role as intermediaries between workers and stakeholders, ensuring long-term workplace safety improvements.

A limitation of this study is the absence of qualitative feedback from participants, which could have provided richer insights into their experiences with and perceptions of the OSH training. Therefore, incorporating qualitative assessments is recommended in future evaluations of this module to enhance program refinement and contextual relevance. Additionally, future research should examine the long-term implementation and policy integration of OSH programs to improve safety practices in the plantation sector.

Conclusion

This study confirms that module-based education and OSH cadre empowerment effectively enhance knowledge, attitudes, and behaviors related to occupational safety and health (OSH) among oil palm plantation workers. The intervention also significantly reduced occupational accidents and diseases, emphasizing the importance of structured and sustained OSH programs. A community-based OSH approach, supported by policy integration, is essential for long-term impact. This model can serve as a scalable strategy for improving workplace safety, particularly in industries with limited access to technology and formal training.

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