RISK FACTORS RELATED TO CARBAMATE AND ORGANOPHOSPHATE PESTICIDE POISONING IN RICE FARMERS IN MASANGAN KULON VILLAGE, SIDOARJO DISTRICT

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ABSTRACT

To increase the production of crops, pesticides that can exterminate pest is unavoidable. However, a spray of pesticides that is over the volume standard might increase poison incidents in farmers. This study aimed to find risk factors affecting carbamates and organophosphates poison in Masangan Kulon village, Sukodono sub-district, Sidoarjo district in 2019. This study was analytic observational with a cross-sectional approach. The sample was 28 farmers. The collected data were analyzed analytically using the Fisher Exact test. The independent variables included age, sex, education level, work period, the use of Personal Protection Equipment (PPE), duration of exposure, knowledge, a total of pesticides, and management of pesticides. The cholinesterase level in blood was done using Kinetic Photometric DGKC in the Surabaya Health Laboratory Center. The results showed 2 farmers (7.1%) were poisoned. The statistic test found no significant relationship between sex (PP = 0.091), education level (P = 0.553), work period (P = 0.288), use of PPE (P = 0.622), the number of pesticides (P = 1.000), knowledge (P = 0.549), and management practices of pesticides (P = 1.000) with pesticide poisoning. There was significant relationship between age (P = 0.001) and duration of exposure (P = 0.001) to pesticides. Several actions are required to avoid pesticide poisoning, such as counseling from relevant agencies about pesticides, periodically checking cholinesterase of farmers, and observing pesticide sale distribution in the village.

Keywords: pesticides, carbamate, organophosphate, cholinesterase.

ABSTRAK

Untuk meningkatkan hasil pertanian, pemakaian pestisida yang dapat membunuh hama tidak dapat dihindarkan. Namun, penyemprotan pestisida yang menyalahi aturan mengakibatkan dapat meningkatkan kejadian keracunan pada petani. Penetian ini bertujuan untuk mengetahui faktor risiko yang berhubungan dengan kejadian keracunan karbamat dan organofosfat di Desa Masangan Kulon Kecamatan Sukodono, Kabupaten Sidoarjo pada 2019. Penelitian ini bersifat observasional analitik dengan pendekatan potong lintang. Sampel penelitian ini berjumlah 28 petani. Analisis data menggunakan uji Fisher Exact. Variabel independen meliputi umur, jenis kelamin, tingkat pendidikan, masa kerja, pemakaian Alat Perlindung Diri (APD), lama paparan, pengetahuan, jumlah jenis pestisida, dan praktik pengelolaan pestisida. Pemeriksaan kadar enzim kolinesterase dalam darah menggunakan metode Fotometrik Kinetik DGKC di BBLK Surabaya. Hasil penelitian ini menunjukkan petani yang menderita keracunan sebanyak 2 orang (7,1%). Hasil uji statistik menunjukkan tidak adanya hubungan yang bermakna antara jenis kelamin (P = 0,091), tingkat pendidikan (P = 0,553), masa kerja (P = 0,288), pemakaian APD (P = 0,622), jumlah jenis pestisida (P = 1,000), pengetahuan (P = 0,549), dan praktik pengelolaan pestisida (P = 1,000) dengan keracunan pestisida. Ada hubungan yang bermakna antara umur (P = 0,001) dan lama paparan (P = 0,001) dengan kejadian keracunan. Perlu adanya upaya untuk mencegah keracunan pestisida, seperti penyuluhan dari pihak terkait tentang pestisida, pemeriksaan enzim kolinesterase secara berkala pada petani padi serta pengawasan distribusi pestisida di desa.

***Kata kunci**: pestisida, karbamat, organofosfat, kolinesterase.*

 License doi: 10.20473/ijph.vl15il.2020.190-200 Received 1 July 2019, received in revised form 10 July 2019, Accepted 17 September 2019, Published online: August 2020

INTRODUCTION

Today, agriculture has a huge contribution to the life of the living creature in terms of economy for the fulfillment of the basic needs. Along with the increasing population, the need for food is also increasing. It also affects the quantity and quality of food itself. Farmers become players that ensure the provision of healthy food (Shohib, 2013).

As time goes by, the number of crop pests has increased (Shohib, 2013). To minimize pests in plants, farmers then start using pesticides. Pests that attack plants will harm food, and thus it reduces the selling price of the food.

The use of pesticides was estimated to reach 4,429 tons of active ingredients of organochlorine, 1,375 tons of organophosphate, 30 tons of carbamate, and 414 pyreids each year. Developed countries, such as North America, Russia, Japan, Australia, and the country in continental Europe had 80% of the most pesticide usage in the world. While the use of pesticides in developing countries reached 20%, particularly 5% in Indonesia (WHO, 2012)

According to the (Directorate General of Agricultural Infrastructure and Facilities., 2016) the number of pesticides in Indonesia reached 17,977 tons annually, affected by the increasing number of trade names (brands) of the pesticides. The total types of pesticides registered were as many as 2,605 brands in 2019, 2,672 brands in 2011, 2,987 brands in 2012, 3,335 brands in 2014, 3,541 brands in 2014, 3,749 brands in 2015, and 3,930 brands in 2016.

In the Regulation of the Indonesian Ministry of Agriculture Number 107 of 2014 about pesticide supervision, pesticides are defined as all chemical substances and other substances that are used to eradicate or prevent pests and diseases that can harm crops, eradicate grass, kill unwanted leaves, eradicate and prevent wild pests and animals that can transfer a disease to humans. Pesticides in controlling the plant pests greatly affect the quality of plants which later results in the high frequency of harvesting (Agustina, F., Suhartono, 2018). Pesticides are mostly used in rice plants or oryza sativa.

Types of pesticides that are often used include carbamate and organophosphate pesticides. Carbamate and organophosphate pesticides might affect insects, mammals, and humans due to the inhibition of acetylcholinesterase (AChE) during the process of the forforylation of anion seter. The AChE of the enzymes remains inhibited until the formation of new enzymes or the reactivator of cholinesterases. The buildup of Asetikoline (ACh) caused poisoning symptoms due to contact with pesticides and lack of the ACh (Mitra, A., & Maitra, 2018).

According to (WHO, 2012), 1.5 million cases of pesticide poisoning occurred in the agriculture sector. The number of cases in developing countries reached 20.000 cases, particularly While, Indonesia with 771 cases. The incidence of pesticide happened due to farmer's ignorance of the dangers of pesticides (National Agency of Drug and Food Control, 2016).

Risk factors associated with the incidence of carbamate poisoning included age, gender, knowledge, experience, education level, the use of Personal Protection Equipment (PPE), and pesticide management practices. While, the critical phase was considered, such as storing, mixing, use, and post-use of pesticides. Farmers often experienced vomiting, nausea, headache, diarrhea, and tremor, which are all perceived ordinary (Runia, 2008).

The Mulya farmer group in Masangan Kulon village, Sukodono sub-district used carbamate pesticides, such as Furadan 3 GR, Antracol 70 WP, Amabas 500 EC, and Baycarb 500 EC. While, they also usually used organophosphate

pesticides, such as Topnil 50 SC, Curbix 100 SC, Decis 25 EC, Curacron 500 EC, and Regent 50 SC. The pesticide was mixed with water and then filled into 14-16-liter tank. In this case, the blood sampling was done after the farmers made contact with pesticides within maximumly a week. As the crops reached a growing season of 60 to 75 days after sprayed for 1 to 3 times a week to minimize the pests and diseases.

METHODS

This study was analytical observational, using a cross-sectional design. This study observed the independent and dependent variables at the same time. The population of this study was as many as 30 farmers from the Mulya farmer group 2 in Masangan Kulon village Sukodono sub-district, Sidoarjo district. The respondents have filled a consent form to participate in this study. The blood sampling was done one week before the research. This study was conducted between the growing season of 60 to 75 days after the planting period. As many as 28 respondents were acquired based on Slovin's formula (1960) with a degree of deviation of 5%.

$$n = \frac{N}{N(d)^2+1}$$

Description:
N = Number of population
n = Number of research samples
D = Degree of deviation (0.05)
1 = Number of constants

This study collected primary data directly by observing, interviewing, and sampling blood of the respondents. Blood sampling of 2 ml was done by midwives in Sukodono sub-district. Next, the level of cholinesterase was examined by using a DGKC kinetic photometric method in the Surabaya Health Laboratory Center

The, the data analysis was conducted using chi-square statistical trials. However, because there are less than 20% having an expectation value of less than 5, using the Fisher exact test. This exact fisher test aimed to identify the relationship between independent variables and dependent variables. The independent variables included age, gender, level of knowledge, education level, duration of exposure, the use of Personal Protection Equipment (PPE), work period, pesticide management practices, and the number of pesticide types. While, the dependent variable was the incidence of poisoning detected from the level of cholinesterase sampled from the respondents' blood. the P-value of less than 0.05 showed a meaningful relationship between the independent variables and dependent ones. Further results of the test were presented in tables to facilitate the discussion. This study has passed the ethics approval from the Health Research Ethics Commission of the Faculty of Dentistry, Universitas Airlangga No. 152/HRECC. FODM/VI/2019.

RESULT

The pesticide poisoning can be identified from the level of cholinesterase in the blood. The normal level of cholinesterase unpoisoned was 4,620 to 11,500 in males while 3,930 to 10,800 in females. Table 1 illustrates the majority of respondents were not poisoned (92.9%). With regards to age, most of them were 18 to 55 years old (71.4%) and males (78.6%). In terms of education level, most of the respondents had a low education (82.1%) and a working period of more than 5 years (75%). Nearly all the respondents did not use complete PPE (92.9%). They mostly got exposed to pesticides less than or equal to 3 hours per day (71.4%). The data showed the respondents used more than 1 type of pesticide per contact (85.7%) and had poor knowledge (78.6%). More than a half of the respondents applied poor management practices (75%).

Table 1. Overview of frequency distribution of incidence of poisoning, age, gender, level of education, employment, use of PPE, prolonged exposure, number of pesticides, knowledge, and pesticide management practices

Variable	Frequency	Persentase
Poisoning	**n**	**%**
Abnormal level of cholinesterase (poisoning)	2	7.1
Normal level of cholinesterase (unpoisoned)	26	92.9
Total	28	100
Age	**n**	**%**
> 55 years	8	28.6
18-55 years old	20	71.4
Total	28	100
Gender	**n**	**%**
Female	6	21.4
Male	22	78.6
Total	28	100
Education level	**n**	**%**
Low (not completed elementary, had completed elementary and junior high school)	23	82.1
High (Senior high school, university)	5	17.9
Total	28	100
Working period	**n**	**%**
> 5 years	21	75
≤ 5 years	7	25
Total	28	100
Use of Personal Protection Equipment	**n**	**%**
≥ 1 PPE	26	92.9
Wearing all the PPE	2	7.1
Total	28	100
Duration of exposure	**n**	**%**
> 3 hours/day	8	28.6
≤ 3 hours/day	20	71.4
Total	28	100
Number of pesticide types	**n**	**%**
> 1 type	24	85.7
1 type	4	14.3
Total	28	100
Knowledge	**n**	**%**
Poor knowledge (answering the correct questions < 75%)	22	78.6
Good knowledge (answering the correct questions ≥ 75-100%)	6	21.4
Total	28	100
Pesticide management practices	**n**	**%**
Poor management practices (answering the correct questions < 75%)	21	75
Good management practices (answering the correct	7	25

Variable	Frequency	Persentase
questions ≥ 75-100%)		
Total	28	100

The relationship between age and the incidence of pesticide poisoning

Age is the length of one's life was after birth. Age became a determining factor in the incidence of pesticide poisoning because older age may increase the level of cholinesterase in blood. In this study, age was clarified to 2 sub-variables, over 55 years and 18 to 55 years. Table 2 shows the majority of the respondents were at the age of 18 to 55 years (71.4%)

Table 2. The relationship between age and the incidence of pesticide poisoning

Age	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
> 55 years	1	12.5	7	87.5	8	100
18-55 years	1	5	19	95	20	100
Total	2	7.1	26	92.9	28	100
p = 0.001						

Table 2 shows a p-value of 0.001 which is less than the α value (0.05), meaning there was a relationship between age and poisoning.

The relationship between gender and the incidence of pesticide poisoning

Gender is the physical sign seen since birth. The majority of respondents were males (78.6%). Based on the primary data, there was a relationship between gender and the incidence of pesticide poisoning

Table 3. Relationship between gender and the incidence of pesticide poisoning.

Gender	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
Female	1	16.7	5	83.3	6	100
Male	1	4.5	21	95.5	22	100
	2	7.1	26	92.9	28	100
p = 0.091						

The exact fisher test shows a P-value of 0.091 which is more than the α-value (0.05). This suggested there was no relationship between gender and the incidence of poisoning.

The relationship between education level and the incidence of pesticide poisoning

Education level is a stage of education which exerts development, objectives, and willingness of being developed. This variable can affect someone's behavior. Individuals with the higher education level are expected to have good knowledge that can result in good behavior. In this study, Most of the respondents were low educated (82.1%). The education level was associated with the incidence of pesticide poisoning.

Table 4. The relationship between education level and the incidence of pesticide poisoning.

Education level	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
Low	1	4.3	22	95.7	23	100
High	1	20	4	80	5	100
Total	2	7.1	26	92.9	28	100
$p = 0.553$						

Based on the exact Fisher test, the P-value obtained was at 0.553), exceeding the α-value (0.05). This value indicated there was no relationship between education level and the incidence of pesticide poisoning.

The relationship between work period and the incidence of pesticide poisoning

Work period is an accumulated length of working. This variable can affect individuals to have contact with pesticides which can be seen from the level of cholinesterase. Longer exposure to pesticides will create more residual pesticides in the farmers' body. This study found the relationship between work period and the incidence of pesticide poisoning.

Table 5. The relationship between work period and the incidence of pesticide poisoning.

Working period	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
> 5 years	1	4.8	20	95.2	21	100
≤5 years	1	14.2	6	85.8	7	100
Total	2	7.1	26	92.9	28	100
$p = 0.288$						

The P-value obtained for this variable was 0.288, which is more than the α-value (0.05). The results showed there was no relationship between work period and the incidence of pesticide poisoning.

The relationship between the use of PPE and the incidence of pesticide poisoning

The use of PPE was measured from whether the farmers wore complete tools to protect themselves to avoid direct contact with pesticides in pesticide mixing and distribution. The PPE involved hats, glasses, masks, boots, trousers, gloves, and long-sleeved shirts

Table 6. The relationship between the use of PPE and the incidence of pesticide poisoning

Application of APD	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
Incomplete	1	3.8	25	96.2	26	100
Complete	1	50	1	50	2	100
Total	2	7.1	26	92.9	28	100
$p = 0.622$						

The P-value obtained in the exact fisher test was at 0.622. Since it was less than the α-value (0.05), the use of PPE was related to the incidence of pesticide poisoning. In this case, the majority of respondents did not wear complete PPE (92.9%)

The relationship between duration of exposure and the incidence of pesticide poisoning

Duration of exposure is the length of contact with pesticides in hours per day. This study found the majority of farmers were exposed to pesticide less than or equal to 3 hours per day (71.4%).

Table 7. The relationship between duration of exposure and the incidence of pesticide poisoning

Prolonged exposure	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
Bad	1	12.5	7	87.5	8	100
Good	1	5	19	95	20	100
Total	2	7.1	26	92.9	28	100
p value = 0.001						

Table 7 shows a P-value of 0.001, which is less than the α-value (0.05). It meant there was a relationship between duration of exposure and the incidence of pesticide poisoning.

The relationship between the number of pesticide types and the incidence of pesticide poisoning

The number of pesticides is the number of pesticides for spraying rice crops. The possibility of poisoning will increase when the number of pesticides is greater. Two types of pesticides, namely the carbamate pesticides and organophosphate pesticides were commonly used. The types of pesticides used included insecticide, nematicide, and fungicide. Most of the farmers used Regent 50 SC, Curacron 500 EC, Decis 25 EC, Curbix 100 SC, Topnil 50 SC, Baycarb 200 EC, Amabas 500 EC, Furadan 3 GR, and Antracol 70 WP.

Table 8. The relationship between the number of pesticide types and the incidence of pesticide poisoning

Number of pesticide types	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
> 1 pesticide types	1	4.2	23	95.8	24	100
1 pesticide types	1	25	3	75	4	100
Total	2	7.1	26	92.9	28	100
p value = 1.000						

From Table 8, the P-value obtained was at 1.000, which is more than the α-value (0.05). It indicated there was no link between the number of pesticide types and the incidence of pesticide poisoning.

The relationship between knowledge and the incidence of pesticide poisoning

Knowledge is is the understanding of information related to carbamate and organophosphate pesticides, signs of

poisoning, first aid, means of storing, mixing, and spraying.

Table 9. The relationship between knowledge and the incidence of pesticide poisoning

Knowledge	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
Bad	1	4.5	21	94.5	22	100
Good	1	16.7	5	83.3	6	100
Total	2	7.1	26	92.9	28	100
$p = 0.549$						

The variable had the P-value of 0.549, lower than the α-value (0.05), meaning there was no relationship between knowledge and the incidence of pesticide poisoning.

The relationship between pesticide management practices and the incidence of pesticide poisoning

The pesticide management practices are the actions of mixing, spreading, storing residual pesticides, and disposing pesticide package.

Table 10. The relationship between pesticide management practices and the incidence of pesticide poisoning

Pesticide management practices	Incidence of poisoning				Total	
	Yes		No			
	n	%	n	%	n	%
Bad	1	4.8	20	95.2	21	100
Good	1	14.3	6	85.7	7	100
Total	2	7.1	26	92.9	28	100
$p = 1.000$						

The exact fisher test obtained the P-value of 1.000, greater than the α-value (0.05). This meant that there was no relationship between pesticide management practices and the incidence of poisoning.

DISCUSSION

The relationship between age and the incidence of pesticide poisoning

The respondents in this study were mostly at the productive ages from 18 to 55 years. The analysis showed the age variable had a meaningful relationship to the incidence of poisoning. The result was in line with the research of (Lucki, 2018) who found the increasing risks of pesticide poisoning due to age factor in which older age might increase the level of cholinesterase.

Theoretically, Ancient (2009) mentions that as age increases, the physiological function and metabolism of the body also decrease. As a result, the level of cholinesterase decreases too, meaning the risk of pesticide poisoning is likely to happen..

The relationship between gender and the incidence of pesticide poisoning

This study showed no meaningful relationship between gender and the incidence of poisoning. The results of (Zuraida., 2011) and (Hermawan, 2018)strengthened this finding. This might

be due to the number of male respondents which was more than that of females, affecting the statistical calculation of this variable.

Comparing the level of cholinesterase based on gender, males have the higher level of cholinesterase. Supporting this fact, Ma'arif (2016) found a meaningful relationship between gender and the level of cholinesterase.

The relationship between education level and the incidence of pesticide poisoning

Education level had no meaningful relationship to the incidence of poisoning. (Zuraida., 2011) and (Faizah, 2017) found the same results as this study did. It turns out that knowledge and pesticide management practice demand on work experience (Lucki, 2018). If an individual has a good experience of how to use pesticides, then he will be able to minimize the risks of pesticide poisoning.

According to (Runia, 2008), the education level will affect the process of gathering information, affecting individual's actions. The higher level of education expectedly gives the high level of knowledge that will contribute to how they manage to use pesticides. Similarly, (Hermawan, 2018) found a link between education level and the incidence of pesticide poisoning in farmers.

The relationship between work period and the incidence of pesticide poisoning

Work period is the duration that individuals spend to work. Longer work period in farming will put farmers at more risks of contacting with pesticides (Samosir, K., Setiani, O., 2017). The exact fisher test showed that there was no meaningful relationship between work period and the incidence of pesticide poisoning. Another study also indicated no relationship between work period and the incidence of pesticide poisoning (Zuraida., 2011). Since the farmers did not conduct agricultural activities, especially spraying pesticides every day, work period seemed not to have a relationship to the incidence of poisoning. However, a contradictory finding was found in the study of (Samosir, K., Setiani, O., 2017) which found a relationship between work period and the incidence of pesticide poisoning.

The relationship between the use of PPE and the incidence of pesticide poisoning

The use of PPE reflects individuals' behavior, habits and knowledge. Good knowledge raises a good behavior which then becomes a habit. The use of PPE serves as a body protector from a direct contact with pesticides. The exact fisher test showed that there was no meaningful relationship between the use of the PPE and the incidence of pesticide poisoning. (Zuraida., 2011) showed the same result. This study only gathered data on the number of PPE used by the farmers; hence, it did not clearly state kinds of PPE the farmers wore. However, (Samosir, K., Setiani, O., 2017) discovered a relationship between the use of PPE and the incidence of pesticide poisoning. Pesticides can be absorbed through skin, inhalation, and ingestion, and thus ideally farmers should wear a hat, mask, long-sleeve shirt and trousers, boots, gloves, and glasses (Samosir, K., Setiani, O., 2017)

The relationship between duration of exposure and the incidence of pesticide poisoning

Duration of exposure is the length of time in being in contact with pesticides in a day. This study found a meaningful relationship between duration of exposure and the incidence of poisoning. The farmers made contact with pesticides more than 3 hours per day so that they were more likely to have more risks of poisoning.

The same result found by (Samosir, K., Setiani, O., 2017) suggested showed the respondents had longer

exposure to pesticides which could lower the level of cholinesterase in blood.

The relationship between the number of pesticide types and the incidence of pesticide poisoning

In this study, there was no meaningful relationship between the number of pesticide types and the incidence of poisoning. Supporting this finding, (Samosir, K., Setiani, O., 2017) found a relationship of the two variables with the P-value of 0.681. This present study's finding contradicted with the theory that the number of pesticide types used could increase the risk of poisoning.

The relationship between knowledge and the incidence of pesticide poisoning

Knowledge is one of the driving factors of individual's behaviors. Good knowledge about pesticides will put farmers in smaller risks of poisoning. Knowledge is related to the respondents' understanding about pesticides, such as the definition of pesticides, procedures of using pesticide, first aids required in case of pesticide poisoning after contact. Knowledge can influence individual's actions.

This study indicated no meaningful relationship between pesticide management practices and the incidence of pesticide poisoning. The same thing was found in (Zuraida., 2011) in which the majority of the respondents answered questions based on their experience rather than the theory. However, (Ipmawati, 2016) found different results in which there was a relationship between knowledge and the incidence of pesticide poisoning.

The relationship between pesticide management practices and the incidence of pesticide poisoning

In this case, one way to minimize the risk of poisoning is conducting good pesticide management practices either before, during, or after in contact with pesticides, such as in the stages of compounding stage, spraying, storing residual pesticides, PPE fittings, and packing.

The analysis resulted in no meaningful relationship between pesticide management practices and the incidence of poisoning. (Zuraida., 2011) and (Samosir, K., Setiani, O., 2017) found the same result, but (Istianah, 2017) indicated a relationship between pesticide management practices and the incidence of poisoning. Poor management practice might increase the risks of poisoning.

CONCLUSION

Only two rice farmers experienced pesticide poisoning based on the abnormal level of cholinesterase (7.1%) Most of them did not experience such poisoning issues (92.9%). Gender (P = 0.091), education level (P = 0.553), work period (P = 0.288), use of PPE the(P = 0.622), the number of pesticide types (P = 1.000), knowledge level (P = 0.549), and pesticide management practices (P = 1.000) did not have a relationship to the incidence of pesticide poisoning. However, age (P = 0.001) and duration of exposure (P = 0.001) were related to the incidence of poisoning in rice farmers in Masangan Kulon district of Sukodono District Sidoarjo year 2019.

The farmers who mostly were in contact with pesticides were aged 18 to 54 years. They mostly did not get exposed to pesticides less than 3 hours per day. The health office should examine the level of cholinesterase by collaborating with local health professionals periodically at least in 6 months. The Indonesian government also could urge the ministry to form a group of village farming cadres, which are expected to provide counseling on the importance of planting galindia refugia and gupol owl for controlling crop pest evolution and understand the condition of local farmers and farmlands.

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