

Risk Factors for Pesticide Poisoning in Horticultural Farmers in the Agricultural Area of West Seram Regency, Indonesia

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ABSTRACT

Background: In the field of environmental health, pesticide poisoning is still an important health problem in agricultural areas, especially horticultural agriculture, as a result of the risky habit of using pesticides. This study aimed to analyse the risk factors for poisoning in horticultural farmers in West Seram District, Indonesia.

Methodology: This study applied a cross-sectional design, involving 298 farmers selected by proportional random sampling technique. The risk factors studied included tenure, the use of personal protective equipment, duration of spraying, frequency of spraying, number of types of pesticides, method of mixing, direction of spraying, and dose of pesticides, smoking while spraying, washing hands when eating, drinking while spraying, spraying time and personal hygiene. Data were collected through interviews, then analyzed using multiple logistic regression test.

Results: The results showed that the p-value for each factor was use of personal protective equipment = 0.025, frequency of spraying = 0.023, method of mixing pesticides = 0.004, direction of spraying = 0.017 and personal hygiene = 0.002.

Conclusions: It could be concluded that the use of personal protective equipment, personal hygiene, frequency of spraying, method of mixing and spraying direction are risk factors for pesticide poisoning in horticultural farmers.

Key-words: Horticultural Farmers; Pesticide Poisoning; Risk Factors

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INTRODUCTION

Indonesia is an agrarian country that relies on the agricultural sector as the main commodity. In this case, pesticides are needed to control, prevent or ward off insects, rodents, nematodes, weeds, viruses, bacteria and micro-organisms that are considered pests, in order to support increased productivity.¹ The use of pesticides that do not comply with standards will cause health problems for farmers.

One of the populations at risk of long-term negative impacts from pesticide use is pesticide-using farmers. This relates to their involvement in agricultural activities such as mixing pesticides, spraying, washing equipment, and harvesting agricultural products. Health problems due to pesticides include difficulty breathing, headaches, neurological or psychological disorders, skin irritation and mucous membrane disorders. The manifestation of these effects depends on the type and duration of pesticide exposure.²

Pesticides can enter the body through the skin, digestive tract, or respiratory tract; then inhibits the action of pseudocholinesterase in plasma and cholinesterase in red blood cells at their synapses.³ This all happens because pesticides are mutagenic, carcinogenic, endocrine system disruptors, reproductive system disruptors and neurotoxic substances.⁴

The World Health Organization (WHO) reports that there are around 250,000 deaths every year as a result of pesticide poisoning. Approximately 5,000-10,000 people experience health problems such as cancer, infertility, birth defects, and hepatitis; especially for workers in the agricultural sector.⁵ The results of the research by Wolfgang Boedeker, et al. in 141 countries in December 2020 showed that around 385 million cases of acute pesticide poisoning in farmers and farm workers occur annually worldwide and cause around 11,000 deaths.⁶

In Indonesia, the Central Java Provincial Health Office reported that 1,764 farmers in Brebes Regency had carried out health checks, with the following results: 33.05% of farmers experienced pesticide poisoning. In Magelang Regency, of the 550 farmers examined, 99.8% experienced pesticide poisoning.⁷ One extreme impact was the occurrence of 10 deaths due to pesticide poisoning in Kanigoro Village, Central Java.⁸

In Maluku Province, pesticides are also used by farmers, including in West Seram District, which is a center for horticultural agriculture, which supplies vegetables for Seram Island and Ambon City. Tuhumury (2012) reported that in Mardika market and Passo market, Ambon City, Maluku province, residues of organochlorine, organophosphate, carbamate and pyrethroid pesticides were found in spinach, kale, mustard greens and long beans.⁹ This shows that the use of pesticides is high in Maluku region.

Based on the results of a survey in West Seram District, Maluku Province, vegetables, beans and rice are the most abundant commodities, so these plants are

very susceptible to pests or diseases, so farmers usually use pesticides in plant care. The use of pesticides in various brands, the high use of pesticides, the indiscipline in the use of personal protective equipment (PPE) causes high pesticide exposure to farmers. In West Seram District, farmers usually mix pesticides without wearing gloves, without using PPE (masks, hats, goggles, long-sleeved shirts, long pants and boots), spraying while smoking, spraying against the wind, not washing hands, also store the remaining pesticides in the house in open conditions. The results of the survey indicate a high risk of exposure to pesticides to farmers, so there is the potential for health problems to them.

Based on the urgency of the problem above, it is important to conduct research to analyse the risk factors for pesticide poisoning in farmers in West Seram District. This research is intended to obtain basic information as evaluation material, reference in policy making by the local government, in order to improve public health.

METHODOLOGY

This study applied a cross-sectional design carried out in 2023 by the horticultural agriculture center of West Seram Regency, covering five sub-districts namely Kairatu, West Kairatu, Huamual, Waesala and Amalatu Districts, which involved 300 pesticide-using farmers as research samples, who were selected by proportional random sampling technique, based on the population of farmers in each district. However, during the research process, 2 farmers withdrew so that the sample size became 298 farmers. This sample was selected based on inclusion criteria, namely farmers who actively use pesticides, active period as pesticide farmers for at least 6 years, residing in agricultural areas and workers as horticultural farmers.

The independent variables of this study were tenure, the use of PPE, duration of spraying, frequency of spraying, number of types of pesticides, method of mixing, direction of spraying, and dose of pesticides, smoking while spraying, washing hands when eating, drinking while spraying, spraying time and personal hygiene; while the dependent variable was the poisoning symptoms due to pesticide.

Operation definition of each variables were predetermined before the start of the study. Tenure is the period of time working as a pesticide user; with categories namely ≤ 10 years and > 10 years. The use of PPE is the use of protective equipment when using pesticides such as hats, glasses, masks, long sleeves, gloves, trousers, boots; with categories namely complete and incomplete.

Duration of spraying is the time it takes to spray crops with pesticides; with categories namely < 3 hours and > 3 hours. Frequency of spraying is the number of activities spraying plants with pesticides

in 1 week; with categories namely 2 times and > 2 times a week. Number of types of pesticides is the number of brands of pesticides mixed in 1 tank for 1 time spraying of plants; with categories namely 2 types and > 2 types of pesticides. The method of mixing pesticides is the status of using gloves in the activity of mixing pesticides; with categories namely using gloves and not using gloves. Direction of spraying is the suitability of the direction of spraying pesticides with the direction of the wind; with the category that is according to the direction of the wind and not according to the direction of the wind. Dose of pesticides is conformity between pesticide doses with standards or instructions; with categories that are according to standards and not according to standards. Smoking while spraying is the behavior of spraying plants together with smoking; categories namely smoking and not smoking. Washing hands before eating is the behavior of washing hands before eating, after working with pesticides; with categories namely washing hands and not washing hands. Drinking water while spraying is the behavior of spraying plants together with minimal water; with categories namely spraying while drinking water and spraying while not drinking water. Spraying time is the time most often used for spraying pesticides on plants; with categories at 5-10 am and 10-13 am. Personal hygiene is the level of self-cleanliness after using pesticides, such as bathing, changing clothes, brushing teeth, cutting nails and cleaning hair; categories, namely good and bad. Poisoning symptoms are the presence of one or more health problems due to pesticides such as shortness of breath, skin disorders, headache, nausea and vomiting, heart palpitations, muscle pain, blurred vision, diarrhea, tremor and back pain; with categories namely Yes and No poisoning symptoms.

Data on all variables were collected through interviews and observations made on each respondent. The data that had been collected was then analyzed descriptively to describe each variable. Furthermore, the Chi-square test was carried out to select variables that could enter the multivariate analysis. And the last stage was multivariate analysis using multiple logistic regression to determine risk factors for pesticide poisoning. The researchers used a free program for data analysis, namely GNU PSPP 1.2.0-g0fb4db, Version 3, 29 June 2007.

This research had applied the ethical principles of health research such as respect, justice, benefit and not harm the respondent; and had received ethical approval from the Health Research Ethics Committee of College of Health Science "Maluku Husada", No: RK.052/KEPK/STIK/1/2023.

RESULTS

The results showed that in terms of the demographic characteristics of the farmers, the majority (67.8%) was male. In terms of age, most of the farmers aged

41-50 years dominated the sample (42.62%). The highest level of education was at the elementary school level (49.0%). Meanwhile, the majority of farmers (58.7%) had used pesticides for >10 years (table 1).

Table 1: The demographic characteristics of respondents

Demographic characteristics	Respondent (%)
Sex	
Male	202 (67.8)
Female	96 (32.2)
Age (years)	
20-30	17 (5.7)
31-40	70 (23.49)
41-50	127 (42.62)
51-60	84 (28.19)
Education	
None	42 (14.1)
Elementary school	146 (49)
Secondary school	68 (22.8)
High school	38 (12.8)
Higher education	4 (1.3)
Working time (years)	
10-Jun	123 (41.3)
>10	175 (58.7)

Prior to multivariate analysis, candidate selection of risk factors for pesticide poisoning was carried out using the Chi-square test. From the results of this analysis, it is known that there were 7 factors that have a p value <0.05, namely the use of PPE, frequency of spraying, number of types of pesticides, method of mixing pesticides, direction of spraying, dose of pesticides and personal hygiene (table 2). Thus, seven risk factors were further analyzed in a multivariate analysis using multiple logistic regression tests.

The results of multivariate analysis (table 3) show that in final model of logistic regression, there were 5 risk factors with a p-value <0.05, namely the use of PPE, frequency of spraying, method of mixing pesticides, direction of spraying and personal hygiene, so that it was interpreted as 5 risk factors for pesticide poisoning. In this case, the most dominant risk factor was the method of mixing pesticides, because it had the smallest p-value and the largest odds ratio, namely 0.004 and 3.849.

DISCUSSION

Pesticide that enters the human body in a certain amount can cause poisoning and various system disorders in the body. These pesticides can enter through the skin, digestive tract or respiratory tract, then inhibit the action of pseudo-cholinesterase in plasma and cholinesterase in red blood cells at their synapses.³ The respiratory system and skin are the main routes of exposure to pesticides. Some symptoms of respiratory problems can occur due to exposure to pesticides such as shortness of breath and irritation of the respiratory tract.¹⁰

Table 2: The results of the selection of candidate risk factors for pesticide poisoning

Risk factors	Poisoning symptoms		p-value (Chi-square)	Odds ratio	95% CI
	Yes (%)	No (%)			
Tenure					
≤10 years	101 (82.1)	22 (17.9)	0.089	0,611	0,345-1.081
>10 years	129 (73.7)	46 (26.3)			
The use of PPE					
Complete	39 (65.0)	21 (35.0)	0.012	2,188	1.178-4.064
Incomplete	191 (80.3)	47 (19.7)			
Duration of spraying					
≤3 hours	11 (61.1)	7 (38.9)	0.094	2,285	0,850-6,144
>3 hours	219 (78.2)	61 (21.8)			
Frequency of spraying					
2 times a week	49 (67.1)	24 (32.9)	0.018	2,015	1,118-3,631
>2 times a week	181 (80.4)	44 (19.6)			
Number of types of pesticides					
2 types	17 (60.7)	11 (39.3)	0.029	2,418	1.073-5.451
>2 types	213 (78.9)	57 (21.1)			
Method of mixing pesticides					
Using gloves	16 (59.3)	11 (40.7)	0.02	2.581	1.135-5.869
Not using gloves	214 (79.0)	57 (21.0)			
Direction of spraying					
With the wind	38 (90.5)	4 (9.5)	0.027	0.316	0.108-0.919
Against the wind	192 (75.0)	64 (25.0)			
Dose of pesticides					
Standard	18 (62.1)	11 (37.9)	0.041	2.273	1.016-5.084
Non-standard	212 (78.8)	57 (21.2)			
Smoking while spraying					
No	71 (72.4)	27 (27.6)	0.173	1.475	0,842-2.583
Yes	159 (79.5)	41 (20.5)			
Washing hands before eating					
Yes	74 (77.1)	22 (22.9)	0.978	1.008	0.565-1.798
No	156 (77.2)	46 (22.8)			
Drinking water while spraying					
No	76 (81.7)	17 (18.3)	0.209	0.675	0.366-1.248
Yes	154 (75.1)	51 (24.9)			
Spraying time					
5.00-10.00	74 (80.4)	18 (19.6)	0.371	0.759	0.414-1.391
10.00-15.00	156 (75.7)	50 (24.3)			
Personal hygiene					
Good	76 (67.3)	37 (32.7)	0.001	2.419	1.394-4.195
Bad	154 (83.2)	31 (16.8)			

Table 3: The results of multivariate analysis (final model of logistic regression, with 5 risk factors)

Risk factors	p-value (Logistic regression)	Adjusted Odds ratio	95%CI
The use of PPE	0.025	2.145	1.101-4.177
Frequency of spraying	0.023	2.072	1.104-3.892
Number of types of pesticides	0.055	2.332	0.982-5.534
Method of mixing pesticides	0.004	3.849	1.557-9.515
Direction of spraying	0.017	0.251	0.080-0.781
Dose of pesticides	0.125	2.043	0.820-5.094
Personal hygiene	0.002	2.551	1.408-4.624

Farmers can be exposed to pesticides through various activities such as of storing and transferring pesticides, the process of mixing pesticides, the process of spraying pesticides on agricultural land and washing tools that have been used to spray crops, the situation of still using clothes contaminated with pesticides and other potential activities.¹¹

The initial survey in this study showed that farmers used pesticides in agricultural areas without paying attention to the correct use standards, such as using excessive doses of pesticides, mixing several types of pesticides in one use, mixing pesticides without

wearing gloves, working without wearing protective equipment. themselves, spraying for a long time and spraying against the wind.

The results of the analysis show that the first significant risk factor has the potential to cause symptoms of pesticide poisoning in farmers, namely the use of personal protective equipment. The use of personal protective equipment in pesticide use activities such as hats, goggles, masks, gloves, boots, long sleeves and long pants is standard for using pesticides.

In this study, the factor of using personal protective

equipment was significantly related to symptoms of pesticide poisoning, where 79.9% of farmers did not use personal protective equipment while working. This makes farmers very vulnerable to exposure to pesticides because they come into direct contact with pesticide residues on farmers' skin. The results of this study are similar to As'adi's report, that there is a relationship between the use of PPE and health complaints. This is because farmers ignore the use of PPE while working and think that PPE interferes with spraying activities, namely the difficulty of moving freely during spraying.¹² Farmers who do not use PPE when mixing or spraying pesticides can experience health complaints. The four health complaints that often arise are headaches, increased fatigue, itching and nausea.¹³ Yushananta et al. also proves that the use of personal protective equipment is also a risk factor for symptoms of pesticide poisoning, with a very high odds ratio of 4.54.¹⁴ Even Saftarina et al. reported a significantly higher odds ratio for this risk factor of 27,448.¹⁵ This reinforces the importance of using personal protective equipment for farmers while using pesticides in agricultural, in order to minimize the adverse effects on their health.

The second risk factor is the frequency of pesticide spraying. The results of the analysis show that the proportion of farmers who usually spray with a frequency of more than 2 times a week is very large, namely 75.5%. Intense spraying more than twice a week has the potential to be exposed to pesticides. According to the farmers, they usually spray with more frequency with the intention that the plants grow faster, avoid pest damage and produce faster. Especially during the rainy season, farmers have to re-spray the plants because they think that the pesticides won't stick to the plants. Oktaviani (2020) reported that using excessive doses of pesticides has a 4.39 times greater risk of poisoning, while the frequency of spraying more than 2 times a week has a 2.33 times higher risk of pesticide poisoning.¹⁶ During interviews it was found that farmers prefer a combination several types of pesticides with the intention that one time spraying can get more benefits such as growth stimulants, lots of fruit, wide leaves, strengthening flowers and preventing pests. But actually, this will lead to high accumulation of toxins and if exposed to farmers, it will have a worse effect. Istiana reported that the number of types of pesticides correlated with the incidence of poisoning among farmers in Brebes, Central Java. In this case, farmers mix at least 3 types of pesticides in one spraying.¹⁶

In their research in West Lampung, Indonesia, Yushananta et al. proves that the frequency of spraying pesticides on plants is also a risk factor for symptoms of pesticide poisoning. The frequency of spraying more than 2 times a week is a risk factor with a fairly high odds ratio of 2.33.¹⁴ In their research in Tanggamus, Lampung, Indonesia, Saftarina et al. also proves that the frequency of spraying pesticides on plants is also a risk factor for symptoms of pesticide

poisoning. The frequency of spraying more than 2 times a week is a risk factor with a fairly high odds ratio of 3.402.¹⁵ This reinforces the importance of maintaining the frequency of pesticide spraying so that it is not too frequent, so that the adverse effects on health due to pesticides can be minimized.

The third factor is how to mix the pesticide in the spray container. The results of the analysis show that 90.9% of farmers mix pesticides in the spray container without using gloves. Farmers feel that it is common and common to open pesticides from their packages, mix pesticides with water, and stir without using gloves. This condition shows the very low awareness of farmers about the dangers of pesticide poisoning, because they consider pesticides to be drugs, so they will not affect their health. Mahyuni (2015) found that farmers who mixed pesticides in a closed room and mixed them using their hands without gloves complained more often of dizziness, reddened hands, itching and pain.¹⁷

The fourth factor is the direction of spraying plants against the wind. The results of the analysis showed that 85.9% of farmers sprayed pesticides on the plants against the wind. This is done by farmers because they are lazy to follow complicated rules, and according to them the results of spraying will be the same regardless of the direction. Spraying against the wind provides a greater chance of being exposed to pesticides, because the spray is carried by the wind and waters the spraying farmers, so that they are directly exposed to pesticides freely and directly. This condition is similar to the results of a study conducted by Osang, et al. (2016) who concluded that there was a significant relationship between the direction of spraying pesticides and cholinesterase levels in the farmers' blood. Spraying that does not follow the direction of the wind causes the pesticide spray liquid to hit the workers' bodies, so that poisoning will occur more easily.¹⁸ According to Djojsumarto (2008), the correct method of spraying pesticides includes: 1) the spray direction must be the same as the wind direction; 2) farmers spraying pesticides should walk in the direction of the wind and try not to go through areas that have been sprayed; 3) wind direction and altitude must match the target; 4) the longer farmers are in contact with pesticides, the more likely they are to be exposed to toxic substances, so spraying should not take more than 3 hours.¹

The fifth risk factor is personal hygiene, where the results of the study show that 62.1% of respondents have bad personal hygiene. This happens because farmers after carrying out activities using pesticides, they do not change clothes that have been contaminated with pesticides during work and the next day they still use them again. In addition, farmers often enter irrigation water that has been contaminated with pesticides but are left to dry on their bodies, causing higher levels of exposure to pesticides.

Similar findings were reported by Ulva (2019) that

the proportion of respondents who had complaints of symptoms of pesticide poisoning was more among respondents with poor personal hygiene than respondents with good personal hygiene.¹⁹ Budiyo (2014) reported that the proportion of absorption of pesticides into the body if you don't change your clothes after spraying is 64.72%, if you don't take a shower after spraying it is 55.88%.²⁰ Personal hygiene practices that must be carried out by farmers after spraying, namely cleaning themselves include washing hands with soap, changing clothes specifically for spraying, washing spraying equipment away from water and food sources. Ibrahim's research (2023) states that the involvement of farmers in agricultural activities with poor personal hygiene makes them vulnerable to exposure to pesticides and is a risk of developing symptoms of poisoning.²¹

In their research in Tanggamus, Lampung, Indonesia, Saftarina et al. also proves that the personal hygiene is also a risk factor for symptoms of pesticide poisoning. Not good personal hygiene is a risk factor with a high odds ratio of 4.349.¹⁵ This reinforces the importance of maintaining the good personal hygiene, so that the adverse effects on health due to pesticides can be minimized.

CONCLUSION

Based on the results of the study it was concluded that the risk factors for pesticide poisoning among horticultural farmers in West Seram Regency were the use of PPE, frequency of spraying, method of mixing pesticides, direction of spraying and personal hygiene; with the method of mixing pesticides as the most risky factor.

RECOMMENDATIONS

Recommendations given based on the results of this study include: 1) Use of pesticides in agricultural areas needs attention to ensure use of standard personal protective equipments 2) The agriculture and health services must regulate the use and distribution of pesticide; 3) Further research related to causality and biological impacts on human health is warranted; 4) Need for further research with a case-control design to obtain a history of previous pesticide exposure to current health problems.

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