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SYSTEMATIC REVIEW

Relationship Between Pesticide Exposure and Neurobehavioral Disorders in Farmers

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ABSTRACT

Introduction: Pesticides are chemicals used to eradicate pests such as insects that damage crops and agricultural products. Farmers often do not realize that the benefits of pesticides are important for agriculture but also have dangerous risks. If farmers are constantly exposed to pesticides this can cause neurological diseases. The purpose of this study was to determine the relationship between exposure to pesticides and neurobehavioral disorders in farmers. **Methods:** The authors of this study conducted research using a systematic literature review on publications published in the last 5 years on two databases namely Google Scholar and Scopus using the keywords pesticides, neurobehavioral, and farmers. The literature review was conducted based on issues, methodology, similarities and further research proposals. The population was all farmers in Indonesia who work with pesticides on their crops. **Results:** Three of the four articles found reported that pesticide exposure and duration of action were associated with neurobehavioral events whereas one article did not state any association between these variables. Some neurobehavioral symptoms caused by pesticide exposure are dizziness, difficulty sleeping, and difficulty concentrating. **Conclusion:** The use of pesticide content must be balanced to minimize the risks caused by exposure. Farmers also have to get enough rest to restore the function of the cholinesterase enzyme in the blood. It can be concluded that exposure to pesticides is associated with neurobehavioral events in farmers.

Keywords: farmer, neurobehavioral, pesticide

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INTRODUCTION

Indonesia is one of the agricultural countries where the agricultural sector is developing in Indonesia, has a tropical climate and many mountainous areas that are considered very suitable for agricultural land. Data from the Central Statistics Agency (BPS) 2020 regarding the percentage of informal workers in the agricultural sector as of August 2020 state there are as many as 128.45 million people. Chemical-based pesticides are still predominantly used by farmers. Often farmers do not know the dangers posed by behavior when using pesticides and, among others, do not wear personal protective equipment (PPE) so are exposed to the effects of pesticides directly, and a long time working spraying the plant causes longer and more pesticides on the body (Joko, Dewanti and Dangiran, 2020). One effect that is often felt by farmers due to pesticides is neurobehavioral (a disease that attacks the nerves that causes a person to forget easily and have trouble sleeping) (Tiwari et al., 2022). If used for a long time it will cause cognitive impairment, and memory to mood disorders (Meirindany, Indirawati and Marsaulina, 2021).

The use of pesticides on agricultural land causes neurobehavioral effects meaning a person is affected by functional disorders in both central and peripheral nerves caused by exposure to chemicals contained in pesticides. According to the United States Environmental Protection Agency (EPA) 2016, neurobehavioral effects account for 1 in 10 workplace health disorders. This type of disease that attacks the nervous system is very easily identified through the symptoms caused including dizziness, difficulty sleeping, and lack of

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concentration. Of the four kinds of literature that have been analyzed, all of them used the German version of the Q18 questionnaire to determine the neurobehavioral effects due to pesticides. This review on the relationship of pesticide exposure with neurobehavioral disorders in farmers is very important because there are not too many studies, especially in Indonesia. By doing this research, the reader can understand the impact caused by exposure to pesticides with neurobehavioral events in farmers as seen from the type of pesticides used, the length of work, and the dose of pesticides.

METHODS

This research is a systematic literature review, data search was carried out from July to August 2022. Journal search was conducted by using Boolean operators with keywords pesticide and neurobehavior or neurobehavioral and farmer and Indonesia on Scopus and using the natural language processing search method on Google Scholar which has SINTA level using the keywords pesticides, neurobehavioral, and farmers.

Journals were selected based on the following inclusion criteria: 1) journals related to pesticide exposure related to neurobehavioral events in plantation workers and farmers; 2) journals that discuss the dangers of pesticides on farmers; 3) using the cross-sectional method; 4) published in the period 2018 – 2022; 5. literature in the form of a journal; 6) literature available in full text.

From all journals that match the inclusion criteria in journal publications for the last five years that have been found, it is known that only four journals in the same year, namely 2021, are very suitable for the researchers' objectives and most fully discuss related to nervous disorders due to exposure to pesticides in farmers.

RESULT

Literature Search Results

After searching the literature by keyword and year of publication in the last five years, it was found as many as 1250 articles on Google Scholar, and 20 articles from Scopus. After screening again, there were four articles found following the topic and research questions (Figure 1). The first article that was reviewed came from Serdang, North Sumatra, the second article was from Cianjur regency, the third article was from Sembalun, East Lombok, and the fourth article did not specifically explain where the research was conducted.

Other studies also discuss the type of neurobehavior l and how to measure; the article explained that there is a type of short-term

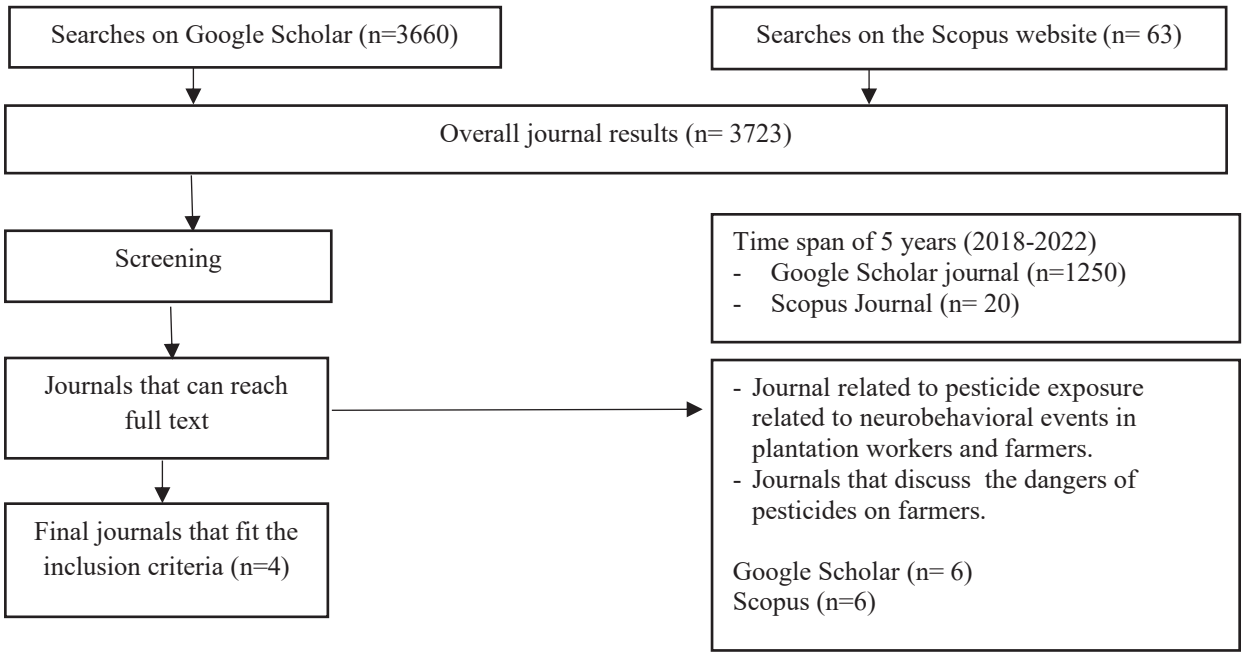

Figure 1. Diagram of the Method of Finding the Relationship of Pesticide Exposure Data with Behavioral Events in Farmers

Table 1. Journal Literature Relationship between Pesticide Exposure with Neurobehavioral Disorders in Farmers

Author/Year	Title	Purpose	Sample Design	Analytical Techniques	Result
Tina Meirindany, Sri Malem Indirawati dan Irnawati Marsaulin, 2021	Relationship of pesticide exposure with neurobehavioral effects on red pepper farmers in Beringin District	The purpose of this study was to analyze pesticide exposure with neurobehavioral effects on red pepper farmers in Beringin District.	This type of study uses observational with cross-sectional studies. The sample determined by the Slovin formula was 90 respondents.	Analytical techniques to analyze the relationship between variables using neurobehavioral performance tests using instrument digit symbol, digit span, pursuit aiming, and trial making.	The results showed that there is a relationship between age, length of service, and the type of pesticide on the incidence of neurobehavioral red pepper farmers in the district of Beringin.
Zahra Salsabila Firdaus, Ismet Muchtar Nur, 2021	Neurobehavioral disorder relationship with pesticide exposure on Tea Plantation Workers PT X Cianjur regency	This study aims to determine the relationship between neurobehavioral disorders in spraying workers (pesticide users) in tea plantations.	This type of research uses an observational analytic approach using a cross-sectional design group and using total sampling techniques.	Analytical techniques to analyze correlational relationships between variables. Independent variables are pesticides and bound variables of neurobehavioral disorders. The research instrument used the German version of the Q18 questionnaire and data analysis used the chi-square test.	The results showed that there is a relationship between neurobehavioral disorders experienced by workers with prolonged exposure to pesticides seen from the length of their work.
Dhody Ardi pratama, Onny setiani, Y.H.D, 2021	Faktor Paparan Pestisida Terkait Gejala Neurologis Pada Petani Penyemprotan Pestisida	This study aims to determine the pesticide factor exposure related to the neurological symptoms of farmers spraying in the Sembalun Lawang agricultural area, East Lombok Regency.	This type of research uses observational analysis with a cross-sectional study design. Sampling technique using simple random sampling.	Data were analyzed using univariate analysis method, bivariate using chi-square, and multivariate using logistic regression.	The results showed that pesticide exposure was shown to have an association with neurological symptoms, including length of service.
Imelda Nafa Pawestri, Erma Sulistyaningsih, 2021	Neurobehavioral performance of Indonesian farmers and its relationship to pesticide exposure: a cross-sectional study	This study aims to examine the relationship between pesticide exposure with neurobehavioral effects in farmers in Indonesia.	This type of research uses the interview method. And using cross-sectional studies	Analytical techniques for analyzing correlational relationships between variables. Instrument research using questionnaire Q18 German version and neurobehavioral WHO Core Battery Test (NCBT) consists of instruments digit span, digit symbol, pursuit aiming, and trial making. Descriptive data using a chi-square test	The results showed that the most common neurobehavioral effects were concentration difficulties, fatigue, and headaches. The chi-square test states the duration of spraying and the service life. And this type of pesticide is not related to neurobehavioral effects.

neurobehavior that is with mild symptoms such as dizziness, excessive fatigue, insomnia, and difficulty concentrating and how to measure that is using Specifications Q18 German version. The next article found the type of long-term neurobehavioral threat on attention, memory, and mood that can be assessed with the Neurobehavioral Core Test Battery performance using the instrument digit symbol, digit span, pursuit aiming, and trial-making by the psychology team.

The entire article was published in the indexed journal SINTA. The results found that pesticide exposure is associated with neurobehavioral events in farmers. long time use of pesticides used for will affect the incidence of neurobehavioral disorders in farmers due to frequent exposure to substances that are neurotoxicants. Based on the four articles reviewed, the results of the description of the causes of neurobehavioral events in farmers due to long periods of work that are not balanced with rest have a higher risk of exposure. Below is shown a flow chart of Prisma data search results with the PICOS method and its explanation.

In the article, it is explained about the relationship of pesticide types with neurobehavioral symptoms, from research Meirindany, Indirawati and Marsaulina (2021) analyzing that pesticide types are related to neurobehavioral events in farmers with the results of the study showing that neurobehavioral effects can be experienced both by farmers who use organophosphorus pesticides and farmers who use non-organophosphorus pesticides because the active ingredients contained in pesticides are harmful to the health of the body. Farmers usually use neonicotinoid-class insecticides such as winder (imidacloprid) and Ares (nitenpyram); this type of pesticide contamination is dangerous because it causes dizziness, chest pain, nausea, and vomiting. This health problem arises due to the presence of anionic substances such as imidacloprid and other neonics, whose mechanism is almost the same as that of organophosphates. In other studies, organophosphate exposure over a long period will cause neurobehavioral effects in farmers.

The article also discusses the relationship of pesticide doses with neurobehavioral symptoms. Research by Pratama, Setiani and Darundiati (2021) analyzed that pesticide doses have a relationship with neurological symptoms in farmers. The dose of pesticides used by their respondents is pesticides with doses that are not in accordance with the rules listed on the package. They use measuring instruments that are not applicable in determining the dose of pesticides such as tablespoons, cups, and used plastic, and, based on the experience of respondents, if there are many pest attacks then the dose of pesticides is increased. Research conducted by Li et al. (2019) states that the use of pesticides in excessive doses can increase the risk of neurological dysfunction in farmers. Therefore, farmers must pay attention to the dosage of pesticides following the recommended rules listed on the packaging.

Furthermore, some articles also discuss the duration of spraying associated with neurobehavioral symptoms in farmers. Based on the analysis of the Meirindany, Indirawati and Marsaulina (2021) study, the results of the analysis of the relationship of the spraying duration variable with neurobehavioral effects obtained a P=1 value, which states that there is no relationship between spraying duration with neurobehavioral effects on red pepper farmers in Beringin District, these results are not in line with Rahmawaty et al. (2019) study that there is an effect of spraying duration with nervous system disorders in body balance and decreased cholinesterase levels in the blood.

DISCUSSION

The results from four past studies obtained that pesticide exposure is associated with neurobehavioral events in farmers, as seen from the results of research that has been done on neurobehavioral factors in farmers, namely the length of service, the type of pesticide used and the dose of pesticides. The author examines what distinguishes this study from other studies, namely this study concluded from various examples of research in Indonesia and abroad.

The article also explained that often farmers are not aware of the adverse effects caused by continuous exposure to pesticide and in high doses; therefore, the authors tried to summarize several related articles and found how the relationship of pesticide exposure causes disease in farmers, one of which is nervous disorders (Aji and Anantanyu, 2022).

Long-term exposure to pesticides on farmers can cause various problems of nervous system disorders which cause acetylcholinerase enzyme activity to be disrupted so that it affects the nervous system, such as attentional and cognitive disorders. Research conducted in Kepakisan Village banjarnegara found that a decrease in the enzyme acetylchonilerase

due to chronic exposure to organophosphate pesticides has a relationship with poor attention levels in potato farmers. Decreased acetylcholinerase activity affects the performance of the central and peripheral nervous system which causes a decrease in the alerting function or the function of selecting information from the input received.

Cognitive impairment can also occur due to the use of pesticides as evidenced from research conducted by Mustakim and Kas (2023) showing that exposure to pesticides in farmers can cause a decrease in cognitive function because it is related to pesticide spraying activities. Thus, the results of the study indicate that the occupational factor of spraying duration has a relationship with a decrease in cognitive function, inhibiting the performance of the enzyme acetylcholineserase in the blood which can cause disruption of the impulse delivery process in the nervous system, which causes cognitive impairment.

The last article discussed in this study was regarding the relationship between exposure to pesticides for vegetable farmers and neurobehavioral effects carried out (Mustakim and Kas, 2023).

From many studies reviewed, four articles were found in Western states and Central Indonesia because it has a distribution of fertile volcanic and alluvial soil and is very beneficial for the agricultural sector; therefore, most areas produce rice and wheat from Western and Central Indonesia.

This research is in line with research Gusti and Desnizar (2017) which shows a relationship between types of pesticides and neurotoxic symptoms, as well as research by Meirindany, Indirawati and Marsaulina (2021) which states that there is a relationship between types of pesticides and neurobehavioral effects in red chili farmers.

All articles reviewed describe the same type of neurobehavioral effect, such as research which discusses the type of short-term neurobehavior such as exposure to pesticides with mild symptoms such as dizziness and difficulty sleeping and long-term neurobehavioral types such as exposure to heavy pesticides causes neurological disorders in farmers, such as decreased memory, nervous system disorders in the balance of the body, and decreased levels of cholinesterase in the blood (Ramírez-Santana et al., 2020).

The strength of this research is that this research is rarely done in Indonesia, so it can be used as a reference for further research by taking the same topic, but with different methods. The weakness of this study is that some articles do not explain the specific relationship of pesticide exposure to neurobehavioral events in farmers (Pawestri and Sulistyaningsih, 2021).

CONCLUSION

The results of this study with the Systematic Literature review method get 4 articles with the results of 3 previous studies showing that there is a relationship between the period of work, long spraying and the type of pesticide used against neurobehavioral events in Farmers, 1 other study showed that the relationship is not significant that the duration of spraying, the period of work and the type of pesticide is not significantly related to neurobehavioral.

ACKNOWLEDGMENTS

Based on the systematic literature review analysis that has been done, the suggestions that can be given are expected to assist researchers to further develop this documentation study and compare it with other variables and to pay more attention to the methods used to search for data in the field so that the resulting data are more accurate.

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