



Pesticide Exposure Factors Related To Neurological Symptoms In Farmers Spraying Pesticides

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Abstract

Farmers use pesticides to avoid crop failure due to pest attacks. One of the bad effects of pesticides on health is that it can cause neurological symptoms. This study aims to determine the factor of pesticide exposure related to neurological symptoms in spraying farmers in the agricultural area of Sembalun Lawang, East Lombok district. This research is an observational study with a cross-sectional approach and conducted by interview. The research variables consisted of pesticide dose, spraying frequency, type of pesticide, duration of spraying, working period, and use of

PPE and spraying position. Data were analyzed by univariate, bivariate using chi-square test and multivariate using multiple logistic regression analysis. Pesticide exposure factors that have been shown to have a relationship with neurological symptoms include working period (p-value= 0.026), length of spraying (p-value= 0.025), frequency of spraying (p-value= 0.034), pesticide dose (p-value= 0.005), type of pesticide (p-value= 0.011) and completeness of PPE (p-value= 0.021). The variable that was proven to have the most dominant effect on neurological symptoms was the type of pesticide (OR=5.077, p-value=0.004).

Keywords: *neurological symptoms, pesticides, spray farmer*

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Introduction

The use of pesticides is almost inseparable from agricultural activities. The pesticide content of a mixture of chemicals is made to control or protect plants from pests and to control insect vectors. (Jonis, 2017). The use of pesticides can help farmers increase crop yields. Globally, pesticide use reaches 3.5 million tons per year. Until 2020, there are 4,380 pesticide brands in Indonesia and have been registered with the Ministry of Agriculture.(Kementan RI, 2020).

The use of pesticides can also cause exposure, especially when spraying pesticides. The toxic nature of pesticides can cause problems such as hepatic, cardiovascular, kidney damage, hormonal system disorders, respiratory system disorders, and neurological disorders. (Rohmah, 2019). Pesticides can inhibit the action of acetylcholinesterase, the enzyme that hydrolyzes acetylcholine into acetic acid and choline by binding to cholinesterase, so that acetylcholine can not forward impulse towards the receptor (Suhartono, 2021). One of the pesticides that has toxic properties because it can inhibit the function of acetylcholinesterase is organophosphate pesticides. (Vitianoza, 2021). The amount of toxicity organoposfat can be seen in the levels of acetylcholinesterase in the blood, low levels of acetylcholinesterase, which indicates the amount of toxicity work organoposfat in inhibiting acetylcholinesterase. (Erni, 2018). Pesticides can enter the body through the dermal route, inhalation, and ingestion. (Maksuk, 2021). Pesticides that have entered and are absorbed by the body will then go to target organs, one of which is the nervous system. Neurological symptoms are health disorders that occur in the nervous system, both the central nervous system and the peripheral nervous system as a result of exposure to toxic materials such as pesticides.(Dhamayanti, 2018).

The disturbed neurological system makes it difficult for farmers to concentrate, suffers from memory loss, dizziness, and headaches, as well as decreased ability to pay attention, a study showed that as many as 42 farmers (62.7%) experienced neurological symptoms due to exposure to pesticides by feeling complaints such as numbness in the hands and feet, often feeling palpitations, pain or tightness in the chest, and difficulty concentrating, and easy to forget. (Quezaada, 2017).

Based on a preliminary study conducted in April 2021, the 10 farmers observed were sprayed farmers who had worked as farmers for more than 10 years, farmers spraying in the morning and evening for 2-5 hours. Farmers spray pesticides according to the area of land to be sprayed with pesticides and the number of pest attacks. Farmers also admitted to mixing pesticides by hand. Of the 10 farmers observed, 9 of them did not wear complete PPE when spraying, so the potential for exposure and the amount of pesticides that enter the body will increase. In addition, based on the results of interviews using the German version of the Q18 questionnaire, 8 of the farmers stated that some health complaints were often felt, especially after carrying out agricultural activities, these symptoms were indicated as neurological symptoms such as frequent dizziness and headaches, nausea, irritability, I feel tightness in my chest and cramps in my hands. Therefore, it is necessary to research to determine the factors of pesticide



exposure associated with neurological symptoms in farmers spraying pesticides in the agricultural area of Sembalun Lawang, East Lombok Regency.

Methods

The approach used in this research is observational analytic with a cross-sectional study design. This research was conducted in Sembalun Lawang Village, Sembalun District, East Lombok Regency. The population in this study were all farmers spraying pesticides in Sembalun Lawang Village, amounting to 1,400 people. The sample size was calculated using the slovin formula, 94 spraying farmers was obtained. The sampling technique used *simple random sampling*. The research data was taken by conducting interviews and observations using the German Q18 questionnaire. The research data were analyzed by univariate analysis, bivariate using chi-square, and multivariate using multiple logistic regression

Results

This study aims to determine the factors of pesticide exposure associated with neurological symptoms in spraying farmers in the agricultural area of Sembalun Lawang, East Lombok Regency, with the variables studied, working period, length of spraying, spraying frequency, position of sprayer, pesticide dose, type of pesticide and completeness of PPE.

Table 1. Test the Relationship of Research Variables with Neurological Symptoms

Variable	Neurological Symptoms		Total	p-value
	Symptoms	Asymptomatic		
Years Of Service				
- Old (>10 Years)	39 (67.2%)	19 (32.8%)	58	0.026
- New ($\leq$ 10 Years)	15 (41.7%)	21 (58.3%)	36	
Long Time Spraying				
- Long (>2 Hours)	34 (69.4%)	15 (30.6%)	49	0.025
- Not Long ($\leq$ 2 Hours)	20 (44.4%)	25 (55.6%)	45	
Spraying Frequency				
- Often ($\geq$ 3 Times A Week)	42 (65.6%)	22 (34.4%)	64	0.034
- Not Often (< 3 Times A Week)	12 (40.0%)	18 (60.0%)	30	
Spraying Position				
- Not According To The Wind Direction	19 (57.6%)	14 (42.4%)	33	1,000
- According To The Wind Direction	35 (57.4%)	26 (42.6%)	61	
Pesticide Dosage				
- Not According To The Rules	42 (68.9%)	19 (31.1%)	61	0.005
- By The Rules	12 (36.4%)	21 (63.6%)	33	
Type Of Pesticide				
- Organophosphate	44 (66.7%)	22 (33.3%)	66	0.011
- Non-Organophosphate	10 (35.7%)	18 (64.3%)	28	
PPE Equipment				
- Incomplete	44 (65.7%)	23 (34.3%)	67	0.021
- Complete	10 (37.0%)	17 (63.0%)	27	



Table 1 shows that most of the neurological symptoms occurred in respondents with a working period of more than 10 years as many as 39 respondents (67.2%), spraying time of more than 2 hours as many as 34 respondents (69.4%), spraying frequency more than 3 times a week. as many as 42 respondents (65.6%), spraying position according to wind direction as many as 35 (57.4%), pesticide dose not according to the rules as many as 42 respondents (68.9%), type of organophosphate pesticides as many as 44 respondents (66.7%) and completeness of PPE as many as 44 respondents (65.7%). In table 1 it is also known that neurological symptoms are influenced by the long working period of spraying, spraying frequency, pesticide dose, and type of pesticide as well as the completeness of PPE as evidenced by $p\text{-value} < 0.05$. While the position of spraying does not affect neurological symptoms ($p\text{-value} = 1,000$).

Table 2. Neurological Symptoms In Spraying Farmers Based On The Answers To The German Of The Q18 Questionnaire

No	Question	Yes <i>n</i>	%	No <i>n</i>	%	Total <i>n</i>	%
1	Do you feel forgetful about what just happened?	70	74.5	24	25.5	94	100
2	Has anyone in your family said you often forget about things that just happened?	30	31.9	64	68.1	94	100
3	Do you often have to take notes about things that should not be forgotten?	51	54.3	43	45.7	94	100
4	Do you generally find it difficult to understand the contents of a letter/invitation/newspaper/reading book?	25	26.6	69	73.4	94	100
5	Are you having trouble concentrating?	55	58.5	39	41.5	94	100
6	Do you often feel irritable/emotional for no apparent reason?	48	51.1	46	48.9	94	100
7	Do you often feel sad/depressed for no apparent reason?	2	2.1	92	97.9	94	100
8	Do you often feel excessively tired out of the ordinary?	27	28.7	67	71.3	94	100
9	Have you ever felt your heart pounding without any pressure/doing anything?	49	52.1	45	47.9	94	100
10	Do you often feel tightness/pain like being pressed in the chest?	56	59.6	38	40.4	94	100
11	Are you sweating for no apparent reason?	22	23.4	72	76.6	94	100
12	Do you have frequent headaches in a week or so?	65	69.1	29	30.9	94	100
13	Do you often feel unwell?	17	18.1	77	81.9	94	100
14	Do you have numbness/numbness in your hands/feet?	69	73.4	25	26.6	94	100
15	Is there weakness/tiredness in your arms/legs?	53	56.4	41	43.6	94	100
16	Are your hands shaking (tremor)?	46	48.9	48	51.1	94	100
17	Are you used to drinking alcohol?	6	6.4	88	93.6	94	100



Table 2 shows the neurological symptoms experienced by the respondents obtained from the answers to the German version of the Q18 questionnaire. Table 2 shows that the most common neurological symptoms experienced by respondents include feeling forgetful about things or events that have just happened, experienced by 70 respondents (74.5%), feeling numb in the hands or feet experienced by 69 respondents (73.4%). , frequent headaches in a week or more experienced by 65 respondents (69.1%), often felt pain in the chest experienced by 56 respondents (59.6%), and difficulty concentrating experienced by 55 respondents (58.5%).

Discussion

Neurological Symptoms

The nervous system plays an important role in all human activities, the central nervous system is one of the nervous systems in humans found in the brain and spinal cord. Disorders that occur in the nervous system are often ignored by most people, if there are only slight symptoms or disturbances in the nervous system, it can become a serious problem for human health that can interfere with body functions such as stroke or other neurological functions disorders (Pratama, 2019), (Najihah, 2020).

Based on the results of research and data collection using the German version of the Q18 questionnaire, 53 spraying farmers (56.4%) experienced neurological symptoms with the most common symptoms felt by respondents, including feeling forgetful about things or events that had just happened (74.5%), had a headache in the past week (69.1%), felt numbness in the hands or feet (73.4%) and felt tightness or pain like being pressed in the chest (59.6%) and had difficulty concentrating (58.4%)). The symptoms felt by the respondents have been detailed according to the answers given in the German version of the Q18 questionnaire in table 2.

The Relationship Of Working Period With Neurological Symptoms

The results of data analysis in table 2 show that tenure has a relationship with neurological symptoms ($p\text{-value} = 0.026$). The working period is the duration or length of time passed by someone who has worked starting from the first day of work until the time the research is conducted, the longer a person's working period, the more potential exposure to hazards in the workplace. (Novianti, 2019). Duration or long working period as a farmer can increase the level of pesticide exposure in the sense that the working period is related to the more often a person is exposed to pesticides which makes farmers experience pesticide poisoning and causes other health problems. (Zulfania, 2017).

The results of the study with 58 respondents who had a working period of more than 10 years showed 39 respondents (67.2%) of whom experienced neurological symptoms, which means that the respondents answered yes to the Q18 questionnaire, namely 5 or more based on the symptoms they felt while working as farmers. Work related to the use of pesticides can cause a person to be exposed to pesticides and cause health problems, especially for farmers who have a long working period of more than 10 years, this can cause health problems, especially in the persistent nervous system. (Gangemi, 2016).



The Long-Standing Relationship Of Spraying With Neurological Disorders

The results of data analysis in table 2 show that the duration of spraying has a relationship with neurological symptoms ($p\text{-value} = 0.025$). Spraying pesticides is part of farmers' efforts to save crops from pests. Pesticide spraying is based on the area of land or area being sprayed and the number of pests that appear.

Based on the results of the study, 34 respondents (69.4%) sprayed pesticides for more than two hours and 20 respondents (44.4%). The large area of land and the large number of pests that appear are the reasons for farmers to spray pesticides for more than two hours. (Suparti, S, 2016). Long-term spraying of pesticides can increase the level of pesticide exposure to farmers' bodies (Suparti, S., 2021). Therefore, farmers should always pay attention to the length of time used in spraying a way to give the body a rest some time so that the body can be released from exposure to pesticides. (Isnawan, RM, 2013).

The Relationship Of Spraying Frequency With Neurological Symptoms

The results of data analysis in table 2 show that the frequency of spraying by farmers has a relationship with neurological symptoms ($p\text{-value} = 0.034$). It was found that 64 respondents (68.1%) sprayed pesticides more than 3 times a week. Table 2 shows that most of the respondents experienced neurological symptoms with the frequency of spraying more than 3 times a week.

The frequency of spraying pesticides is based on the number of pest attacks, the frequency of spraying will be more frequent if there are more pest attacks, especially in the rainy season, so that pesticide poisoning is also influenced by the frequency of spraying, if farmers spray pesticides more often, the risk of poisoning due to exposure to pesticides increases. (Budiawan, 2013). Research conducted by Ipmawati (2016) states that the frequency of pesticide spraying has an influence on poisoning, the effects can not always be felt directly, after exposure to pesticides, the toxins contained in pesticides will enter and accumulate in the body for a long time until someone suffers from chronic poisoning. (Ipmawati, 2016).

The Relationship Of Spraying Position With Neurological Symptoms

The results of data analysis in table 2 show that the spraying position has no relationship with neurological symptoms ($p\text{-value} = 1,000$). This is because most of the respondents spraying pesticides are always based on the wind direction, so the possibility of pesticide exposure can be reduced. A total of 61 respondents (64.9%) sprayed pesticides according to the wind direction, 35 respondents (57.4%) experienced neurological symptoms. This shows that the neurological symptoms that occur due to pesticide exposure are not influenced by the position of spraying, but the intensity of pesticide exposure caused by other exposure factors. Research by Ma'arif (2016) states that the position of spraying has no relationship with low cholinesterase levels in farmers. (Ma'arif, 2016).



The correct body position when spraying pesticides is by the direction of the wind. If pesticide spraying is done in the wrong position, then the sprayed pesticide can be inhaled because the pesticide blows towards the spraying farmer, so that it can increase the risk of pesticide poisoning and cause various health problems (Fauziyah, 2021).

Pesticide Dosage Relationship With Neurological Symptoms

The results of data analysis in table 2 show that pesticide dose has a relationship with neurological symptoms ($p\text{-value} = 0.005$). The dose of pesticides used by respondents in this study was known that as many as 61 respondents (64.89%) used pesticides with doses that were not in accordance with the rules stated on the pesticide packaging, 42 respondents (68.9%) experienced neurological symptoms.

The use of pesticides by farmers is usually based on previous experience as a farmer who used to use pesticides by calculating so that it cannot be ascertained the amount of pesticide used. (Fauziyah, R 2016). Respondents in this study used measuring instruments that were not valid in determining pesticide doses such as using tablespoons and used plastic cups. In addition, based on the respondent's experience, if there are more pest attacks, the pesticide dose will be increased, therefore the risk of pesticide exposure will also increase.

Research conducted by Li (2014) states that the use of excessive doses of pesticides can increase the risk of neurological dysfunction in farmers (Li, 2014). The use of doses that exceed the limit is said to be non-breeding, therefore farmers must pay attention to the doses of pesticides used in accordance with the rules listed on the pesticide packaging. The pesticide dose listed on the pesticide package is the recommended or recommended dose because it is more effective in controlling pests and can minimize the occurrence of environmental pollution due to pesticide contamination (Susanto, 2021).

The Relationship Between Types Of Pesticides And Neurological Symptoms

The results of data analysis in table 2 show that the type of pesticide has a relationship with neurological symptoms ($p\text{-value} = 0.011$). The results of this study are in accordance with research conducted by Gusti (2017) which states that the type of pesticide used by farmers has an influence on neurotoxic symptoms ($p\text{-value} = 0.002$). (Gusti, 2017).

Generally, respondents do not know the type of pesticide used, but only know the trademark of the pesticide, the pesticides commonly used are recommendations from other farmers. The results of interviews and observations showed that the types of pesticides commonly used by respondents in this study were organophosphate pesticides such as *Basudin*, *Curacron*, *Roundup*, *Orthene*, and *Profil*. A total of 66 respondents (70.2%) who used organophosphate pesticides, 44 respondents (66.7%) experienced neurological symptoms. Research conducted in the western part of Mexico in 2019 stated that exposure to organophosphate pesticides caused farmers to experience chronic poisoning resulting in a decrease in acetylcholinesterase activity which caused farmers to experience neuropsychiatric disorders in the form of anxiety, mild to severe depression. (Media, 2019).



The type of pesticide used determines the level of pesticide residue according to its physical and chemical properties. Organophosphate pesticides are synthetic pesticides which contain chlorpyrifos as the active ingredient. (Tuhumury, 2012). Pesticides enter the body through the respiratory tract, skin, and digestive tract. Organophosphate pesticides that enter the bloodstream will inhibit the work of the cholinesterase enzyme by attaching to cholinesterase so that acetylcholine cannot be broken down into acetate and choline, as a result, the nervous system is disrupted and causes the flow of nerve impulses to take place continuously. (Yusnani, 2013).

Relationship Of PPE Completeness With Neurological Symptoms

The results of data analysis in table 2 show that the completeness of PPE has a relationship with neurological symptoms ($p\text{-value} = 0.021$). A total of 67 respondents (71.28%) did not wear complete PPE when spraying pesticides, 44 respondents (65.7%) of whom experienced neurological symptoms. Personal protective equipment is equipment that is useful in protecting yourself from work accidents and other potential hazards. (Hayati, 2018). PPE that must be used by farmers, namely hand protection (gloves), headgear/hat, face-covering (mask), covered clothing such as long-sleeved shirts and trousers and boots. (Aeni, 2020).

The cause of respondents not wearing full PPE when spraying is because they think the use of PPE is not important, the reality in the field is that farmers only use head coverings such as hats or harps, long pants, and long-sleeved shirts, for other PPE it is considered to interfere with the comfort and slow down work because the process of using PPE can take time to carry out the spraying process, the types of PPE that are rarely used are masks, gloves, and long sleeves. If the completeness of PPE is neglected, the risk of exposure to pesticides will increase.

Pesticide exposure that most often occurs is through the skin and respiratory system, about 90% of pesticide poisoning cases in the world are caused by exposure to pesticides through the skin, exposure to pesticides through the respiratory system is the second cause of poisoning after exposure through the skin, besides that pesticide exposure can also occur through the eyes, and the mouth or digestive system. (Istianah, 2018). Research conducted in Ngurensiti Pati in 2014 stated that the use of incomplete PPE can affect cholinesterase levels in farmers spraying shallots, the health complaints felt by farmers after spraying pesticides are caused by reduced levels of cholinesterase in the blood. (Budiawan, AR, 2014). Therefore, it is very important to always pay attention to the completeness of PPE when carrying out agricultural activities, especially when spraying pesticides.

Conclusion

A total of 54 respondents (57.4%) experienced neurological symptoms, namely answering yes to the German version of the Q18 questionnaire as many as 5 or more. The most common neurological symptoms include feeling forgetful about things or events that have just happened, feeling numb in your hands or feet, having headaches for a week or more, and feeling tightness or pain like being pressed in the chest, and difficulty concentrating.



There is a relationship between working period, length of spraying, spraying frequency, pesticide dose, type of pesticide, de and completeness of PPE with neurological symptoms and there is no relationship between spraying position and neurological symptoms. The most influential pesticide exposure factor based on the results of the multivariate analysis was the type of pesticide (OR=5.077, *p-value* = 0.004), meaning that spraying farmers who used organophosphate pesticides had a 5 times greater risk of experiencing neurological symptoms than spray farmers who did not use organophosphate pesticides.

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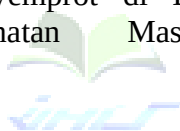
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