The Indonesian Journal of Occupational Safety and Health
2024, 13 (2): 182-193
p ISSN: 2301 8046, e ISSN: 2540 7872
http://doi.org10.20473/ijosh.v13i2.2024.182-193

ORIGINAL ARTICLE

Mild Cognitive Impairment Associated with Pesticides use Among Vegetable Farmers and Their Wives in Sukorambi Village Jember Regency

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ABSTRACT

Introduction: Mild Cognitive Impairment (MCI), according to several studies, has been discovered to be related to exposure to pesticides. Sukorambi Village is the largest vegetable producer village in Jember Regency and pesticides are used in the vegetable cultivation process. This study aimed to analyze the relationship between the age of vegetable farmers and the frequency of pesticide spraying with the incidence of MCI and to analyze differences in the incidence of MCI in farmers and their wives. **Methods:** This research is an analytical research with a cross-sectional design which was carried out in Sukorambi Village, from June to December 2022. The samples of this research are 142 people, obtained from a proportional stratified random sampling technique and represented groups of farmers in each hamlet. In this case, the research variables include age, frequency of pesticide spraying, as well as the incidence of MCI in vegetable farmers and their wives. Data were further collected through direct interviews, which were then analyzed through bivariate analysis using Spearman and paired t tests. **Results:** The results showed that the majority of vegetable farmers were above 55 years old and most of them sprayed pesticides for 3-4 and 5-6 times a month. Most farmers and their wives experience MCI. **Conclusion:** The farmer's age and the frequency of spraying pesticides are related to the incidence of MCI in farmers. There is a significant difference between the incidence of MCI in vegetable farmers and their wives, where MCI is more experienced by vegetable farmer wives.

Keywords: farmer, mild cognitive impairment, pesticide

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INTRODUCTION

Efforts to meet the food needs of the community certainly require agricultural machinery, agricultural equipment, fertilizers, and pesticides to support optimal agricultural production processes (Dewi, Utama and Yuliarmi, 2017). In practice, the use of pesticides is very common in agriculture to protect plants from the attacks of pests, weeds, fungi, viruses, bacteria, and diseases that can reduce the quality and quantity of the agricultural production. The Food and Agriculture Organization (FAO) noted that in 2019, there were 4.2 million tons of global pesticide use in agriculture. The World Health Organization (World Health Organization) also estimated that the use of pesticides in developing countries, especially the Asian continent, has increased by around 20% (Sharma *et al*., 2019). As a work sector with the highest exposure to pesticides, farmers are at risk of being directly exposed to pesticides when carrying out the process of mixing pesticides, spraying pesticides, and washing pesticide spray equipment (Mahyuni *et al*., 2021). This can have a negative impact on the health of farmers, agricultural commodities, and the surrounding environment (A'yunin, Achdiyat and Saridewi, 2020; Nurika *et al*., 2022). Farmers who are exposed to pesticides for a long time have the potential to experience pesticide poisoning and other health problems (Damalas and Koutroubas, 2016; Boedeker *et al*., 2020).

The World Health Organization (WHO) estimated that as many as twenty-five million cases of pesticide poisoning occur in developing countries in Asia (Mayasari, 2017). The National Poisoning Information Center (SIKerNas) recorded that there

Cite this as: *Fidiyaningrum, R., Sujoso, A. D. P. and Idrayani, R. (2024) 'Mild Cognitive Impairment Associated with Pesticides use Among Vegetable Farmers and Their Wives in Sukorambi Village Jember Regency', The Indonesian Journal of Occupational Safety and Health, 13(2), pp. 182-193.*

 doi:10.20473/ijosh.v13i2.2024.182-193. Received October 05, 2023; 1st revision June 10, 2024; 2nd revision June 25, 2024; Accepted July 10, 2024; Published: August 2024. Published by Universitas Airlangga.

were 771 cases of poisoning due to pesticides in 2016. In this case, pesticides provide both acute and chronic effects for exposed individuals. The effects of acute effects due to exposure to pesticides include skin irritation, nausea, and dizziness. Meanwhile, the impact of chronic effects can cause health problems for farmers such as anemia, hypertension, diabetes mellitus, hypothyroidism in women, disorders of the female reproductive system, impaired male fertility, and disorders of the nervous system (Pratama, Setiani and Darundiati, 2021).

One of the chronic nervous system disorders due to exposure to pesticides is Mild Cognitive Impairment (MCI). MCI represents the early phase of a cognitive impairment. MCI is characterized by cognitive function that is below normal but does not interfere with daily activities and is not sufficient to be diagnosed as dementia (Lamptey *et al*., 2022). Someone with MCI has cognitive complaints criteria, such as having one or more cognitive functions that are not in accordance with the age, a decrease in one or more aspects of cognitive function, functional activity is within normal limits, and no dementia (Jongsiriyanyong and Limpawattana, 2018). This happens due to excessive exposure to pesticides that can interfere with the performance of the cholinesterase enzyme which can affect the nervous system. The workings of pesticides which continuously suppress the cholinesterase enzyme are irreversible. The inhibition of the work of the cholinesterase enzyme causes failure in hydrolyzing acetylcoline which functions to continue nerve stimulation to muscle and gland cell receptors. If this condition occurs continuously, cognitive impairment cannot be avoided (Dewi, Utama and Yuliarmi, 2017). MCI can be detected using the Montreal Cognitive Assessment (MoCA) test. The use of the MoCA instrument is more sensitive in detecting mild cognitive impairment compared to other similar instruments (Nurfadia *et al*., 2021).

Mild cognitive impairment in farmers as a result of the use of pesticides was proven in a study by Indrayani *et al*. (2020) on tobacco farmers. It was found that 73% of tobacco farmers in Jember Regency experienced Mild Cognitive Impairment (MCI) from a total of 200 samples studied. The variable related to the incidence of MCI in this study was the duration of pesticide spraying in one day. Dewi, Utama and Yuliarmi (2017) on citrus farmers in Sukoreno Village, Jember Regency further also showed that 39.1% of orange farmers experienced MCI. In another study, the incidence of MCI in pesticide-using farmers in Sumowono District, Semarang Regency was 63% of a total of 100 samples (Sari, 2020). In this case, pesticide exposure does not only affect farmers who have direct contact with pesticides, but also other people who experience indirect contact with pesticides. Residues from pesticides that stick to all parts of the plant can pose a risk of harm to farmers or the wider community, such as the farmer's wife who carries out activities in the fields, for example cleaning weeds and harvesting the planted commodities (Tyrell, Willis and Guadagnini, 2020). A study in Chile also stated that exposure to pesticides, both directly and indirectly, can affect cognitive function decline in farmers (Silva *et al*., 2019). The impact of exposure to pesticides does not only affect farmers, but also their wives. Research conducted by Werder *et al*. (2020), stated that farmers' wives in Iowa and North Carolina involved in agricultural work experience considerable exposure to various kinds of pesticides, including herbicides, fumigants, and fungicides. Pesticides exposure to farmer's wives can occur in the fields or at home. Exposure when in the field occurs during the process of cultivating crops such as planting, weeding, picking leaves, harvesting. and packaging the crops (Andersson and Isgren, 2021; Martin-Reina *et al*., 2021). Meanwhile, pesticides exposure to farmer's wives at home is related to their duties in the household including washing contaminated clothing and equipment, storing pesticides, and disposing of used pesticide containers. Another study on onion farmers in Ngablak Village, Central Java, found that 71.02% of the farmers' wives were poisoned by organophosphate pesticides (Prijanto, 2009).

One type of plant that requires pesticides is vegetable plants. Vegetable crops are very vulnerable to the attack of Plant Pest Organisms (OPT), which are the enemies of vegetable farmers, including tritip caterpillars, crop caterpillars, and armyworms (Fajriani, Aeni and Sriwiguna, 2019). Jember Regency is one of the areas suitable for growing various types of vegetables and has great potential in the production of various types of vegetables. One of the areas in Jember Regency, namely Sukorambi District, particularly Sukorambi Village, is a center for the production of kale vegetables in Jember Regency (Wildan, Santoso and Kusuma, 2018). Apart from kale, Sukorambi Village is also known as the largest mustard producer in Jember Regency. According to the main supplier of vegetables in Jember Regency (Afif and Kusmiati, 2020), the use

of organophosphate class of pesticides in Sukorambi Village is higher than other villages. Interviews with vegetable farmers during the preliminary study found that farmers experienced several complaints related to acute symptoms of organophosphate pesticide poisoning such as headaches, watery eyes, and nausea. This fact shows that it is very likely that vegetable farmers will also experience chronic impacts from the exposure to organophosphate pesticides. This study further aimed to analyze the relationship between farmer age and pesticide spraying frequency with the incidence of MCI in vegetable farmers. In addition, this study also analyzed the differences in the incidence of MCI in vegetable farmers and their wives who usually help their husbands in the fields. The involvement of farmers' wives in the vegetable cultivation process in Sukorambi Village has been proven through observations in preliminary research. This involvement includes cleaning weeds, removing young plant seeds, harvesting and tying plants.

METHODS

This research was an analytic research with cross-sectional design. The research was conducted in Sukorambi Village, Sukorambi District, Jember Regency from June to December 2022. The population in this study were vegetable farmers whose wives actively helped in the fields, totaling 325 people. Furthermore, the sample in this study were 142 people divided into 71 farmers and 71 farmers' wives. Sampling was carried out using a proportionate stratified random sampling technique so that it was evenly distributed in each hamlet and farmer groups (Table 1).

Furthermore, the variables in this study include farmer's age, frequency of spraying pesticides, the incidence of MCI in vegetable farmers, and the incidence of MCI in vegetable farmers' wives. The categorization of frequency of spraying pesticides was based on previous research on the relationship between pesticides exposure and MCI (Indrayani *et al*., 2020). Data were collected through direct interviews. MCI measurement used the Indonesian language Montreal Cognitive Assessment (MoCA-Ina) instrument whose validity and reliability have been tested in the previous research conducted by Panentu and Irfan (2013). MoCA-Ina consists of 30 questions divided into eight cognitive domain assessments, namely: visuospatial/executive function (5 points), naming (3 points), memory and attention (6 points), language (3 points), abstraction (2 points), delay recall (5 points), and orientation (6 points). Bivariate analysis was also carroed out on the data obtained using Chi-square, Spearman and paired t-test. In addition, this research has received ethically proper assessment and approval from the Health Research Ethics Committee, Faculty of Public Health, the University of Jember with ethical review number No. 187/KEPK/FKM-UNEJ/V/2022.

Table 1. Distribution and Number of Research Samples

Hamlet	Farmers Group	Sample
Krajan	Sejahtera	104/266 x 71 = 28
	Sari Alam	7/266 x 71 = 2
Manggis	Sukorambi Jaya	93/266 x 71= 25
	Hasil Bumi	42/266 x 71 = 11
Curahdami	Cahaya Terang	6/266 x 71 = 2
	Nurussa'adah	9/266 x 71 = 2
	Trisno Maju	5/266 x 71 =1
Total		71

RESULT

Frequency Distribution of Farmer's Age

The results of interviews concerning the age of vegetable farmers in Sukorambi Village, Jember Regency are shown in Table 2. Based on Table 2, it is known that the majority of the respondents were at the age of 36-45 years old by 35.2%.

Frequency Distribution of Variable Pesticide Spraying Frequency

The results of interviews concerning the frequency of spraying pesticides on vegetable farmers in Sukorambi Village, Jember Regency are shown in Table 3. Based on Table 3, it is known that the most frequency of pesticide spraying by

Table 2. Distribution of Respondents' Age Frequency in Sukorambi Village in June 2022

Age	Frequency (n)	Percentage (%)
>55 years	12	16.9
46-55 years	24	33.8
36-45 years	25	35.2
26-35 years	9	12.7
18-25 years	1	1.4
Total	71	100.0

vegetable farmers in Sukorambi Village, Jember Regency is 3-4 times/month (31%) and 5-6 times/month (31%). Furthermore, another frequency showed that the spraying was carried out more than 6 times/month by 14.1% of respondents. In this case, the frequency of spraying pesticides by vegetable farmers is highly dependent on pest attacks and also the weather season.

Frequency Distribution of MCI Incidents among Vegetable Farmers and Vegetable Farmers' Wives

The incidence of MCI in vegetable farmers and vegetable farmer wives, based on the results of measurements using the MoCA instrument is shown in Table 4. Based on the Table, it is known that the majority of vegetable farmers (54.9%) and their wives (74.6%) experienced MCI.

Relationship between Farmer Age and MCI Incidence in Vegetable Farmers

The results of the bivariate analysis between the variable farmer's age and the incidence of MCI are presented in Table 5. Based on Table 5, it is known that the p-value of the relationship analysis using the Spearman correlation test is <0.0001 (<0.05). This means that there is a relationship between farmer age and the incidence of MCI in vegetable farmers in Sukorambi Village, Jember Regency. The correlation coefficient value is 0.453, which means that the age variable and the incidence of MCI in vegetable farmers have a positive relationship. This means that the older a person is, the more MCI occurs in vegetable farmers in Sukorambi Village. The correlation coefficient value of 0.453 can indicate the level of strength of the relationship between the age variable and the incidence of MCI on vegetable farms, which is quite strong.

Relationship between Pesticide Spraying Frequency and MCI Incidence in Vegetable Farmers

The results of the bivariate analysis between the variable frequency of spraying pesticides

Table 3. Frequency Distribution of Pesticide Spraying

Pesticide Spraying Frequency	Frequency (n)	Percentage (%)
>6 times/month	10	14.1
5-6 times/month	22	31.0
3-4 times/month	22	31.0
1-2 times/month	17	23.9
Total	71	100.0

Table 4. Distribution of Frequency of MCI Events among Farmers and Farmers' Wives

MCI Incidence	Frequency (n)	Percentage (%)
Farmers		
Yes	39	54.9
No	32	45.1
Farmer's Wife		
Yes	53	74.6
No	18	25.4
Total	71	100.0

Table 5. Relationship between Farmer Age, Pesticide Spraying Frequency and MCI Incidence in Vegetable Farmers

Independent Variable	MCI Incidence				Total		p-value	r
	Yes		No					
	n	%	n	%	N	%		
Age								
>55 years	22	31.0	4	5.6	26	36.6		
46-55 years	12	16.9	15	21.1	27	38.0	< 0.001	0.453
36-45 years	3	4.2	10	14.1	13.0	18.3		
26-35 years	2	2.8	3	4.2	5.0	7.0		
Pesticide Spraying Frequency								
>6 times/month	6	8.5	4	5.6	10	14.1		
5-6 times/month	17	23.9	5	7.0	22	31.0	0.037	0.249
3-4 times/month	9	12.7	13	18.3	22	31.0		
1-2 times/month	7	9.9	10	14.1	17	23.9		

and the MCI incident are presented in Table 6. Based on Table 6, it is known that the p-value of the relationship analysis using the Spearman correlation test is 0.037 (<0.05). This means that there is a relationship between the frequency of spraying and the incidence of MCI in vegetable farmers in Sukorambi Village, Jember Regency. The correlation coefficient value is 0.249 and shows a positive direction. This means that the more the frequency of spraying pesticides by vegetable farmers in Sukorambi Village, the more vegetable farmers experience MCI events. In this case, the correlation coefficient value of 0.249 is included in the weak category.

Differences between the Incidence of MCI in Vegetable Farmers and the Incidence of MCI in the Wives of Vegetable Farmers

The results of the bivariate analysis between the farmer's MCI event variable and the MCI event in the farmer's wife are presented in Table 6. Based on Table 6, it is known that the p-value of the comparative analysis using paired t-test is 0.014 (<0.05). This means that there is a difference between the incidence of MCI in vegetable farmers and the incidence of MCI in the wives of vegetable farmers in Sukorambi Village, Jember Regency. The incidence of MCI is more experienced by the wives of vegetable farmers than the vegetable farmers themselves.

DISCUSSION

Frequency Distribution of Farmer's Age

The older someone age, the more decrease their metabolic functions. Getting older is a natural thing and old age is the final phase of life. In this phase, a person will experience a gradual decline in physical, social, and mental functioning (Howes *et al*., 2020; Castro *et al*., 2022). Mental changes that are often experienced by the elderly include changes in personality, memory, and in intelligence as a result of developments in the outside world, increased age, geographical factors, social pressure, social support, gender, and work (Ramli and Masyita Nurul Fadhillah, 2022). Age is also closely related to cholinesterase activity which is decreasing (Wicaksono, Widiyanto and Subagiyo, 2018). The cholinesterase enzyme is an enzyme in the intracellular fluid that functions to stop the action of acetylcholine by hydrolyzing acetylcholine into choline and acetic acid. Acetylcholine itself functions as a nerve agent in the central nervous system, autonomic nervous system, and somatic nervous system (Marisa and Pratuna, 2018). If the activity of the cholinesterase enzyme is disrupted as a result of excessive use of pesticides and increasing age, it can inhibit the rate of delivery of stimulation to the nerves and in the long term, it will cause cognitive impairment (Aloizou *et al*., 2020).

The chronic effects of pesticide exposure that usually appear in old age can actually be prevented by using PPE (Abdollahzadeh and Sharifzadeh, 2021). Unfortunately, based on researchers' observations, the majority of research respondents did not use PPE. The PPE required during pesticides application includes a hat, protective glasses, respirator/mask, rubber gloves, long-sleeved shirt, trousers and boots (Okoffo, Mensah and Fosu-Mensah, 2016). According to the characteristics of the respondents of this study who are workers in the informal sector, PPE can be provided independently or through Pos Upaya Kesehatan Kerja (POS UKK) which are established in vegetable farming communities under the guidance of local health centers (Dharmawan *et al*., 2018).

Table 6. Differences in the Incidence of MCI in Vegetable Farmers and Wives

	MCI Incidence				Total		p-value
	Yes		No				
	n	%	n	%	n	%	
Farmers	36	54.9	32	45.1	71	100.0	0.014
Farmer's Wife	53	74.6	18	25.4	71	100.0	

Frequency Distribution of Variable Pesticide Spraying Frequency

The large number of spraying carried out by farmers in 1 month is the definition of the spraying frequency in this study. This variable is an important variable in the research on the effects of chronic exposure to pesticides considering that previous research has mentioned this (Perwitasari *et al*., 2017). The results of the interviews showed that the majority of vegetable farmers in Sukorambi Village sprayed pesticides by 5-6 times and 3-4 times in one month or one vegetable harvest, namely 22 people each.

Vegetable plants have an average harvest period of around 25-30 days from the time the seeds are spread until they are ready for harvest, so the

calculations in this study are based on 1 vegetable harvest (Nuramadani and Susanti, 2022). Vegetable farmers in Sukorambi Village sprayed based on 2 conditions, namely spraying to prevent pests or spraying when pests had attacked. This makes the frequency of spraying by farmers relatively different. Research by Halisa, Ningrum and Moelyaningrum (2022) stated that the closer the distance to spraying pesticides, the more often the exposure will be experienced and will accumulate in the body and affect cholinesterase levels in the blood, especially for farmers who have direct contact with pesticides. Therefore, if possible, the use of pesticides should be minimized by spraying to prevent pest attacks and not waiting until pests have attacked plants. Spraying too late when pests have attacked can make it difficult to control pests so farmers tend to increase the dose and frequency of pesticide use (University of California Agriculture and Natural Resources, 2019).

Distribution of Frequency of MCI Events in Vegetable Farmers and in Vegetable Farmers' Wives

MCI is a condition in which a person has a cognitive score below normal but has no effect on daily activities (Andersson and Isgren, 2021). Cognitive impairment is the initial stage of a person experiencing even worse cognitive impairment such as dementia and Alzheimer's. Early detection of cognitive impairment can be carried out using the Indonesian version of the standardized Montreal Cognitive Assessment (MoCA) questionnaire. The MoCA questionnaire had previously been tested for validity and reliability between the original version from English to Indonesian. As for several assessment points from the MoCA for detecting MCI in a person including executive function, naming, memory, language, abstraction, delayed recall, and orientation (Nurfadia *et al*., 2021).

The implementation of the Indonesian version of the MoCA test on vegetable farmers and their wives in Sukorambi Village, Jember Regency, found that more farmers' wives experienced MCI than vegetable farmers. It can be seen that there were 39 vegetable farmers who experienced MCI, while the wives of vegetable farmers were 53 people out of a total sample of 71 people. This means that there are more cases of MCI among wives than the vegetable farmers themselves. In other words, it can be said that more female respondents in this study experienced MCI compared to male respondents. This is interesting matter because it is not in line with the previous research investigating the relationship between gender and the effects of exposure to organophosphate pesticides. In previous research, it was said that men are more susceptible to exposure to organophosphate pesticides than women, even in the womb (Comfort and Re, 2017; Wang *et al*., 2022). It was known from experimental research using experimental animals (rats) that male rat show the greatest deficit and the weakest inhibition of AChE in plasma after exposure to organophosphate pesticides. Additionally, compared to male rat, female rat had increased plasma PON1 activity, a key xenobiotic metabolic enzyme involved in the detoxification of organophosphate pesticides that may protect females from neurotoxicity (Voorhees *et al*., 2019)

The high incidence of MCI among vegetable farmer wives in Sukorambi Village could occur because the farmer's wife has a dual role as a housewife who has many activities not only in the fields but also doing housework. This was also mentioned in the research by Choi, Moon and Roh (2020) that neurotoxic symptoms result from chronic effects because women have a dual role in carrying out activities at home and in the fields and have longer working hours. Research by Firdaus, Nur and Purnomo (2021), which was conducted on workers at the PT X plantation, Cianjur Regency, further found that 14 people out of 30 respondents experienced chronic pesticide exposure and felt neurobehavior disorders. There is a significant relationship between neurobehavorial disorders and exposure to pesticides at the PT X Cianjur plantation as measured using the German Q18 questionnaire which contains questions that refer to cognitive disorders such as memory, concentration and mood.

Relationship between Farmer Age and MCI Incidence in Vegetable Farmers

Age is a measure of time in years since a person was born into the world. Increasing age can affect the decline in body function. MCI is also known as one of the most common diseases in the elderly, and can increase the risk of dementia (Andersson and Isgren, 2021). In addition, for types of work with a high risk of exposure to chemicals, such as pesticides, it can exacerbate the decline in metabolic function in the farmer's body. Theoretically, according to Ancient in Vutrianingsih, Zulfa and Mukono (2020), as we get older, the physiological and metabolic functions of the body will also decrease. As a

result, cholinesterase levels also decrease, thereby increasing the risk of pesticide poisoning in people who are exposed.

Cross tabulation in this study shows that the incidence of MCI tends to occur in the older age group, namely above 55 years old. The results of the correlation analysis between age and the incidence of MCI obtained a p-value of 0.000 <0.05, which means H0 was rejected so it can be concluded that there is a relationship between age and the incidence of MCI in vegetable farmers in Sukorambi Village, Jember Regency. In line with this research, Oktaviani and Pawenang (2020) also stated that people in their older age will have a tendency to experience MCI because the activity of the cholinesterase enzyme in the body decreases. The age variable with the incidence of MCI in vegetable farmers in Sukorambi Village also has a positive relationship direction of 0.453. This means that the older the vegetable farmers are, the higher the risk of MCI incidence. The older the age of farmers with decades of working experience, the more exposure to pesticides they get and it will accumulate in the body and increase the risk of chronic pesticide poisoning. Research by Oktaviani and Pawenang (2020) conducted on greenhouse farmers in Badungan District, found that there was a relationship between age and the incidence of pesticide poisoning among chrysanthemum flower and vegetable farmers (p-value 0.035). This happens as someone gets older, since there will be a decrease in the amount of hormones in the body and the function of the organs of the body so that the immune system can decrease. Research conducted by Hermawan, Widjasena and Kurniawan (2018) also revealed that there is a relationship between cholinesterase levels in guava farmers in Pesaran Village, Sukorejo District, Kendal Regency (p-value 0.001).

However, research by Wicaksono, Widiyanto and Subagiyo (2018) which was conducted on potato farmers in Wonosobo Regency was not in line with the results of this study, namely that there was no relationship between age and cholinesterase enzyme levels. This happens because the activities of farmers in the field with different age categories, there are no visible differences as in the process of mixing various brands of pesticides and using incomplete PPE. The function of the cholinesterase enzyme is to keep muscles, glands and nerve cells working in an organized manner, so that if the cholinesterase enzyme is disturbed for years it can cause chronic effects of cognitive impairment. Efforts that can be made to reduce the risk of MCI occurring in vegetable farmers in Sukorambi Village, especially in the age group above 55 years old, are consuming nutritious food especially foods rich in antioxidants, and being able to reduce activities related to activities in contact with pesticides (Wahyuni and Nisa, 2016; Sule, Condon and Gomes, 2022).

Relationship between Pesticide Spraying Frequency and MCI Incidence in Vegetable Farmers

The frequency of spraying in this study was the amount of spraying carried out by vegetable farmers in one month or 1 vegetable harvest period. The average length of the process from sowing the vegetable seeds until they are ready for harvest is around 25-30 days depending on the type of vegetables planted. The results showed that the more often farmers spray pesticides, the higher exposure to pesticide chemicals the farmers will get. The frequency of spraying and the use of excessive doses of pesticides will increase the risk of pesticide poisoning in vegetable farmers. This is because the frequency and duration of exposure affects the internal dose of exposure to chemicals including pesticides (Kurniawidjaja *et al*., 2021).

The results of the relationship analysis using the Spearman correlation test obtained a p-value of 0.037, which is <0.05. Therefore, H0 is rejected, so it can be concluded that there is a relationship between the frequency of spraying and the incidence of MCI among vegetable farmers in Sukorambi Village, Jember Regency. In this case, the correlation coefficient value obtained is 0.249 which is positive so that the more spraying frequency, the more MCI events in vegetable farmers. These results are in line with previous research by Perwitasari *et al*. (2017) on farming communities in Yogyakarta, Indonesia who used pesticides. Spraying pesticides carried out by vegetable farmers in Sukorambi Village, Jember Regency was carried out as an effort to prevent vegetables from pests and to exterminate pests.

There are farmers who spray before the pests attack and there are also farmers who spray while waiting for the pests to attack their vegetables. This is what causes variations in the frequency of spraying carried out by vegetable farmers in Sukorambi Village, Jember Regency. Regarding the difference in spraying times, several guidelines state that the more appropriate time to spray pesticides is before a pest attack occurs (preventive), not after a

pest attack occurs (curative) (Dinas Pertanian Tulang Bawang, 2019; University of California Agriculture and Natural Resources, 2019).

The results of this study are in line with the research carried out by Hardi, Ikhtiar and Baharuddin (2020) on the vegetable farmers in Janetallasa Village, Makassar, revealing that the frequency of spraying pesticides has a relationship with cholinesterase activity. Others study stated, the more often farmers spray pesticides by do not pay attention to the right dose, and do not use complete PPE, the more it will accumulate in the farmers' bodies, causing the risk of chronic poisoning (Joko, Dewanti and Dangiran, 2020; Pawestri and Sulistyaningsih, 2021; Lari *et al*., 2023). Research by Sari (2020) also states that there is a relationship between the frequency of spraying and the incidence of MCI. However, there is research by Fajriani, Aeni and Sriwiguna (2019) which is not in line with the research already mentioned, that is, there is no relationship between the frequency of spraying and the blood cholinesterase levels of farmers in Pasirhalang Village, West Bandung Regency. Farmers there spray more than 2 times in 1 week because of pests that can damage plants and cause losses.

Efforts that can be made by the vegetable farmers in Sukorambi Village, Jember Regency in spraying pesticides are adjusting the distance between the time of the first spraying and subsequent spraying, paying attention to the dose of pesticides used, using complete PPE, and implementing good personal hygiene practices to reduce long-term risks and avoid health problems.

Differences between the Incidence of MCI in Vegetable Farmers and the Incidence of MCI in the Wives of Vegetable Farmers

The results of the analysis using the comparative test using the paired t-test yielded a p-value of 0.14 (<0.05), so this study concluded that there was a difference between the incidence of MCI experienced by farmers and their wives. This is an interesting finding considering that the incidence of MCI was found to be more experienced by the wives of farmers than the farmers themselves as the main actors in vegetable farming. Most of the stages of work in vegetable cultivation include seed preparation, seeding, land preparation, fertilization, shelter, maintenance, control of plant-disturbing organisms, and harvesting and post-harvesting, that are carried out by farmers. In this case, the role of the wife only helps the farmers, such as cleaning weeds, moving young plant seeds, harvesting and tying the crops. As far as researchers know, there has been no research that examines the incidence of pesticide exposure and the incidence of MCI in farmers' wives. In previous studies, exposure to pesticides in farmers' wives was associated with other health impacts such as depression and breast cancer (Beseler *et al*., 2006; Werder *et al*., 2020).

Researchers through field observation on the respondents found that in one field managed by the same respondent, there were variations in the types of vegetables and the age of vegetable plants in each plot. These types of vegetables include mustard greens, basil, kale, marigolds, and spinach. The types of vegetables and the age of the plants determine the stages of cultivation carried out by farmers, so that differences in the types and ages of vegetable plants cause the land to be managed by the farmer and his wife. Based on the observations, it is known that farmers often spray pesticides together with other activities by the farmer's wife, such as removing weeds and transferring young plant seeds to new holes. The distance between spraying pesticides and the farmer's wife can be said to be close, with the closest distance being only 3 meters, allowing the farmer's wife to be exposed to pesticides through the air or through skin contact with the plants sprayed with pesticides. This is in line with the research conducted previously (Markantonis *et al*., 2018), that the exposure to pesticides experienced by farmers who carry out plant maintenance such as pruning, thinning, and harvesting, is the same as that of farmers who mix and spray pesticides. During pesticide spraying, droplet size also plays an important role in the movement of spray particles (aerosols) away from the spray site. Small droplets are lighter so they can float in the air and be blown around the spraying area so that there is a greater

Figure 1. Activities of Farmers and Farmers' Wives in the Field

risk of exposure to workers in the area around the spraying area (Boonupara *et al*., 2023).

The size of the pesticide droplet is greatly influenced by the pressure on the sprayer used by the farmer. Therefore, it is recommended to spray pesticides as close as possible to the target plants (Riyaz, Ahmad Shah and Sivasankaran, 2022). Apart from droplets, other factors that can affect the movement of spray particles are the type and angle of the sprayer, the height of the spray, wind speed and direction, as well as humidity and temperature (Kruger, 2019).

After spraying, farmers often move places while the farmer's wife stays in a position adjacent to the plants that have been sprayed in a sitting/squatting position on the ground for a longer time (Figure 1). This allows the farmer's wife to be exposed to pesticides, even longer than the farmer himself so that the impact of pesticide exposure including MCI is experienced more by the farmers' wives than the farmer themselves. As previously explained, the length of time or duration of exposure will affect the internal dose of pesticide in the farmers' wives' body (Kurniawidjaja *et al*., 2021). Based on the results of interviews, it is known that farmers have never received education regarding safe farming practices. Therefore, both vegetable farmers and their wives in Sukorambi Village need education regarding safe farming practices so that they can reduce the risk of chronic pesticide poisoning such as cognitive impairment.

CONCLUSION

The results show that the majority of vegetable farmers were above 55 years old and the most frequent pesticide spraying carried out by the vegetable farmers is 3-4 and 5-6 times a month. In this case, most farmers and farmers' wives experience MCI. Based on the correlation analysis test, it is concluded that the farmer's age and the frequency of pesticide spraying were related to the incidence of MCI in farmers. In addition, through a correlation test, it was concluded that there was a significant difference between the incidence of MCI in farmers and vegetable farmer wives, where MCI was more experienced by vegetable farmer wives. Suggestions that can be given based on these findings are for the relevant agencies, in this case the Department of Food Crops, Horticulture and Plantation, Jember Regency, to be able to provide regular counseling with Field Extension Farmers (PPL) regarding the use of pesticides that are good and correct, as well as carry out routine health tests. to farmers and their wives periodically and provide recommendations with the local health center.

ACKNOWLEDGEMENTS

This research is financially supported by Grant of Thesis Reworking, Institute for Research and Community Service, Universitas Jember.

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