Literature Review: The Association Between Personal Protective Equipment Use and Occupational Accidents in Palm Oil Mills and Plantations

Nita Astuti[1], Eka Arwidya Purbaningrum[2], Santo Petrus Junjung[3], Gipta Galih Widodo[4]

[1]Bachelor Nursing Program, Universitas Ngudi Waluyo, nitastuti14@gmail.com
[2]Bachelor Nursing Program, Universitas Ngudi Waluyo, ekaarwidya92@gmail.com
[3]Bachelor Nursing Program, Universitas Ngudi Waluyo, santopetrusjunjung@gmail.com
[4]Bachelor Nursing Program, Universitas Ngudi Waluyo, giptagalih@gmail.com
Email Correspondence: nitastuti14@gmail.com

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Abstract

Acute Occupational accidents remain a major challenge in occupational health and safety (OHS), particularly in high-risk industries such as palm oil processing. One of the principal preventive strategies to reduce occupational injuries is the appropriate and consistent use of personal protective equipment (PPE). This study aimed to review the relationship between PPE use and occupational accidents among palm oil factory workers. This study employed a literature review design by analyzing scientific articles published between 2021 and 2025. Relevant literature was identified through Google Scholar, PubMed, and ScienceDirect using combined keyword strings such as ("occupational accidents" OR "workplace injuries") AND ("personal protective equipment" OR "PPE use"). The article selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, encompassing four sequential stages: identification of records through database searching, screening of titles and abstracts, assessment of full-text eligibility, and final inclusion of studies meeting all criteria. Five studies met the inclusion criteria and were included in the final analysis. The findings demonstrated a significant association between PPE use and occupational accidents. Several influencing factors were identified, including workers' knowledge, attitudes, behavioral compliance with PPE use, ergonomic conditions, and safety training. Workers with adequate knowledge and positive safety behaviors tended to have a lower risk of occupational accidents. In contrast, non-compliance with PPE use, negative attitudes toward workplace safety, and poor ergonomic conditions increased accident risk. Educational background and occupational safety training were also found to contribute significantly to PPE compliance, while age was not consistently associated with compliance behavior. Conclusion of this study was PPE use is strongly associated with occupational accident prevention among palm oil factory workers. Comprehensive interventions involving worker education, promotion of positive safety attitudes and behaviors, ergonomic improvements, and strengthening occupational safety training programs are essential to reduce workplace accidents

Introduction

Occupational accidents are unexpected and undesired events that can disrupt work processes. However, they are fundamentally preventable through risk control measures such as elimination, substitution, engineering controls, administrative controls, and the use of personal protective equipment (PPE) as the last line of defense in the hierarchy of controls, to be used only after elimination, substitution, engineering controls, and administrative controls have already been applied (Wahyuni et al., 2025; Andwina et al., 2024). Occupational accidents also arise from workplace hazards that are not properly controlled. Every work activity carries inherent risks that may lead to accidents if appropriate risk management measures are not implemented (Putri, 2023; Ramadhan et al., 2024). Personal protective equipment (PPE)

Corresponding author:
Nita Astuti
Nitastuti14@gmail.com

includes items such as helmets, masks, gloves, hearing protection, and safety footwear, which are designed to protect workers from potential injuries or occupational diseases caused by hazardous work environments (World Health Organization, 2021).

Palm oil processing is recognized as a high-risk industrial sector due to exposure to mechanical hazards, chemical substances, heat, heavy equipment, and ergonomic stressors. These hazards increase workers' vulnerability to occupational injuries if preventive measures are not adequately implemented. Among the available preventive strategies, PPE serves as a critical protective barrier against workplace hazards. Personal protective equipment refers to devices or equipment designed to protect workers from exposure to hazards that may threaten their safety and health. Proper PPE should be comfortable, meet safety standards, and provide effective protection against occupational risks (Afrilia et al., 2022).

Approximately 2.78 million people die each year from work-related causes worldwide, according to the International Labour Organization (ILO). More than 380,000 (13.7%) of these deaths result from occupational accidents, while around 2.4 million (86.3%) are caused by work-related diseases. In Indonesia, the number of occupational accidents recorded by the ILO showed a decline over a three-year period, with 173,451 cases in 2018, 155,327 cases in 2019, and 153,044 cases in 2020; however, the annual figures remain relatively high (ILO, 2023, as cited in Muhammad Luqman Dzaky, 2024). It should be noted that this ILO-reported decline differs from the BPJS Ketenagakerjaan national insurance data discussed below, which instead shows an increasing trend over a similar period; the discrepancy likely reflects differences in data source, reporting mechanism, and case-recording coverage rather than a genuine contradiction.

Occupational accidents remain a serious issue in occupational health and safety (OHS) at both global and national levels. In Indonesia, the number of workplace accidents continues to show an increasing trend. Based on data from BPJS Ketenagakerjaan (Badan Penyelenggara Jaminan Sosial Ketenagakerjaan, the Indonesian Social Security Administering Body for Employment, as officially reported in its annual statistics, BPJS Ketenagakerjaan, 2023), the number of occupational accidents in 2020 was 221,740 cases and increased to 234,270 cases in 2021, representing a 5.65% rise. This upward trend has continued in subsequent years (Adi, 2023; Sari, 2023). Furthermore, over the past five years, the number of occupational accidents in Indonesia has increased significantly, from 123,040 cases in 2017 to more than 200,000 cases in 2020–2021 (BPJS Ketenagakerjaan, 2023).

In East Kalimantan, a region dominated by mining, construction, and oil-related industries, approximately 19,000 occupational accidents were reported in one year alone (Nasrun et al., 2024). This regional figure illustrates that high-risk extractive and processing industries, similar in hazard profile to palm oil processing, continue to record substantial numbers of workplace injuries despite existing safety regulations. Such regional data reinforce the relevance of examining PPE-related determinants specifically within high-risk industrial settings such as palm oil factories. Occupational accidents may result from unsafe actions and unsafe conditions. One common unsafe action is failure to use PPE correctly and consistently. Despite the recognized importance of PPE in reducing injury risk, many workers remain non-compliant due to insufficient knowledge, negative attitudes toward safety, weak supervision, and poor safety culture.

Several studies have examined determinants of PPE compliance and their relationship with occupational accidents; however, findings remain varied. Therefore, this literature review was conducted to synthesize current evidence regarding the relationship between PPE use and occupational accidents among palm oil factory workers.

Methods

This study employed a literature review approach. A literature review is a research method that utilizes secondary data derived from various library-based sources, including books, scientific articles, and relevant scholarly journals related to the research problem (Adi et al., 2020). This method involves a systematic process of reviewing and critically evaluating existing literature. The primary purpose of a literature review is to understand and describe the current state of research in a field related to the topic under investigation. Through this approach, researchers are expected to identify recent evidence, recognize existing research gaps, and develop a strong theoretical foundation for future studies, thereby contributing to more appropriate solutions for the issues being addressed (Wahyuni, 2022).

The study selection process was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Literature identification was carried out through the Google Scholar database using the keywords "occupational accidents" and "personal protective equipment (PPE) use." The initial search yielded 15,200 articles. Subsequently, a screening process was performed based on publication year (2021–2025), title, and abstract to ensure relevance to the research topic. Articles that did not meet these criteria were excluded.

The next stage involved an eligibility assessment through full-text review. Articles were selected according to predefined inclusion criteria, namely studies examining the relationship between PPE use and occupational accidents and published in scientific journals. Following the selection process, five articles met all inclusion criteria and were included in the final analysis of this study.

Inclusion Criteria of this study were included if they: 1) Were published between 2021 and 2025; 2) Examined the relationship between PPE use and occupational accidents; 3) Focused on workers in palm oil plantations or palm oil processing industries; 4) Were published in peer-reviewed scientific journals; 5) Provided full-text access. Study Selection of articles were screened based on title and abstract relevance, followed by full-text eligibility assessment. After applying the inclusion criteria, five studies were selected for final analysis. Data extracted from included studies covered: 1) Study design; 2) Sample characteristics; 3) Variables investigated; 4) Key findings; 5) Strengths and limitations.

A comparative synthesis approach was used to identify recurring themes and determinants associated with occupational accidents.

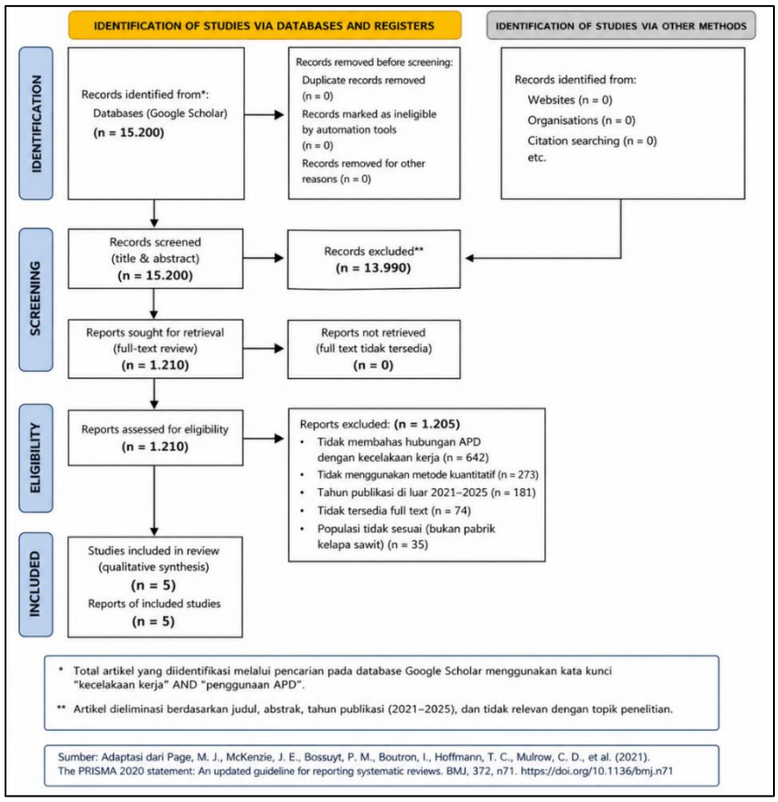

Figure 1. PRISMA 2020 Flow Diagram of Article Selection Process (enlarged for readability; exclusion counts and reasons at each stage are indicated in the diagram)

Results and Discussion

Table 1. Comparative Summary of Reviewed Studies on Personal Protective Equipment (PPE) Use and Occupational Accidents

No	Author	Method	Variables	Main Findings	Strengths	Limitations
1	Bastian et al. (2023)	Cross-sectional	Knowledge, PPE behavior, ergonomics	Significant relationship between PPE-related factors and occupational accidents	Comprehensive variables (knowledge, behavior, ergonomics) allowed broader analysis	Cross-sectional design cannot establish causality; relatively small sample size
2	Sinurat et al. (2022)	Descriptive quantitative	Knowledge, attitude	Knowledge ($p = 0.023$) and attitude significantly associated with occupational accidents	Statistical analysis (Chi-Square) strengthened analytical validity	Did not evaluate other factors such as ergonomics or work environment;

						possible self-report bias
3	Jayanti et al. (2023)	Descriptive survey	PPE use, occupational accidents	Low PPE use, yet low reported accident occurrence	Total sampling improved representativeness of the study population	No statistical analysis of association; contradictory findings may indicate potential bias
4	Nafisa et al. (2025)	Cross-sectional	Attitude, subjective norms, behavioral control, intention (TPB)	Attitude, norms, and behavioral control significantly associated with PPE use	Applied Theory of Planned Behavior (TPB), providing deeper behavioral analysis	Complex variables required valid instruments; intention was not significant and needs further exploration
5	Marsoep & Wahyudi (2021)	Cross-sectional	Compliance, education, training	Education and training significantly associated with PPE compliance	Highlighted individual characteristics influencing compliance	Very small sample; did not directly examine relationship with occupational accidents

Based on the comparative analysis of the five included studies, all were national peer-reviewed articles indexed with ISSN/e-ISSN and conducted in Indonesia, primarily focusing on the relationship between personal protective equipment (PPE) use behavior and occupational accidents among palm oil factory workers. All studies employed quantitative methods, predominantly cross-sectional designs, with sample sizes ranging from 30 to 109 participants. Across these studies, the principal variables examined included workers' knowledge, attitudes, PPE use behavior, ergonomic factors, and psychosocial constructs derived from the Theory of Planned Behavior (TPB), such as subjective norms, perceived behavioral control, and intention. Overall, most of the five reviewed studies indicate that PPE use is associated with occupational accident prevention, although the magnitude and mechanisms of association varied among studies, and this claim should be interpreted with caution given the small number of primary studies analyzed. Recent evidence also supports that inadequate PPE compliance, unsafe behavior, and poor occupational safety and health (OSH) training remain major predictors of workplace accidents in palm oil industries. This statement draws on supporting literature outside the five primary articles analyzed in this review by Silmi & Kurniawan, 2023; Noviarmi & Prananya, 2023, and is presented as corroborating, rather than primary, evidence.

The study by Bastian et al. (2023) demonstrated that occupational accidents among palm oil factory workers were significantly influenced by workers' knowledge of PPE, PPE-related behavior, and ergonomic conditions. Workers with insufficient knowledge were more likely to experience accidents due to limited understanding of self-protection practices. Likewise, inconsistent PPE use behavior increased accident risk, even among workers with adequate knowledge. These findings are supported by recent studies emphasizing that knowledge-based occupational safety education significantly improves workers' attitudes and practices while reducing workplace accidents. As supplementary evidence beyond the 2021–2025 inclusion window used for primary article selection, a more recent intervention study in Indonesian palm oil plantations reported significant improvements in knowledge, attitudes, and safe practices following context-specific OHS training ($p < .001$), reinforcing the importance of education as a preventive strategy.

Similarly, Sinurat et al. (2022) found that workers' knowledge and attitudes were significantly associated with occupational accidents, indicating that cognitive and behavioral determinants are fundamental in workplace injury prevention. These findings align with contemporary occupational safety literature suggesting that workers' risk perception, safety awareness, and hazard recognition strongly influence compliance with protective measures and accident prevention outcomes. Furthermore, a recent study (Putra et al., 2025) identified lack of OSH training as the strongest predictor of occupational accidents, increasing accident risk by more than fivefold.

In addition to the findings from the five analyzed articles, recent studies indicate that the effectiveness of Personal Protective Equipment (PPE) use is not solely dependent on individual

compliance, but is also strongly influenced by occupational safety management systems and workplace safety culture. A study by Febriansyah et al. (2024) emphasizes that organizations with a strong safety culture tend to have higher levels of PPE compliance and lower rates of occupational accidents. This suggests that system-based interventions are more effective than relying solely on individual behavior change.

Another study by Putra et al. (2025) found that active supervision, along with the implementation of sanctions and reward systems, has a significant impact on PPE compliance. Workers in environments with strict supervision are two to three times more likely to comply with PPE use compared to those in less regulated environments. These findings reinforce the importance of organizational factors in shaping safety behavior.

Furthermore, technology-based approaches are increasingly being utilized to improve PPE compliance. Recent research in occupational safety, though not yet directly evaluated in the palm oil sector, demonstrates that the use of smart PPE (sensor-based PPE) and digital monitoring systems can increase compliance by more than 30% through real-time monitoring of worker behavior (Zhang et al., 2023).As this evidence has not yet been directly evaluated within the palm oil sector, it should be regarded as a promising future development opportunity for high-risk industries such as palm oil processing, rather than an established or validated solution.

The behavioral dimension was further strengthened by Nafisa et al. (2025), whose TPB-based analysis demonstrated significant associations between PPE use and attitudes, subjective norms, and behavioral control, although intention alone was not significant. This supports the relevance of psychosocial theories in explaining occupational safety behavior. Recent evidence has similarly shown that structured safety monitoring and supervisory reinforcement significantly shape workers' safety behavior ($r = 0.851$, $p < .001$), suggesting that compliance is influenced not only by individual motivation but also by organizational monitoring and safety culture.

In addition to behavioral factors, ergonomic conditions were identified as important determinants of accident occurrence. Poor ergonomic practices—including non-neutral working postures, inappropriate equipment use, and excessive physical workload—may increase fatigue, reduce concentration, and elevate accident risk. Recent hazard analyses in palm oil industries have similarly identified ergonomic hazards, machinery risks, and unsafe work environments as substantial contributors to occupational injuries, emphasizing that accident prevention should not rely solely on PPE use but should involve broader improvements in work systems and hazard control.

Meanwhile, Marsoep and Wahyudi (2021) highlighted the importance of education and safety training in promoting PPE compliance, while age showed no significant relationship. This finding is reinforced by more recent intervention studies demonstrating that regular OHS education programs significantly improve workers' knowledge, attitudes, and safety practices, suggesting that compliance is more strongly shaped by cognitive and experiential factors than demographic characteristics.

Although most studies showed consistent findings, Jayanti et al. (2023) reported contradictory evidence in which incomplete PPE use was prevalent despite relatively low accident occurrence, a discrepancy that may be attributable to underreporting of minor incidents, the descriptive (non-analytic) study design employed, the absence of formal statistical testing of the PPE–accident relationship, or task-specific risk differences not captured by the study. This inconsistency may reflect underreporting, task-related risk differences, or unmeasured protective factors. Such findings reveal an important research gap and indicate the need for stronger longitudinal and mixed-methods studies to better understand causal pathways between PPE compliance and accident outcomes.

Overall, the findings of this review support that occupational accidents are multifactorial phenomena shaped by interactions among individual, behavioral, organizational, and environmental determinants. Knowledge remains a primary determinant of PPE compliance, while attitudes, subjective norms, behavioral control, ergonomic conditions, supervision, and training collectively influence occupational safety behavior. This is consistent with contemporary occupational safety frameworks emphasizing integrated interventions rather than single-factor approaches. Recent studies increasingly advocate comprehensive prevention strategies that combine safety education, behavior-based safety interventions, ergonomic improvements, and organizational safety culture strengthening to reduce accident incidence in high-risk industries.

Therefore, preventing occupational accidents in palm oil factories requires a comprehensive systems approach involving enhancement of workers' knowledge, development of positive safety attitudes and disciplined PPE behavior, continuous training, stronger safety supervision, and improvement of ergonomic working conditions. Such integrated interventions are expected to contribute substantially to reducing occupational accident rates and strengthening sustainable workplace safety performance.

Conclusion and Recommendations

Based on the findings of this literature review, occupational accidents among palm oil factory workers are influenced by multiple interrelated factors, particularly workers' knowledge, attitudes, PPE compliance behavior, and ergonomic conditions. Adequate knowledge was consistently associated with reduced accident risk, although knowledge alone is insufficient without positive safety attitudes and consistent compliance behavior.

Behavioral and psychosocial factors, including subjective norms and perceived behavioral control, also contribute substantially to PPE use and accident prevention. In addition, ergonomic improvements, educational background, and occupational safety training were identified as important supporting factors for enhancing PPE compliance and reducing accidents. Therefore, preventing occupational accidents in palm oil factories requires comprehensive interventions involving: 1) Improving workers' knowledge; 2) Strengthening positive safety attitudes and behaviors; 3) Enhancing ergonomic work conditions; 4) Expanding occupational safety education and training; 5) Strengthening workplace safety management systems. Such integrated strategies are expected contribute to reducing occupational accident rates.

Companies should strengthen supervision regarding PPE use and ensure the availability of standardized and comfortable PPE, operationalized through routine PPE inspections, periodic occupational safety training, structured reward-and-sanction systems for compliance, and regular evaluation of workers' PPE compliance rates. Regular occupational safety training programs should also be implemented to improve workers' knowledge and awareness.

Workers should maintain discipline and consistently use complete PPE correctly during all work activities as a preventive measure against occupational accidents. For Occupational Safety Practitioners: OHS professionals should strengthen their roles in education, monitoring, and evaluation of PPE compliance. Behavioral-based safety approaches should also be implemented to improve compliance.

For Future Researchers: Future studies are recommended to employ stronger research designs, such as longitudinal or cohort studies, and explore additional factors such as: 1) Safety culture; 2) Occupational safety management systems; 3) Environmental hazards; 4) Organizational commitment to safety.

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