HTechJ Health and Technology Journal (HTechJ)

Volume 03 Number 05
October 2025
p-ISSN: 2986-5662
e-ISSN: 2985-959X

The Impact of Pesticide Exposure on Farmers' Respiratory Health: An Agronursing Perspective

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Abstract:
Pesticide exposure is one of the most significant risks farmers faces, especially regarding respiratory health. Lack of understanding about using personal protective equipment (PPE) and safe work procedures makes farmers vulnerable to respiratory problems. This study aims to identify the impact of pesticide exposure on farmers' respiratory health from an agronursing perspective. This research is a literature review study that uses a quantitative descriptive approach. The sample was taken from 10 articles from PubMed, Science Direct, and Semantic Scholar, which were considered most relevant. The study showed pesticide exposure is significantly associated with increased respiratory disorders such as asthma, chronic cough, and decreased lung function. Risk factors include frequency of spraying, type of pesticide, and lack of PPE use. The agronursing approach is important in the prevention and management of health impacts due to pesticides. The role of nurses as educators, behavior change facilitators, and intervention developers is essential to increase farmers' awareness and health protection.

Article info:
Submitted:
25-08-2025
Revised:
02-10-2025
Accepted:
05-10-2025

Keywords:
pesticide exposure, farmers, respiratory health, agronursing

DOI: https://doi.org/10.53713/htechj.v3i5.514

INTRODUCTION

The agricultural sector is a key pillar of the economy in many developing countries, including Indonesia. In addition to providing food, this sector also serves as a source of livelihood for millions of people, particularly in rural areas. According to data published by the Indonesian Ministry of Agriculture in 2023, the agricultural sector employed an estimated 36.46 million workers, comprising 23.15 million men and 13.31 million women, accounting for 26.07% of the total national workforce (Mimilianti et al., 2024). This number has increased by approximately 1.35 million people, or 3.72%, compared to the previous year. Global evidence reinforces this pattern: agriculture remains the largest employer of rural communities worldwide, providing livelihoods to hundreds of millions of small-scale farmers (Mwangakala et al., 2024). Micro-level research on Indonesian households echoes these numbers; approximately one-third of Indonesians were still farming in 2019, and improvements in rural labor participation were closely tied to poverty reduction programs (Rammohan & Tohari, 2023). Cross-country studies further confirm that even as economies diversify, agriculture's labour-absorption function persists, making the sector indispensable to inclusive growth agendas (Erdiaw-Kwasie et al., 2024). These findings underscore agriculture's dual role in Indonesia: it is simultaneously a pillar of national food security and a critical determinant of the social and economic welfare of millions of farm families.

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October 2025
p-ISSN: 2986-5662
e-ISSN: 2985-959X

In an effort to increase production yields and protect crops from pests and diseases, the use of pesticides has become a common practice among farmers. However, the use of massive, uncontrolled pesticides, often without adequate understanding of work safety, seriously threatens farmers' health (Alcalá et al., 2024). Farmers are the most vulnerable group because they are directly exposed to hazardous chemicals over the long term. The study conducted by Liem et al. (2021) showed that pesticide exposure, not balanced with the correct and consistent use of personal protective equipment (PPE), can increase the risk of health problems, especially respiratory system disorders.

Pesticide exposure can occur through various routes, including dermal (skin), oral (gastrointestinal tract), and inhalation (respiratory tract). The inhalation route is of particular concern as pesticides in aerosol or gaseous form can easily become airborne during mixing, spraying, or equipment cleaning, especially without adequate ventilation and respiratory protection. Recent studies have shown that inhalation exposure to pesticides is associated with an increased risk of respiratory symptoms, including wheezing, coughing, and asthma, among agricultural workers (Rahmawati et al., 2025).

Globally, pesticide exposure among farmers has been associated with an increased prevalence of respiratory disorders. According to a study by Huyen et al. (2020), the prevalence of health problems associated with pesticide use is relatively high among farmers in Tu Ky, Hai Duong Province, Vietnam, particularly in areas where vegetables are produced. This study involved 300 farming households and found that approximately 19.7% of farmers experienced upper respiratory tract disorders, such as chronic cough, shortness of breath, and throat irritation. Interestingly, the prevalence of these disorders was higher among farmers working in vegetable fields than in areas producing rice. This may be due to the higher frequency of pesticide spraying in vegetable fields, as these crops are generally more susceptible to pests.

Another study conducted by Ratanachina et al. (2022) also showed that farmers in Thailand had a prevalence of chronic airflow obstruction of 5.5%. Chronic airflow obstruction is one of the primary indicators of chronic obstructive pulmonary disease (COPD), characterized by long-term airway narrowing and breathing difficulties. Furthermore, the study found that farmers had lower lung function than the control group, which consisted of government employees who were not directly exposed to pesticides in their daily activities. These findings reinforce the suspicion that pesticide exposure significantly contributes to reduced lung function and increased risk of chronic respiratory disorders among farmers.

In Indonesia, pesticide exposure poses a serious health risk to farmers, with respiratory disorders being the most common, affecting 62.6% of them. In Mayang Village, Jember, many rice farmers report experiencing symptoms such as asthma, shortness of breath, and bronchitis. These issues are linked to the intensive use of pesticides during planting seasons (Nur et al., 2023). The study by Joko et al. (2020) also demonstrated that pesticide exposure has a significant impact on farmers' respiratory health. In a study conducted in Wanasari Subdistrict, Brebes, 51% of farmers reported experiencing difficulty breathing after being exposed to pesticides. This symptom had a significant value ($p = 0.021$), indicating a strong correlation between pesticide exposure and respiratory disorders. This condition is exacerbated by farmers' inadequate and incomplete use of personal protective equipment (PPE), thereby increasing the risk of acute poisoning, which affects the respiratory system.

In addition to the Southeast Asian region, the prevalence of pesticide-related respiratory disorders among farmers in the Americas, specifically in Brazil, is also notably high. A study conducted by Evaristo et al. (2022) found that, out of 79 farmers surveyed in southern Brazil, 21.5% reported experiencing pesticide poisoning, with 58.8% of those cases occurring through inhalation.

This exposure frequently occurred during pesticide spraying, particularly among farmers who did not use enclosed-cabin tractors or relied solely on backpack sprayers. The study also revealed a significant correlation between the use of more traditional pesticide application methods and a higher incidence of respiratory disorders, highlighting that the lack of protective measures, such as personal protective equipment (PPE), increases the risk of respiratory health problems among farmers.

Health risks from pesticides are also influenced by various other factors, such as the type of crop cultivated, the intensity and frequency of spraying, the type and concentration of pesticides used, and the behavior of farmers in storing, mixing, and disposing of pesticide residues (Ahmad et al., 2024). Unfortunately, many farmers in Indonesia still lack a comprehensive understanding of the potential dangers of pesticides and how to use them safely. The lack of education, lack of supervision from related parties, and low awareness of the importance of using PPE are the main challenges in efforts to protect farmers' health (Febriana et al., 2023).

Considering the high prevalence of respiratory disorders among farmers exposed to pesticides and the various risk factors associated with them, a comprehensive and contextual approach is necessary to protect farmers' health. The agronursing perspective views farmers' health not only from the clinical side but also emphasizes the importance of nurses in the agrarian sphere in conducting health promotion, education, and advocacy related to the safe use of pesticides. Agronursing positions nurses as strategic partners for farmers in identifying risks, promoting behavioral change, and developing community-based interventions tailored to the needs and characteristics of the agricultural environment (Susanto et al., 2022).

Agronursing provides agricultural-based nursing services in agriculture, plantations, waters, or industrial agriculture (Kurniawan et al., 2022). This field expands the traditional role of nurses by positioning them as educators, advocates, and facilitators who actively engage with farmers, agricultural workers, and their families to promote safe farming practices and mitigate health risks. By combining clinical care with environmental and occupational health perspectives, agronursing fosters a holistic understanding of farmers' well-being that encompasses physical, psychological, and social dimensions (Baloyi, 2022).

The role of agronurses is multifaceted, encompassing health promotion activities such as training farmers on the correct use of personal protective equipment (PPE), advising on proper pesticide handling and storage, and raising awareness about the potential health effects of chronic pesticide exposure (Susanto et al., 2022). Furthermore, agronursing emphasizes an interprofessional and preventive approach by collaborating with agricultural extension officers, environmental health specialists, policymakers, and local community leaders. This collaborative model ensures that health interventions are comprehensive, evidence-based, and reinforced through policies that regulate pesticide usage and promote occupational safety standards (Susanto & Berdadi, 2025). Preventive strategies implemented by agronurses include early detection of respiratory symptoms, referral systems for medical care, and continuous monitoring of health indicators in farming populations. These efforts are crucial to breaking the cycle of exposure and illness, ultimately contributing to healthier work environments and improved quality of life for farmers and their families (Susanto et al., 2022).

Based on the description above, this literature review was prepared to identify and analyze the impact of pesticide exposure on farmers' respiratory health from the perspective of agronursing. This review aims to provide a comprehensive understanding of the respiratory problems faced by farmers, the factors that influence the risk of these problems, and the crucial role of agronursing in efforts to prevent and manage pesticide-induced health issues in agricultural communities. Thus, the results of this study can serve as a basis for developing more effective and sustainable intervention

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p-ISSN: 2986-5662
e-ISSN: 2985-959X

strategies to improve farmers' quality of life and create a healthier work environment in the agricultural sector.

METHOD

This research uses the literature review method. Literature sources were collected from research journal databases and the internet, with a focus on PubMed and ScienceDirect for publications between 2020 and 2025. Search keywords in English were used to find relevant literature, with the keywords used in the search being "Pesticide Exposure", "Farmers," AND "Respiratory Health".

The next stage was screening for duplicate titles, records marked as ineligible by automation tools, and records removed for other reasons. As a result, 3,682 journals remained. Further screening was then conducted for journals published within the last five years, and reports were sought for retrieval, resulting in 1,108 journals. Next, the publications were screened based on the inclusion criteria, which consisted of populations in the agricultural sector, written in English, available in full text, and having relevant topics. From this process, 10 journals were selected that met the inclusion criteria. The search and screening results are presented in the PRISMA diagram below.

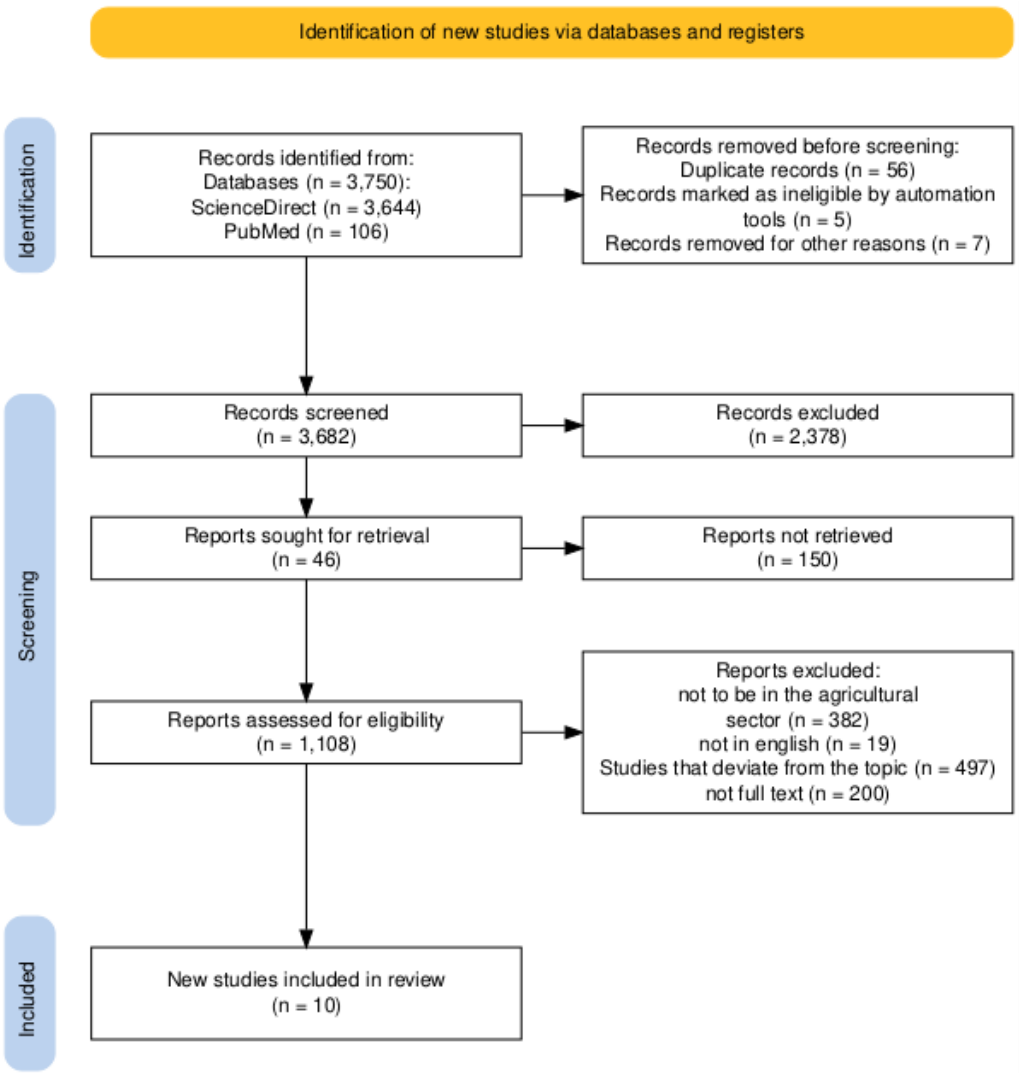

Figure 1. PRISMA 2020 Flow Diagram

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e-ISSN: 2985-959X

RESULT

After reviewing various studies and articles, ten studies indicated the existence of The Impact of Pesticide Exposure on Farmers' Respiratory Health. For more information, refer to Table 1, which presents the findings below.

Table 1. Results of Article Analysis

ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Results
A1	Author: Rodríguez-Zamora et al. Journal Identify: Science of the Total Environment, Elsevier/ 2024/ vol.954: 176776.	Respiratory and allergic outcomes among farmworkers exposed to pesticides in Costa Rica	To examine the association between pesticide exposure and respiratory/allergic outcomes among farmworkers in Costa Rica	299 farmworkers from Costa Rica, both from organic and conventional farms	Cross-sectional study with surveys and urine sample analysis for pesticide biomarkers. Bayesian statistical models are used for analysis.	Higher exposure to pesticide mixtures, especially organophosphates and fungicides, was associated with increased asthma, rhinitis, and eczema. Some herbicides showed inverse associations.
A2	Author: Alcalá et al. Journal Identify: Science of the Total Environment, Elsevier/ 2024/Vol. 945: 173855.	Association of Pesticide Exposure with Respiratory Health Outcomes and Rhinitis in Avocado Farmworkers from Michoacán, Mexico	To examine the link between pesticide exposure (insecticides, fungicides, herbicides) and respiratory health and rhinitis in avocado farmworkers	105 avocado farmworkers from Michoacán, Mexico	Cross-sectional study with urine sample analysis, exposure-intensity scoring, and a survey on respiratory symptoms	Exposure to a mixture of pesticides, especially pyrethroids, was associated with an increased risk of night cough. After adjusting for multiple comparisons, no significant associations were found for other respiratory outcomes.
A3	Author: Ratanachina et al. Journal Identify: Occupational and Environmental Medicine/ 2021/Vol. 79: 1–8.	Farming, pesticide exposure, and respiratory health: A cross-sectional study in Thailand	To assess the association of lung function and respiratory symptoms with farming, particularly pesticide use, in an agricultural province in Thailand.	All adults aged 40–65 years in Nan Province, Thailand, particularly those who live or work in the Tha Wang Pha district. The sample comprised 427 individuals, including 345 villagers and 82 government employees.	A cross-sectional survey method was used, with cluster random sampling for villagers and enrichment sampling for government employees.	The study had a 94% response rate. Chronic airflow obstruction was found in 5.5% of villagers. Villagers had slightly lower FEV_1/FVC than government employees. No link was found between lung function and general farming or most pesticides. Exceptions were poultry farming (linked to chronic cough and higher FEV_1/FVC) and atrazine, which showed mixed effects depending on exposure level.

ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Results
A4	Author: Díaz-Criollo et al. Journal Identify: Industrial Health/ 2020/Vol. 58: 15–21.	Chronic Pesticide Mixture Exposure Including Paraquat and Respiratory Outcomes Among Colombian Farmers	Investigating the link between chronic mixed pesticide exposure, including paraquat, and respiratory health in Colombian farmers.	The study included 217 farmers from three cities in Antioquia, Colombia, with a history of exposure to paraquat and other pesticides.	This cross-sectional study used surveys, spirometry, and HPLC to assess respiratory health and paraquat levels, analyzed with Poisson regression.	Chronic exposure to paraquat was slightly associated with self-reported asthma (PR: 1.06; 95% CI 1.00 to 1.13). Different pesticide mixtures were linked to respiratory symptoms such as flu, thoracic pain, allergic rhinitis, and obstructive patterns in spirometry.
A5	Author: Chittrakul et al. Journal Identify: Toxics/ 2021/Vol. 9: 228.	Insecticide Exposure and the Risk of Asthmatic Symptoms: A Systematic Review and Meta-Analysis	Investigating the link between insecticide exposure and asthma symptoms through a systematic review and meta-analysis.	This study analyzed occupational insecticide exposure in farmers across five studies, involving 45,435 subjects.	A PRISMA review (1990–2021) assessed insecticide exposure and asthma in farmers using selected studies and NIH quality appraisal.	The meta-analysis revealed a strong association between insecticide exposure and asthma, with a higher risk in farmers exposed to organophosphates (OR 1.31), carbamates (OR 1.44), and organochlorines (OR 1.31), emphasizing the need for further research.
A6	Author: Akkouch et al. Journal Identify: International Journal of Environmental Research and Public Health/ 2025/Vol. 22: 260.	Exploring Pesticide Knowledge, Practices, and Health Perceptions Among Farmers in Akkar, Lebanon	To assess small-scale farmers' knowledge, practices, and perceptions of pesticide use in Akkar, Lebanon, and its health and environmental impacts.	The study involved 151 smallholder farmers from 10 Akkar Valley, Lebanon coastal villages.	A cross-sectional study (Nov 2022–Jan 2023) surveyed smallholder farmers in Akkar Valley on pesticide knowledge, practices, and health impacts using a KAP questionnaire and SPSS.	Farmers had moderate knowledge (0.545) and practices (0.607) on pesticide use. Only 9.3% recognized water risks, 37.7% lacked protective gear, and 67.5% had health issues. Education influenced knowledge, stressing the need for training and better equipment.
A7	Author: Gutiérrez-Jara, et al. Journal Identify: PLoS ONE/ 2020/Vol 15(12): e0243048	Pesticide Application, Educational Treatment and Infectious Respiratory Diseases: A Mechanistic Model with Two Impulsive Controls	Developing and analyzing SIS-type models to study the interaction between pesticide use and the spread of infectious respiratory diseases.	This study focuses on pesticide exposure in agricultural environments, using mathematical simulations instead of direct human population samples.	The study used an SIS model with pesticide and education controls, analyzing impacts through MATLAB simulations and assessing disease spread risk with R_0.	Pesticide exposure can increase susceptibility to infectious respiratory diseases, so that in an exposed population, diseases that previously had a basic reproductive number (R_0) of less than 1 can rise above the epidemic threshold and spread more widely.
A8	Author: Zhao et al. Journal	The Associations between	To analyze the pooled effect estimates and	The analysis of 19 observational	The study reviewed databases until	The meta-analysis found a significant link between organophosphate

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ID	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Results
	Identify: Toxics/ 2023/Vol. 11: 741.	Organophosphate Pesticides (OPs) and Respiratory Disease, Diabetes Mellitus, and Cardiovascular Disease: A Review and Meta-Analysis of Observational Studies	mechanisms linking organophosphate pesticide (OP) exposure to respiratory diseases, diabetes mellitus (DM), and cardiovascular diseases (CVD).	studies on OP exposure highlights its link to respiratory diseases, diabetes, and cardiovascular issues across diverse populations, including the general public and at-risk workers.	September 2022 for observational studies on organophosphate exposure, with data extracted by two authors and quality assessed using the Newcastle–Ottawa scale.	exposure and respiratory diseases (OR: 1.12) and diabetes (OR: 1.18). Wheezing (OR: 1.19) and asthma (OR: 1.13) showed stronger associations, while no link was found with cardiovascular diseases (OR: 1.00).
A9	Author: Díaz-Criollo et al. Journal Identify: Industrial Health/ 2020/Vol 58(1)	Chronic pesticide mixture exposure, including paraquat, and respiratory outcomes among Colombian farmers	To explore the potential link between chronic exposure to pesticide mixtures, including paraquat, and respiratory effects in Colombian farmers.	Profiles of pesticide mixtures were identified among 217 farmworkers, but profenofos and methamidophos-based mixtures were more frequent.	Sociodemographic, occupational, respiratory, and spirometric data were collected, HPLC measured paraquat levels, and Poisson regressions identified factors linked to respiratory outcomes.	Chronic paraquat exposure was slightly linked to asthma, while pesticide mixtures were associated with flu, thoracic pain, rhinitis, and obstructive spirometry. Further studies on chronic exposure to profenofos, methamidophos, and glyphosate are needed.
A10	Author: Teera Kangkhetkron and Chudchawal Juntarawijit Journal Identify: International Journal of Environmental Research and Public Health/ 2021/Vol. 18(16): 8803.	Factors Influencing Practice of Pesticide Use and Acute Health Symptoms among Farmers in Nakhon Sawan, Thailand	To investigate the relationship between pesticide exposure and respiratory health problems among farmers in Nakhon Sawan Province, Thailand.	680 farmers from Nakhon Sawan Province, Thailand, aged 20 years and older, who had worked as farmers for at least three years. Participants were selected from all 15 districts using systematic random sampling.	A descriptive cross-sectional study used face-to-face interviews and ordinal logistic regression to explore associations between demographics, knowledge, attitude, practice, and acute health symptoms.	The study found that poor pesticide use practices were linked to acute respiratory symptoms, including difficulty breathing (47.2%) and chest pain (31.5%), with an increased risk (OR = 2.17, 95% CI = 1.04-4.35), suggesting that improper practices increase the risk of respiratory disorders.

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DISCUSSION

Pesticide exposure in agricultural activities has become a significant concern in occupational health, especially regarding its impact on the respiratory system of farmers (Shekhar et al., 2024). Studies consistently show a strong association between repeated exposure to various types of pesticides and the occurrence of respiratory disorders, both acute and chronic (Alcalá et al., 2024). Symptoms often include asthma, chronic cough, chest pain, wheezing, and decreased lung function. The severity of these disorders is strongly influenced by the type of pesticide used, the duration and intensity of exposure, and the level of compliance with safety procedures during the handling process (Hughes et al., 2024). One of the riskiest behaviors is the direct mixing of pesticides without following established safety standards. This mixing activity significantly increases the risk of inhalation and skin absorption, thus contributing to respiratory health problems experienced by farmers.

A study by Lee et al. (2022) in Korea revealed that approximately 90% of farmers mix their pesticide combinations and apply them directly in the fields, often carelessly and without proper precautions. Improper mixing and misuse of pesticides are standard, ultimately increasing health risks. The study also highlighted a significant association between mixing pesticides and reduced lung function. These findings are consistent with those of Hansen et al. (2021), who reported decreased FEV_1 and FVC values among Ugandan farmers exposed to insecticides. Both studies highlight that the type of pesticide matters, as well as how it is handled in practice, particularly when conducted without proper protective measures or adequate knowledge.

Support for the association between pesticide exposure and respiratory problems also comes from several other studies. Rodríguez-Zamora et al. (2024) found that high exposure to pesticide mixtures, particularly organophosphates and fungicides, was associated with an increased risk of asthma, rhinitis, and eczema among farmers. Similarly, a meta-analysis by Chittrakul et al. (2021) reported a strong association between exposure to insecticides, especially organophosphates, carbamates, and organochlorines, and asthma. Zhao et al. (2023) further supported this by revealing significant links between organophosphate exposure and respiratory symptoms such as wheezing and asthma. Alcalá et al. (2024) also found that exposure to pyrethroids increased the risk of nighttime cough. These studies suggest that chronic pesticide exposure may result in short-term symptoms and long-term structural and functional damage to the respiratory system.

Farmers' use of Personal Protective Equipment (PPE) remains considerably low despite the known health risks associated with pesticide exposure. A study conducted by Loha et al. (2024) in Ethiopia reported that only 8.9% of farmers used PPE while spraying pesticides, and merely 8.6% adhered to proper pesticide handling practices. The primary barriers identified were a lack of training and discomfort with equipment. Consistent with these findings, a review by Garrigou et al. (2020) emphasized that regular and appropriate use of PPE can significantly reduce the risk of respiratory symptoms among farmers, highlighting the critical role of preventive measures in occupational health.

However, not all research demonstrates a consistent correlation. Ratanachina et al. (2022), in a study conducted in Thailand, found no significant associations between levels of pesticide exposure and respiratory symptoms or decline in lung function. This indicates that other factors, such as spraying techniques, duration of agricultural work, and the use of personal protective equipment (PPE), may influence individual risk levels. Nonetheless, an earlier study by Ratanachina et al. (2021) identified exceptions: poultry farming and atrazine exposure were associated with chronic cough and elevated FEV_1/FVC values. These findings indicate that health responses to pesticide exposure may vary depending on the chemical type, level of exposure, and individual characteristics, warranting further investigation.

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Several other studies stress the importance of safe pesticide use practices. Kangkhetkron and Juntarawijit (2021) observed poor pesticide handling behaviors were closely associated with acute respiratory symptoms, including shortness of breath and chest pain. Akkouch et al. (2025) found that many farmers had limited knowledge of pesticide use and lacked proper protective equipment, leading to increased health complaints. Gutiérrez-Jara et al. (2020) further highlighted how chronic pesticide exposure may increase vulnerability to infectious respiratory diseases, potentially enabling diseases with previously low transmission rates to spread more easily. These findings underscore the need for comprehensive and continuous efforts to promote occupational safety in agricultural settings. This includes the strict monitoring of pesticide mixing and handling procedures, ongoing education and training programs tailored to farmers' specific needs, and the consistent use of appropriate Personal Protective Equipment (PPE) to mitigate respiratory health risks.

CONCLUSION

Pesticide exposure significantly increases farmers' risk of respiratory disorders, especially if not accompanied by the use of personal protective equipment (PPE) and the implementation of safe work behaviors. The agronursing approach is a crucial strategy in addressing this issue by positioning nurses as agents of change, who play a vital role in health promotion, education, and advocacy within agricultural communities. Prevention efforts, including continuous education, increased awareness among farmers, and the development of community-based interventions, are necessary to create a healthier and safer agricultural work environment.

ACKNOWLEDGEMENTS

We extend our sincere gratitude to all members of Group 2, namely Mohammad Andra Febriyansah, Tazkiyah Tanjung Cahaya Rizki, A'isah Janusaputri, Poppy Aularita Febiola, and Nabilatul Arifah, for their dedication, teamwork, and valuable contributions throughout the writing process.

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