

Pesticide Exposure and the Risk of Asthma Among Agricultural Workers: A Literature Review

Alfid Tri Afandi^{1*}, Hesti Puspita Ningrum², Alifiyah Salsabila Murdiyanti³, Renata Setyorini⁴, Enggal Hadi Kurniawan⁵, Dicky Endrian Kurniawan⁶, Kholid Rosyidi Muhammad Nur⁷

^{1,5,6,7} Faculty of Nursing, Universitas Jember, Jember, Indonesia

²⁻⁴ Student of Faculty of Nursing, Universitas Jember, Jember, Indonesia

*Corresponding author : Alfid Tri Afandi, Email: alfid@unej.ac.id

ABSTRACT

Farmers are potentially at increased risk of respiratory disorders, including asthma, due to chronic exposure to pesticides. Many pesticide formulations contain chemical compounds with irritant or neurotoxic properties that may induce airway inflammation and bronchial hyperresponsiveness. This risk may be further amplified by inadequate use of personal protective equipment (PPE) and poor ventilation during pesticide application. This review aims to examine the association between pesticide exposure and the incidence of asthma among farmers based on recent scientific evidence. A literature review was conducted using articles published between 2020 and 2025 retrieved from PubMed, ScienceDirect, and Springer databases. The search strategy employed the keywords "pesticide exposure" OR "pesticide poisoning" AND "asthma" AND "farmer." Eligible studies were selected through a screening process based on relevance, study quality, and publication credibility. The reviewed literature consistently indicates an association between pesticide exposure and an increased risk of asthma among farmers. Several studies report that exposure to specific classes of pesticides is linked to airway inflammation, impaired lung function, and exacerbation of asthma symptoms, particularly with prolonged or high-intensity exposure. Current evidence suggests that pesticide exposure is associated with a higher incidence of asthma among farmers. These findings underscore the importance of strengthening occupational health interventions, including improved risk communication, proper use of PPE, and strategies to minimize pesticide exposure, particularly among vulnerable agricultural populations.

Keyword : *pesticide exposure; asthma; farmers; occupational health*

1. INTRODUCTION

Pesticide exposure among agricultural workers has emerged as a critical issue in the context of agronursing - a field of nursing that deals with the health of agricultural communities. Pesticides as a definition in Indonesian agriculture have advantages such as increasing yields and adverse effects that negatively impact health, especially respiratory health. You et al., (2022) reported in Environmental Research that pesticides are a major risk factor for respiratory disease in agricultural communities. These substances can increase susceptibility to asthma, worsen respiratory symptoms, and cause inflammation of the respiratory tract mediated by both immunological mechanisms and direct irritation because they are immunotoxic and neurotoxic substances. Several studies have shown that long-term exposure to pesticides increases the risk of developing respiratory disorders such as asthma, one of which is a study conducted by Meirindany et al, (2021) which states that there is a significant relationship between years of work and the type of pesticide used with neurobehavioral effects on farmers.

While working, a person faces the possibility of developing work-related asthma when exposed to irritant or allergenic substances. Pesticides are considered a possible trigger. The main biological mechanisms include respiratory tract irritation, oxidative stress, and activation of inflammatory pathways. According to research conducted by Schunck & Liess (2023), even very low exposure to pesticides can disrupt the ecological balance, which can affect human health. In agronursing, understanding the risks of pesticide exposure and its impact on respiratory disorders such as asthma is essential for health prophylaxis and intervention.

In agronursing, attention to this exposure is not only on biomedical aspects, such as wheezing frequency or decreased FEV1, but also on socio-ecological aspects, such as spraying practices, community empowerment, behavior of using PPE (personal protective equipment) and health education (Kurniyawan et al., 2024). Furthermore research by Englert et al. (2024) used statistical models to look at how different air pollutants affect hospital visits for asthma. They found that ozone and nitrogen dioxide were the two main factors that made asthma symptoms worse. Moreira & da Silva et al., (2024) showed

that agricultural workers reported respiratory symptoms such as chronic cough and asthma, and emphasized the importance of the role of community nurses in early detection and preventive intervention.

In the field of agronursing, it is essential to understand these exposures because nurses working in agricultural communities are responsible for preventing, educating, and promoting policies that protect farmworkers. Although data on the impact of pesticides in Indonesia is still limited, several studies continue to show a strong correlation between pesticide exposure and increased risk of asthma, for example, a study in Mexico (Alcalá et al., 2024) which stated that there was pesticide exposure, rhinitis, and respiratory disorders in avocado orchard workers. Recently, the attention given by scientists to the issue of environmental impacts on respiratory health has increased. One issue that often arises and is widely discussed is the relationship between pesticide exposure and asthma symptoms, especially in vulnerable groups such as children, agricultural workers, and low-income urban populations (Fandiño-Del-Rio et al., 2024; Damiri D. et al., 2025).

Pesticide exposure is a significant yet under-recognized environmental factor in relation to asthma incidence and exacerbation in various age groups (Kurniyawan et al., 2023). A study by Vitte et al. (2024) revealed that pesticide exposure contributes to an increased frequency of allergic asthma exacerbations in the general population, indicating that pesticides not only trigger allergic responses but also worsen the clinical condition of asthma sufferers. In addition, Buralli et al. (2020) reported that pesticide exposure negatively impacts respiratory health and triggers allergic reactions in children, which may increase the risk of developing asthma from an early age. A study by Ventura-Miranda et al. (2022) adds an important dimension by finding that pesticide exposure during pregnancy can disrupt the development of the fetal respiratory system, potentially increasing the child's susceptibility to chronic respiratory disorders, including asthma, after birth.

Furthermore, a scoping review conducted by Mattila et al. (2021) strengthens the evidence of a close association between exposure to environmental chemicals, especially pesticides, and an increased risk of asthma and impaired lung function. This study highlights the biological mechanisms by which pesticides can trigger airway inflammation and exacerbate bronchial

hyperresponsiveness, which are the main characteristics of asthma. That pesticide exposure is correlated with decreased lung function, which is a common clinical manifestation in asthmatics. This finding confirms that pesticide exposure not only plays a role in the development of new-onset asthma but can also worsen respiratory function in individuals who already have asthma, causing a significant health burden.

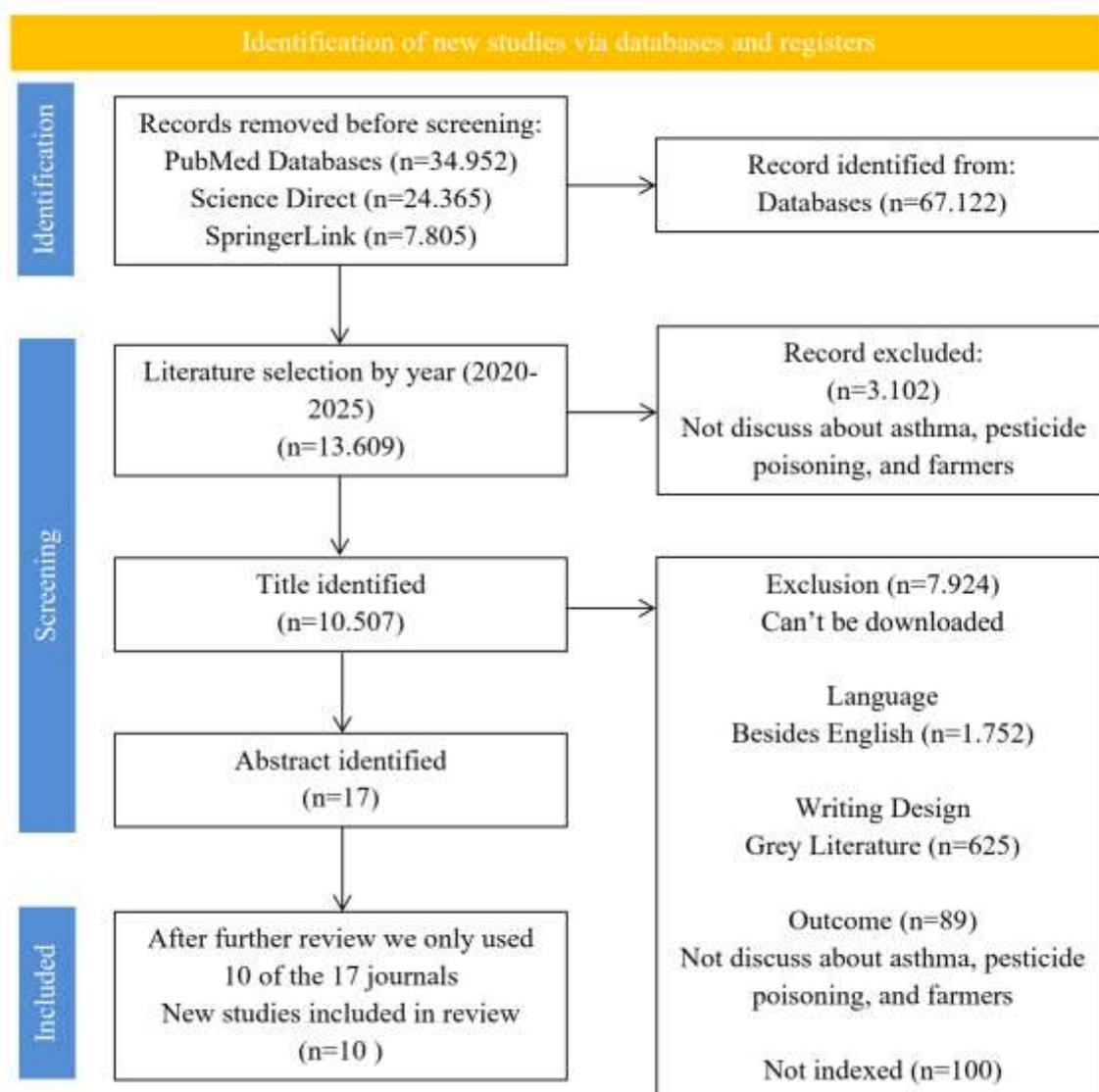
Overall, these evidences emphasize the importance of attention to pesticide exposure as an environmental risk factor that influences the incidence, development, and severity of asthma. A deeper understanding of this relationship can help in more effective asthma prevention and management efforts, especially in vulnerable groups such as children, pregnant women, and agricultural workers who are intensively exposed to pesticides. This evidence can be the basis for taking appropriate interventions to carry out nursing actions.

2. METHOD

This research uses the literature review method, which is research that has been done and is not based on direct observation. In this study, researchers needed secondary data with a literature review research design collected from several trusted sources. PubMed, Science Direct, and SpringerLink are database sources used by researchers to find articles needed in this study. The source articles used came from publications from 2020 to 2025. The research articles were found by using search keywords in English. In the English literature search, the keywords used were "Pesticide Exposure" OR "Pesticide Poisoning" AND "Asthma" AND "Farmer". The method used in the process of analyzing and selecting articles in this study is the PRISMA method. This approach starts from collecting relevant articles, which are then selected and summarized in a table that includes the article number, author name and publications identify, population and sample, research methods, and a summary of the results obtained

The article search stage began with the identification of predefined keywords. At this initial stage, 67.122 articles were found from PubMed (n=34.952), Science Direct (n=24.365), and SpringerLink (n=7.805) databases that

matched the search keywords. Next, filtering was carried out based on the year of publication within the last five years (2020-2025) and the availability of full and free access. From this process, 543 articles were obtained that met the initial criteria. The next stage involved applying inclusion and exclusion criteria, which included abstract relevance, keywords appropriateness, and appropriateness of the research results to the topic under review. After this stage, 31 articles remained that met the criteria. Finally, after several stages of



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Figure 1. Prisma Flow Diagram

3. RESULT

Based on a review of ten journals analyzed, a strong association was found between pesticide exposure in the farmer's work environment and an increased incidence of asthma and respiratory symptoms related to asthma. A study by Ahmed et al. (2022) showed that 7.3% of farmers in Greater Cairo experienced work-related asthma (WRA), most of which was allergic asthma with symptoms appearing about 78 minutes after contact with pesticides, indicating acute exposure that triggered airway reactions. A similar finding was found by Zamora et al. (2024) in Costa Rica, where farmers exposed to pesticides experienced chronic respiratory symptoms such as wheezing and shortness of breath, with 12% of them using asthma medications and 25% experiencing rhinitis, which is a common comorbid condition in asthma sufferers. Further support comes from a meta-analysis by Chittrakul et al. (2021), which stated that exposure to pesticides such as organophosphates, carbamates, and organochlorines significantly, increased the risk of developing asthma (OR 1.31-1.44). The study by Puvvula et al. (2022) also noted a prevalence of asthma of 4.4% in farmers and ranchers exposed to pesticides, as well as environmental allergies that can worsen asthma symptoms due to chronic inflammation of the airways. In the study by Eunica et al. (2022), there was a significant relationship between pesticide exposure and respiratory symptoms such as coughing and shortness of breath, which may reflect early or latent symptoms of occupational asthma.

This is reinforced by the findings of Veeraiyan et al. (2024), who reported that 76.4% of farmers experienced coughing when exposed to pesticides and spirometry results showed obstructive and restrictive lung disorders, conditions that are also common in asthma sufferers. Fishwick et al. (2022) stated that high exposure to pesticides in the workplace is associated with increased incidence of wheezing, chronic cough, and chest tightness, all of which are typical symptoms of asthma.

Meanwhile, Lee et al. (2022) showed that farmers who mix pesticides have a higher risk of obstructive pulmonary disorders (OR=2.30), which may

be related to the mechanism of airway obstruction in asthmatics. Díaz-Criollo et al.'s (2020) study found that chronic exposure to paraquat significantly increased the prevalence of self-reported asthma (PR=1.06), indicating a long-term effect of exposure on the respiratory system. Finally, Samanta et al. (2023) revealed that lack of education about pesticide use contributes to symptoms of respiratory disorders such as coughing, airway irritation, and wheezing, which are common symptoms in occupational asthmatics.

Table 1. Results of Literature Review

No	Author /Year	Article Title/Journal Name/Volume	Sample	Method	Result	Limitation
1.	Ahmed , et al/ 2022	Prevalence of work-related asthma among Egyptian farmers in Great Cairo/ The Egyptian Journal of Immunology/ 29(3)	150 adult workers ≥ 18 years from four different farms, two grape farms and two strawberry farms, in great Cairo in the period from 2019 to 2021.	Multi-center cross-sectional study	Out of 150 cases, 11 (7.3%) were diagnosed as WRA. According to the WRA sub-types, allergic OA was the most frequent (54.5%, n=6), followed by work-exacerbated asthma (WEA) (27.3%, n=3) and only 2 participants had irritant OA (18.2%, n=2) Figure 1. Their mean time of work at the current farm was 4.91±2.02 years. They reported asthma symptoms 78.18 ± 41.91 minutes daily after starting the working day.	This study was limited by a small sample size, focus only on male workers in greater cairo.
2.	Zamora , et al/ 2024	Respiratory and allergic outcomes among farmworkers exposed to organic and	The sample in this study 299 farmworkers from 9 organic and	cross-sectional study	Prevalence of respiratory and allergic outcomes among study participants, Zarcero County, Costa Rica (n =299). Individual asthma	This study has several limitations, including the reliance on modeled data

pesticides in 83
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Total Zarcero
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shortness of breath 31 averages and
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score 0=198 (66.2); 1 =45 capture local
(15.0); 2=30 (10.0); 3=12 or regional
(4.0); 4=12 (4.0); 5=2 (0.7). disparities
Asthma symptoms or
medication use 36 (12.0)
Rhinitis 76 (25.4) Chronic
bronchitis 20 (6.7)
Eczema 42 (14.0)

3	Chittra Insecticide kul, et Exposure and al/2021 Risk of Asthmatic Symptoms: ASystematic Review and Meta-Analysis / toxics /9(288)	This systematic review and meta- analysis included five studies-three cross- sectional and two cohort studies- with total sample size of 45,435 subject, primarily farmers with occupational	systema tic review and meta- analysis include d five studies- three cross- sectiona l and two cohort studies	The meta-analysis found a significant association between exposure to certain insecticides and asthmatic symptoms. Specifically, exposure to organophosphates (OR = 1.31), carbamates (OR = 1.44), and organochlorines (OR = 1.31) was linked to an increased risk of asthma.	A limitation of this study is the sensitivity analysis, which indicated instability in the result, suggesting that more high-quality, large-sample studies are needed to confirm the findings
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exposure to
insecticide

4. Puvvula, et al / 2022
Prevalence and Risk Factors for Pulmonary Conditions among Farmers and Ranchers in the Central United States / Journal of Agromedicine / 27(4)
Farms and ranches (n = 16,818) with an email address and annual sales exceeding \$5,000 were randomly selected for the survey. We received responses from 3,268 agricultural operations (19% response rate) containing information on 4,064 individual operators.
This was a cross-sectional study using survey data from the 2018 Farm and Ranch Health and Safety Survey (FRHSS)
Of the respondents, 18% reported having at least one of the listed conditions diagnosed by a physician. The disease-specific prevalence varied, being highest for environmental allergies (8.5%), and followed by rhinitis (5.4%), sinusitis (4.9%), asthma (4.4%), and farmer's lung (2.2%).
The limitations of the study include self-reporting, which could introduce biases that we could not quantify. The response for the respiratory outcomes was based on "ever" diagnosed by a physician, whereas the exposure information was based on the "past 12 months" and this, along with the cross-sectional study design, does not enable establishing a temporal connection between cause and
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effect. It is uncertain how well self-reporting exposure conditions reflect real-life exposures vs. quantifying them with standard industrial hygiene methods, which would be exceedingly expensive for this size study.

5.	Eunica, , et al (2022)	Impact of Pesticide Exposure on the Health of Agricultural Workers in Northern Region of Kwara State, Nigeria / International Journal of Innovative Science and Research Technology / 7(6)	A sample size of 384 people was adopted for the study, according to the Research Advisors Convenience sampling was used to sample 310 consenting agricultural workers.	A Cross sectional descriptive study	The P-value of the Pearson Chi Square test is 0.000. This P-value is lesser than 0.05 alpha level of significance, which indicate the rejection of the null hypothesis. Therresult shows that respondent's exposure to pesticide significantly affected their health.	the article does not explicitly state any limitations of the study
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6.	Veeraiyan et al / 2024	Respiratory Profiling Among The Farmers With Pesticide Exposure A Field Based Cross Sectional Study / International Journal of Academic Medicine and Pharmacy/ 6(1)	97 farmers from rural Puducherry in 2021	A Field Based Cross Sectional Study	The pesticide exposure period was found to be eleven to fifty hours and more than a hundred hours in 45.5% and 12.7% of study participants respectively. Around 76.4% of them had a history of cough during exposure. Mean values of the Pulmonary Function Test had significantly reduced than expected values, with the majority showing Mixed restrictive and obstructive types of lung disease	The researchers did not include limitations in the journal article.
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7	Fishwick, et al (2022)	Asthma in pesticide users: an update from the Great Britain Prospective Investigation of Pesticide Applicators' Health (PIPAAH) cohort study / BMJ Journals / 79(6)	The sample in this study consisted of 5,817 pesticide workers, the majority of whom were based in the United Kingdom	cross-sectional study	High Pepticide exposure was associated with an increased risk of work-related wheezing and chest tightness, but not significantly linked to doctor-diagnosed asthma or general wheezing. Self-reported respiratory symptoms were common, and many asthma sufferers believed their condition was work-related, particularly due to organic dust exposure	The follow-up participation rate was relatively low, with only about 44% of the original participants responding, which may affect the representativeness of the findings. Lastly, there was no clinical re-evaluation conducted

						during follow-up; asthma diagnoses relied on self-reports or previously recorded diagnoses rather than updated medical assessments
8	Lee et al., 2022	Occupational factors affecting the decline in pulmonary function among male farmers using occupational pesticide in Gyeonggi-do, South Korea/ Annals of Occupational and Environment Medicine / 8(34)	Surveys and pulmonary function tests were conducted on 1,697 farmers in 16 regions of Gyeonggi-do	A one-on-one interview was conducted using structured questionnaires consisting of agricultural work history, pesticide exposure, respiratory symptoms, disease	Pesticide work groups showed significant association with an obstructive pattern in the lung function test (unadjusted OR, 2.38; 95% CI, 1.17–5.52). Selected work-related variables of pesticide exposure were ‘start age,’ ‘cumulative duration,’ ‘mixing pesticides,’ and ‘protection(goggle).’ The obstructive pattern of lung function test showed significant associations with mixing pesticides (OR, 2.30; 95% CI,1.07–5.46), and protection (goggle) use (OR, 0.34; 95% CI, 0.12–0.79).	The researchers did not include limitations in the journal article.

9	Diaz-criollo et al., 2020	Chronic pesticide mixture exposure including paraquat and respiratory outcomes among Colombian farmers / Industian Health / . 58 (1)	A cross-sectional study was conducted with a volunteer sample of 217 farmworkers, in the municipalities of Carmen de Viboral, Granada and La Unión, all in Antioquia, Colombia.	This study used a cross-sectional design	Profiles of pesticide mixtures used were identified among 217 farmworkers, but profenofos and methamidophos-based mixtures were more frequent. Chronic paraquat exposure was slightly associated with self-reported asthma (PR: 1.06; 95% CI 1.00 to 1.13).	This cross-sectional study cannot confirm exposure timelines. The exposure estimate may not reflect actual levels, though urinary biomarkers were used. Possible selection bias may exist due to voluntary participation.
10	Samanta et al., 2023	Health Effects Of Pesticides On Agricultural Workers	his study we have collected data from 19 countries	Canonical correlation analysis	The study, it was found that pesticides have a negative effect on the health of farm workers. Lack of education and training in the use of pesticides can worsen health conditions due to exposure to the dangers of chemicals. This requires health education and pesticide use program policies that can reduce the impact of direct exposure to health, especially farm workers	In the study, a Canonical correlation analysis study was used, but it was not specifically explained how many respondents were used.

4. DISCUSSION

Some of the journals that have been mentioned show similarities in the focus of research related to the prevalence of respiratory disorders due to pesticide exposure in agricultural workers. The study by Ahmed et al. (2022) showed of the 150 farmers studied in Greater Cairo, 7,3% experienced Work-Related Asthma (WRA), with allergy as the most common type. These result are in line with the findings of Zamora et al. (2024) in Costa Rica, who noted asthma symptoms such as shortness of breath at rest (11.4%) and asthma with medication use (12%). Both studies emphasize the high burden of respiratory disorders in farmers due to occupational environmental exposures, especially pesticides, although their data measurement approaches differ-one through clinical diagnosis, the other based on symptom reports.

Furthermore, additional evidence on the association of pesticide exposure and asthma risk was strengthened by a meta-analysis study by Chittrakul et al. (2021), which identified that organophosphate, carbamate and organochlorine pesticides were significantly associated with asthma symptoms. This finding confirms that the effects of pesticides are universal and can be observed through broader aggregate analysis methods. This finding is also supported by the study of Lee et al. (2022) in South Korea, which found an association between long-term pesticide exposure and patterns of obstructive pulmonary function impairment through spirometry testing. These two studies show that through both macro epidemiological and micro clinical approaches, the risk of pesticide-induced respiratory disorders is real and consistent.

However, a different view was shown by Fishwick et al. (2022) from the UK, who found that although pesticide workers reported symptoms such as chest tightness, there was no significant association with a medical diagnosis of asthma. This is in contrast to other studies such as Eunica (2022) and Veeraiyan

et al. (2024) who stated that pesticide exposure had a significant impact on farmers respiratory health, with significant Chi-square test results ($p < 0,05$) and a marked decrease in lung function. This discrepancy may be due to different methodological approaches the UK study relied on self report with low participation rates, whereas the Nigerian and Indian studies relied on physiological measurements and actual in the field.

Furthermore, Puvvula et al. (2022) in the United States noted that 4.4% of farmers reported having been diagnosed with asthma by a physician, while Díaz-Criollo et al. (2020) found a weak but significant association between chronic paraquat exposure and asthma. Both studies used similar survey approaches and cross-sectional design, but with different populations. The US result emphasized allergy and sinusitis as the predominant conditions, whereas in colombia, the focus was more on the effects of exposure to specific pesticides such as methamidophos and profenophos. Both agreed that the self-report survey approach has limitations in establishing causal relationship.

In addition, research by Samanta et al (2020). also strengthens empirical evidence regarding the impact of pesticide exposure on lung function. This study was conducted on tea plantation workers in India using spirometry to measure lung capacity. The results showed a significant decrease in FEV1, FVC, and FEV1/FVC values in the pesticide exposed group compared to the control group. This study emphasizes that chronic exposure to pesticides can lead to impaired lung function even in individuals with no prior history of respiratory diseases. This consistent decline in lung function parameters strengthens the argument for the importance of regular respiratory health monitoring for agricultural workers.

Overall, the ten journals show consistency in pesticide exposure as a risk factor for respiratory disorders in farmers or agricultural workers, whether in the form of asthma, chronic bronchitis or reduced lung function. Given the limitations of most studies (such as cross-sectional design, reporting bias, and absence of direct biological measurements), there is a need for longitudinal studies and the use of biomarkers for stronger validity in the future.

5. CONCLUSION

Based on the results of a literature review of various studies between 2021 and 2025, it can be concluded that there is a significant relationship between pesticide exposure and the incidence of asthma in farmers. Exposure to pesticides, especially organophosphates, is known to trigger airway inflammation, aggravate asthma symptoms, and increase the risk of other respiratory disorders. These findings are strengthened by the results of studies with systematic designs and the use of biological biomarkers as more objective indicators of exposure.

Although some studies show variations in the strength of association due to differences in research methods, measurement instruments, and population characteristics, overall scientific evidence supports that pesticides are environmental risk factors that play a role in increasing asthma morbidity. Therefore, increasing public awareness, controlling pesticide use, and protecting vulnerable groups are essential to reduce the negative impact of pesticide exposure on respiratory health.

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