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Analysis of Farmers' Awareness Level Toward the Use of Personal Protective Equipment (PPE)

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Abstract:
The use of pesticides in agriculture increases crop yields, but poses health risks to farmers, especially without PPE. Global data shows a high rate of pesticide poisoning, especially in developing countries. In Indonesia, farmers' awareness and compliance with the use of PPE are still low due to factors related to education, training, and risk perception. This study aims to analyze the level of awareness among farmers regarding the use of PPE and the factors that influence their occupational safety practices when using pesticides. This study employed a literature review method, searching articles from three electronic databases: PubMed, ScienceDirect, and SpringerLink. The selection of articles was carried out in stages based on the keywords used "farmers" OR "agricultural workers" AND "awareness" OR "knowledge" OR "perception" AND "personal protective equipment" OR "PPE" AND "use" OR "utilization" OR "practice" AND "analysis" OR "study" OR "assessment", until 12 primary articles were analyzed in depth. The results show that the use of personal protective equipment (PPE) remains relatively low and inconsistent, despite most individuals having received training and sufficient knowledge. There is a gap between knowledge and practice of PPE use among tobacco farmers, which is influenced by various social and structural factors. Educational interventions based on behavioral models, cross-sectoral involvement, and the provision of adequate PPE are essential to improve farmers' work safety sustainably.

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INTRODUCTION

The agricultural sector is one of the main pillars of economic development in many developing countries, including Indonesia. However, behind its contribution to national food security, the sector also harbors various occupational safety and health risks, especially those related to pesticide exposure. The use of pesticides is effective in increasing agricultural yields, but long-term exposure without adequate protection can have profound impacts on farmers' health. These impacts include neurological disorders, skin irritation, respiratory disorders, and even chronic diseases such as cancer and reproductive disorders (Sharifzadeh & Abdollahzadeh, 2021).

There are 1-5 million cases of pesticide poisoning in farmers every year, with 80% of them occurring in developing countries. In Thailand, about 6,000 people experienced pesticide poisoning that caused death in 2016. In Indonesia, based on data from the National Poison Information Center (SIKerNas), there were 771 cases of pesticide poisoning in 2016. In 2017, there were 124 cases, with 2 of them ending in death. This data indicates that the issue of pesticides is not only a concern for agricultural productivity but also a pressing public health concern (Kangavari et al., 2024).

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In an effort to reduce these risks, the use of Personal Protective Equipment (PPE) is one of the most important prevention strategies. PPE such as masks, gloves, eye protection, and special work clothes has been proven effective in protecting the body from direct exposure to pesticides through the skin, breathing, and eyes (Nguyen & Tsai, 2024). However, farmers' awareness and compliance with the use of PPE consistently remain low. Many farmers do not use PPE because they feel uncomfortable, hot, or are not accustomed to it (Straw et al., 2023).

Several studies have mentioned that the level of knowledge among farmers about the dangers of pesticides and the importance of PPE remains inadequate. Lack of access to relevant information and inadequate training are among the primary causes of this low awareness. Farmers also tend to rely on personal experience or information from fellow farmers without sufficient scientific understanding of the impact of exposure to hazardous chemicals (Sapbamrer et al., 2024).

Appropriate education is influential in improving farmers' knowledge, attitudes, and practices. Research has shown that interventions, such as field counseling, group training, and the dissemination of educational media, can increase farmers' awareness and compliance with the use of PPE (Wiedemann et al., 2022). However, changes in attitude are not always directly proportional to changes in behavior. Many farmers still do not use PPE despite knowing its benefits, due to barriers such as the high price of PPE, limited availability, or comfort factors when working under the hot sun (Garrigou et al., 2020; Lari et al., 2023).

Furthermore, socio-cultural aspects also significantly influence PPE use behavior. Farmers who work individually tend to be less concerned about safety than those who belong to active farmer groups. In these groups, social control and collective habituation can encourage gradual behavior change (Oyekale, 2022). This is reinforced by research from Kangavari et al. (2024), which states that the support of the social environment and field extension workers can increase acceptance of the use of PPE.

In addition to individual and social factors, government policies and institutional support also play significant roles. The availability of sustainable extension programs, personal protective equipment subsidies, and regulations governing the safe use of pesticides should be a priority in efforts to protect farmers. However, in practice, a gap still exists between existing policies and their implementation in the field (Nguyen & Tsai, 2024).

Addressing this problem requires an interdisciplinary approach that includes education, provision of facilities, and improvement of the extension system. Furthermore, integrating farmers' local knowledge with scientific approaches will enrich understanding and strengthen their commitment to safe and healthy agricultural practices (Nordin et al., 2023). Therefore, it is essential to conduct in-depth research on farmers' awareness of using PPE, considering various factors that influence it, including personal, social, and structural aspects. This study aims to assess the level of awareness and identify relevant barriers and enablers.

METHOD

The literature search process in this review was conducted using three electronic databases: SpringerLink, PubMed, and ScienceDirect. The publication year for the articles reviewed ranged from 2020 to 2025. The search utilized English keywords. The keywords included: ("farmers" OR "agricultural workers") AND ("awareness" OR "knowledge" OR "perception") AND ("personal protective equipment" OR "PPE") AND ("use" OR "utilization" OR "practice") AND ("analysis" OR "study" OR "assessment"). The search process began with identification, resulting in a total of 3.267 articles matching the keywords. In the screening phase, articles were selected based on title relevance and publication year, resulting in a narrowed selection of 1,207 articles. Next, articles were

filtered according to inclusion and exclusion criteria, reducing the selection to 721 articles. Inclusion criteria involved research focusing on farmers' awareness or behavior regarding PPE usage, published within the defined years, and available in full text. Exclusion criteria included articles that did not discuss PPE usage specifically among farmers or were review/opinion pieces without primary data. Following this, a second filtering was conducted by reviewing article abstracts to ensure alignment with the research focus, resulting in 237 relevant articles. These 60 articles underwent another detailed re-screening based on English language, research design (quantitative or qualitative primary studies), and outcome measures (knowledge, attitude, behavior towards PPE). Finally, a total of 12 articles were selected to be analyzed in this review, focusing on the level of farmers' awareness, factors influencing PPE usage, and suggested interventions to improve safety practices in agricultural work.

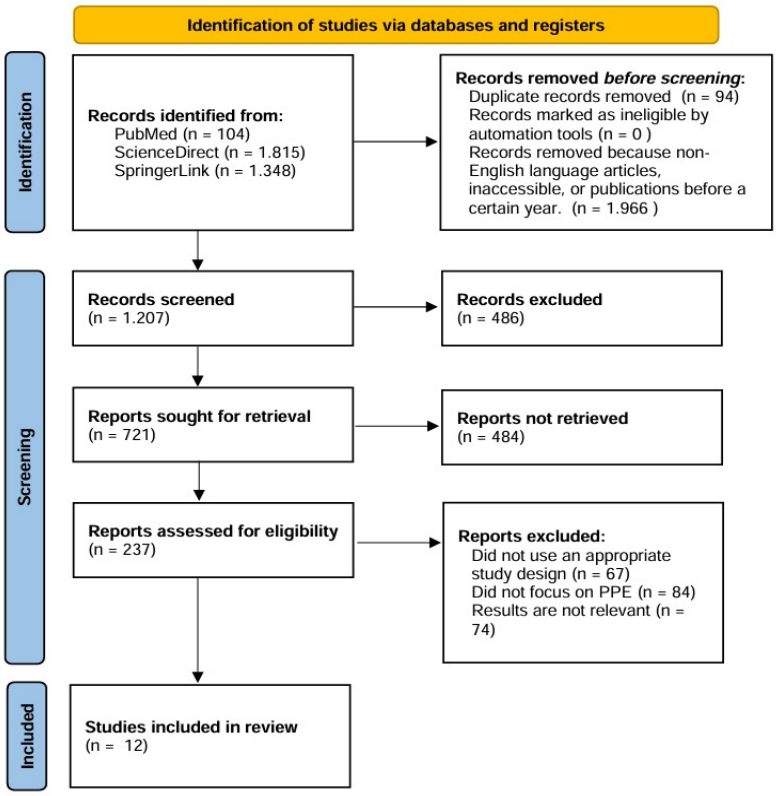

Figure 1. PRISMA Flowchart

RESULT

Based on research results from articles conducted, the use of personal protective equipment (PPE) among farmers remains low and inconsistent, despite many having received training and possessing sufficient knowledge. Several studies, including those by Ansah et al. (2023) and Istriningsih et al. (2022), have highlighted that discomfort, perceived complexity, and a lack of awareness are key barriers to the proper use of PPE. Similarly, Benaboud et al. (2021), Wongta et al. (2024), and Chekol et al. (2025) emphasize issues such as limited access, high costs, and insufficient safety training. Although farmers often recognize the importance of PPE, actual usage tends to fall short, as shown by Joko Tri et al. (2020) and Kwame Osei Boateng et al. (2022), who

also reported a strong link between poor PPE use and pesticide poisoning. On a more positive note, studies by Aye et al. (2024) and Ahmadipour & Nakhei (2024) demonstrate that targeted education and support from health professionals can significantly improve safe pesticide practices. See Table 1 for the results of the following literature analysis.

Table 1. Results of Article Analysis

ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Result
A1	Author: Ansah et al., 2023 Journal Identity: Journal of Agriculture and Food Research.	Assessment of knowledge and patterns of weedicide and personal protective equipment usage among farmers in some cocoa farming communities in Ghana.	This study aims to determine the knowledge and usage pattern of weedicides and PPE in some cocoa-growing communities in the Western North region of Ghana.	The study population consisted of cocoa farmers residing in communities within the Western North Region of Ghana. A total of 92 farmers were selected for interviews based on their experiences with the constant use of weedicides on their farms for three years.	A cross-sectional study was conducted among cocoa farmers using a semi-structured questionnaire. Descriptive statistics were employed to analyze the data, presenting the results in the form of frequencies, percentages, and p-values.	The result indicates an incomplete or improper use of personal protective equipment (PPE) by farmers who were unaware of the health risks associated with using weedicides.
A2	Author: Istriningsih et al., 2022 Journal Identity: Journal Heliyon, vol 8 (1), publication date: January 2022, 1 - 10	Farmer's knowledge and practice regarding good agricultural practices (GAP) on safe pesticide usage in Indonesia	This research aims to examine the gap between farmers' understanding of good agricultural practices (GAP) in the safe use of pesticides and their application in the field. This research was conducted in 2020 across five provinces in Indonesia.	The population for this research consists of food crop and plantation farmers, whose locations were chosen purposively, covering five provinces: West Java, Central Java, Banten, Lampung, and North Sumatra. A total of 298 respondents were randomly selected to complete a structured questionnaire, and subsequently, interviews were conducted with them.	This research method employs purposive sampling from provinces, districts, sub-districts, and villages, selecting six commodities: rice, corn, shallots, red chilies, potatoes, and palm oil.	The results of research carried out show that farmers with high knowledge may not necessarily be able to apply safe methods of using pesticides. During the interview, respondents clarified that they understood the importance of using gloves and masks when spraying pesticides on their agricultural land. The reason they do not use personal protective equipment is that the practice is complicated. Some of them only use scarves to cover their faces.
A3	Author: Benaboud et al., 2021	Farmer's behaviors toward pesticide use: insight from a	The study aims to assess farmers' knowledge and understand the	The population for this study consisted of farmers in the Berkane province	A standardized questionnaire was administered face-to-face to	The results indicated a significant lack of knowledge among farmers regarding pesticide safety and

ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Result
	Journal Identity: Environmental Analysis, Health and Toxicology.	field study in Oriental Morocco.	patterns of pesticide use in Oriental Morocco, focusing on their awareness and attitudes towards pesticide safety and the use of personal protective equipment (PPE).	of Oriental Morocco. A total of 140 farmers were randomly selected from five communes known for their agricultural activities.	evaluate farmers' characteristics, their knowledge about pesticides, their satisfaction with pesticide sources, and their understanding of pictograms on pesticide labels. Data were analyzed using the Statistical Package for Social Sciences (SPSS).	the use of PPE. Over 66% of farmers did not use appropriate safety measures, and more than 65% were found to overuse pesticides. Additionally, 60% of farmers did not respect the pre-harvest interval, highlighting a critical gap in awareness and education about the dangers of pesticide exposure and the importance of using protective equipment. This study emphasizes the need for improved education and training programs to enhance farmers' understanding of pesticide risks and promote the use of PPE.
A4	Author: Wongta et al., 2024 Journal Identity: Safety and Healthy Work, 15(4).	Agricultural Health and Safety: Evaluating Farmers' Knowledge, Attitude, and Safety Behavior in Northern Thailand.	The study aims to evaluate the knowledge, attitudes, and safety behaviors of farmers regarding occupational health and safety in the agricultural sector of Northern Thailand.	The study population comprises farmers in the agricultural areas of northern Thailand.	This study used a quantitative survey with a structured questionnaire.	The results indicate that while farmers have some awareness of occupational health and safety, their use of personal protective equipment (PPE) remains inconsistent. Many farmers neglect the use of PPE due to discomfort, limited accessibility, and a lack of understanding about its importance.
A5	Author: Ekmekci, M, & Yaman, S. 2024 Journal Identity: BMC Public Health (2024) 24:2732	Occupational health and safety among farmers: a comprehensive study in Central Anatolia, Turkey	To identify significant occupational health and safety challenges in the agricultural sector. These challenges are caused by factors such as the use of	The study involved 366 farmers registered with the Yozgat Chamber of Agriculture in Turkey.	Cross-sectional study with interview data collection techniques between May and August 2023. Descriptive data analysis with inferential chi-square and	Thirty-three percent of farmers experienced a work-related accident in the past year. Factors contributing to accidents include lack of personal protective equipment (51.5%) and transportation-related problems (36.4%).

ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Result
			heavy machinery, exposure to chemicals, and challenging environmental conditions.		binary logistic regression analysis.	Working more than 8 hours per day, working five or more days per week, and using bus/minibus transportation significantly increased the likelihood of having a work accident.
A6	Author: Aye, et al., 2024 Journal Identity: International Journal of Nursing Practice, 30(3), 2024	Pesticide safety behaviours among agricultural workersand farmers: A cross-sectional study	This study aims to investigate pesticide safety behavior, identify predisposing, enabling, and reinforcing factors associated with pesticide safety behavior and identify associated factors among cabbage farmers in Kalaw Township, Myanmar.	The population and sample in this study consisted of 195 cabbage farmers who were selected using a single estimation formula with specific criteria.	A cross-sectional study was conducted among 9,195 cabbage farmers between March and May 2019. Bivariate and multivariate logistic regression were used to identify any association.	The results showed that most cabbage farmers in Kalaw Township, Myanmar, had a poor work protection system and experienced health problems due to pesticide exposure. This study shows the relationship between the safe behavior of farmers, coworkers, the role of family, the availability of PPE, and the education of nurses or other health workers regarding the use of PPE and the management of pesticide poisoning.
A7	Author: Chekol et al., 2025 Journal Identity: BMC Research Notes, 18 (1), 177	Understanding the factors behind non-Adherence to pesticide safety guidelines among smallholder farmers in Fogera and Mecha districts, northwestern Ethiopia	The objective of this study is to investigate the key factors contributing to smallholder farmers' non-adherence to recommended pesticide safety practices in northwest Ethiopia.	The study included 318 smallholder farmers from Fogera and Mecha districts in Ethiopia as a quantitative sample selected through stratified random sampling, as well as qualitative data collected through focus group discussions (FGDs) and in-depth interviews with farmers and local agricultural officers.	This study employed a mixed-methods approach, combining quantitative and qualitative methods to understand the factors underlying farmers' non-compliance with pesticide safety guidelines.	The results showed that farmers' non-compliance with pesticide safety guidelines is relatively high, especially in the use of personal protective equipment (PPE). The main factors influencing non-compliance include a lack of knowledge, the high cost of PPE, a low perception of pesticide risks, hereditary habits, and limited access to safety training and information.
A8	Author:	Farmer's behavior in	To investigate the behaviors	The study focused on smallholder	The researchers	The study revealed several critical

ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Result
	Ali et al., 2020 Journal Identity: Science of the Total Environment, 747.	pesticide use: Insights study from smallholder and Intensive agricultural farms in Bangladesh	and practices of smallholder farmers in Bangladesh regarding pesticide use, aiming to identify patterns, knowledge gaps, and potential risks associated with their application.	farmers engaged in intensive agriculture in Bangladesh. The sample in this study consisted of 917 farmers from four geographic areas in Bangladesh, who were interviewed.	employed a mixed-method approach, combining quantitative surveys and qualitative interviews. This methodology provided a comprehensive view of farmers' knowledge, attitudes, and practices concerning pesticide application, safety measures, and awareness of potential health and environmental impacts	insights: - A significant portion of farmers lacked adequate knowledge about the safe handling and application of pesticides. - Many farmers did not use personal protective equipment (PPE) during pesticide application, increasing health risks. - There was a prevalent misuse and overuse of pesticides, often due to misconceptions about their effectiveness. - Farmers primarily relied on peer advice and local vendors for information on pesticide use, rather than seeking guidance from agricultural extension services.
A9	Author: Abdollahzadeh, G., & Sharifzadeh, M. S., 2021 Journal Identity: Journal of the Saudi Society of Agricultural Sciences, 20(1).	Predicting farmers' intention to use PPE to prevent pesticide adverse effects: An examination of the Health Belief Model (HBM)	To predict farmers' intention to use personal protective equipment (PPE) to prevent pesticide-related health issues using the Health Belief Model (HBM) framework	The study focused on rice farmers in Sari County, located in Mazandaran Province, Iran, which is the country's largest rice-producing region. A random sample of 387 rice farmers from this area was selected to participate in the research. These farmers were surveyed to investigate their intentions for using personal protective equipment (PPE) when handling pesticides.	A survey using a questionnaire with 33 variables based on HBM constructs. Data analysis explored the relationships between HBM components and farmers' intentions to use PPE.	The majority of farmers (56,33%) expressed willingness to use PPE in the future. Key positive predictors of intention included perceived severity of pesticide effects, perceived benefits of PPE, and cues to action. Perceived barriers, such as discomfort with PPE, negatively influenced intention. Training programs that emphasize the severity of pesticide risks and address them. PPE benefits and barriers are recommended to improve preventive

ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Result
						behavior among farmers
A10	Author: Ahmadip & Nakhei, 2024 Journal Identity: BMC Research Notes, 17(134).	The effect of education on safe use of pesticides based on the health belief model	This study aimed to investigate the effect of education on farmers' behavior regarding the safe use of pesticides, using the Health Belief Model.	The population in this study was farmers in the Anbarabad region, Kerman Province, Iran, who actively used pesticides. A total of 84 farmers were selected as the sample using the convenience sampling method, with inclusion criteria such as status as a farmer and resident of Anbarabad, and willingness to participate.	Quasi-experimental (pretest-post-test) study was conducted on 84 farmers who were selected using the convenience sampling method. The data collection tool was a two-part questionnaire, including demographic information and a questionnaire designed based on the constructs of the health belief model, using personal protective equipment while working with the pesticides.	Results showed that after the educational intervention, scores on HBM constructs, such as perceived sensitivity, severity, benefits, and self-efficacy, increased significantly, while perceived barriers decreased. PPE use also increased dramatically, with safe behaviour rising from 12% to over 80%. Female and highly educated farmers tended to be more aware of PPE use than male farmers or less educated farmers.
A11	Author: Joko Tri et al., 2020 Journal Identity: Journal of Environmental and Public Health	Pesticide Poisoning and the Use of Personal Protective Equipment (PPE) in Indonesian Farmers	This study aims to analyze the relationship between pesticide poisoning and the use of personal protective equipment. Equipment (PPE) among farmers.	The population in this study consists of all farmers who apply pesticides in Wanasari District, Brebes, Central Java, Indonesia. The sample consists of 152 pesticide-spraying farmers selected using stratified random sampling.	This study used a quantitative method with a cross-sectional design. The data were analyzed using chi-square tests and logistic regression to examine the relationship between independent variables (such as the use of personal protective equipment) and the dependent variable (pesticide	In this study, it was found that the use of complete personal protective equipment (PPE) was very low, with only 6.6% of respondents using it. Additionally, 65.8% of farmers experienced mild to moderate pesticide poisoning. A significant relationship was found between the use of PPE (such as masks, gloves, long-sleeved shirts, long pants, and closed shoes) and the level of pesticide poisoning ($p < 0.05$). Farmers who did not use PPE were

ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Result
					poisoning).	3.9 times more likely to experience poisoning compared to those who used complete PPE.
A12	Author: Boateng, K. O. et al., 2023 Journal Identity: Journal of Toxicology Reports, 20.	Knowledge, perception, and pesticide application practices among smallholder cocoa farmers in four Ghanaian cocoa-growing regions	This study aimed to assess the knowledge, practices, and risk perceptions of cocoa farmers in Ghana towards pesticide use.	The population for this study consisted of all cocoa farmers in Ghana. At the same time, the sample comprised 404 cocoa farmers randomly selected from communities in four major cocoa-producing regions, along with an additional 20 spraying service providers for data validation.	This study employed a quantitative method, utilizing a structured survey. Data was collected through open-ended, closed-ended, and semi-closed inquiry questionnaires, as well as face-to-face interviews, focus group discussions (FGDs), and the Kobo form application. The Chi-Square test was used to measure the relationship between nominal and ordinal variables.	This study revealed that the majority of cocoa farmers in Ghana have access to pesticide information and training through cooperatives and agricultural extension workers; however, there are still gaps in their knowledge and practices regarding the safe use of pesticides. Some unsafe practices, such as storing pesticides in the house (17%), using containers of used pesticides for daily needs (98.5%), and disposing of pesticide residues into the environment, pose significant health and environmental risks.

DISCUSSION

Agronursing, as an interdisciplinary field that combines agricultural science and nursing principles, plays a crucial role in promoting the health and safety of farmers, particularly in relation to the use of Personal Protective Equipment (PPE). Agronurses are uniquely positioned to bridge the gap between healthcare and agricultural practices by educating farmers on occupational hazards such as pesticide exposure, zoonotic diseases, and physical injuries. Their responsibilities include assessing workplace risks in farming environments and delivering targeted health interventions to mitigate these risks. A key aspect of this is raising awareness about the proper selection, use, and maintenance of PPE, which directly contributes to reducing work-related illnesses and injuries among agricultural workers (Ramadhani et al., 2025; Afandi et al., 2023).

The effectiveness of agronursing initiatives heavily depends on farmers' awareness levels regarding the utilization of PPE. Many farmers, especially in developing regions, often underestimate the risks associated with agrochemical exposure or perceive PPE as uncomfortable, costly, or unnecessary. Agronurses conduct community outreach, training sessions, and health screenings to

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improve knowledge and change risk-perception behaviors. By evaluating current awareness levels, agronurses can tailor educational programs that address cultural beliefs, literacy barriers, and economic constraints, ultimately fostering safer farming practices. Thus, the synergy between agronursing and increased PPE awareness is essential for sustainable improvements in agricultural occupational health (Kurniyawan et al., 2023).

From the synthesis of ten peer-reviewed articles, it can be observed that farmers' awareness regarding the use of Personal Protective Equipment (PPE) while handling pesticides is still categorized as low to moderate. Research conducted by Ansah et al. (2023) and Yaseen et al. (2025) revealed that a considerable number of farmers in Ghana and India do not use PPE adequately, with some completely ignoring it. This lack of use is strongly influenced by limited knowledge concerning the health impacts of pesticide exposure. Supporting this, Ahshaina et al. (2021) emphasized that higher levels of knowledge were significantly associated with complete PPE usage, particularly among those with pesticide-related illnesses, such as goiter.

On the other hand, some studies indicate that even with sufficient knowledge, behavior does not always align with safe practices. Istriningsih et al. (2022) and Indriati et al. (2022) explained that many Indonesian farmers understood the importance of PPE but still avoided it due to practical reasons such as discomfort and heat. Similarly, Wongta et al. (2024) and Aye et al. (2024) supported these findings, showing that the main barriers were discomfort and the unavailability of appropriate PPE. These factors suggest that knowledge alone is insufficient to drive behavioral change if environmental and situational barriers are not addressed.

In a more behavioral approach, Abdollahzadeh and Sharifzadeh (2021) applied the Health Belief Model (HBM), highlighting that perceptions of susceptibility and benefits can positively influence the intention to use PPE. Ahmadipour and Nakhei (2024) further supported this by stating that educational interventions based on the HBM framework significantly improved the use of PPE. However, even when farmers perceived PPE as beneficial, personal discomfort continued to be a consistent obstacle. This suggests that while psychological models help to explain intention, real-world application requires addressing physical and contextual barriers as well.

Interestingly, several studies noted the role of information sources in influencing behavior. Ali et al. (2020) found that informal sources, such as peers or pesticide sellers, often played a larger role in promoting pesticide use than trained agricultural extension workers. This was echoed by Boateng et al. (2023), who reported that despite awareness efforts, unsafe practices such as using everyday containers for storage remained prevalent among Ghanaian farmers. These findings underscore the need for more effective and consistent collaboration between formal public health and agricultural professionals in education and outreach efforts.

Lastly, local data from Indonesia, as presented by Joko et al. (2020), showed that only 6.6% of farmers used PPE while spraying pesticides, correlating with a high incidence (65.8%) of mild to moderate pesticide poisoning. Despite most farmers having basic knowledge, they still failed to adopt protective practices due to comfort issues and limited access. Therefore, beyond increasing awareness, strategies must include structural support such as improved availability of PPE and ongoing education. Holistically, the integration of behavioral models, adequate provision, and active institutional involvement is necessary to achieve significant improvement in occupational health practices among farmers.

CONCLUSION

The use of Personal Protective Equipment (PPE) by farmers in handling pesticides remains low, despite many of them having knowledge and awareness of the risks associated with exposure.

Key barriers include physical discomfort when using PPE, limited access, and lack of ongoing counselling at the field level. While educational interventions were shown to increase knowledge and positive attitudes, actual behaviour change did not always occur due to situational and structural barriers. In addition, informal sources of information, such as fellow farmers or pesticide sellers, are often more influential than official extension workers, thus spreading harmful practices. Therefore, a holistic approach that combines increased availability of PPE, regular training, and strengthening the extension system is necessary to achieve genuine occupational safety and health for farmers.

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