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PARAQUAT PESTICIDE EXPOSURE TO THE INCIDENCE OF ANEMIA IN SUGARCANE PLANTATION WORKERS "X"

Vivi Oktari [1]*, Muhammad Irsan Saleh[2], Mohammad Zulkarnain[3], Suheryanto[4]
[1]Doctor of Environmental Science, Graduate Program, Universitas Sriwijaya, Jl. Padang Selasa No. 524 Bukit Besar Palembang, South Sumatra 30139, Indonesia
[2]Biomedical Science Study Programs, Graduate Program, Sriwijaya, Jln Dokter Muhammad Ali, Sekip Jaya, Kemuning, Palembang, South Sumatra 30114, Indonesia
[3]Faculty of Medicine, Universitas Sriwijaya, Jl. Raya Palembang - Prabumulih Km. 32 Indralaya, Ogan Ilir, South Sumatra 30662, Indonesia
[4]Faculties of Mathematics and Natural Sciences, Universitas Sriwijaya, Jl. Raya Palembang - Prabumulih Km. 32 Indralaya, Ogan Ilir, South Sumatra 30662, Indonesia
*vivioktari26@gmail.com

ABSTRACT
Pesticide poisoning, especially paraquat, is a significant health problem for agricultural workers, including sugarcane plantation workers in Indonesia. This study aims to evaluate the relationship between pesticide use and hemoglobin levels. This study is a descriptive study to find the correlation between paraquat pesticide exposure and hemoglobin levels. Quota sampling technique was used to collect 51 samples. Data were collected through interviews, observation of the use of Personal Protective Equipment (PPE), and measurement of hemoglobin levels by laboratory methods on 51 workers exposed to paraquat pesticide. The Chi-Square test was used to analyze the relationship between the use of PPE and the level of pesticide poisoning as measured by hemoglobin levels. The results showed that incomplete use of PPE was associated with a decrease in workers' hemoglobin levels. As many as 40% of workers who did not use PPE experienced a significant decrease in hemoglobin levels compared to workers who used complete PPE. The calculated Chi-Square value is 6.45 with a p value = 0.011 ($p < 0.05$) which indicates a significant relationship between the use of PPE and hemoglobin levels in sugarcane plantation workers. Based on these results, it can be concluded that proper use of PPE can reduce the risk of pesticide poisoning and maintain hemoglobin levels at normal levels.

Keywords: hemoglobin level; paraquat; sugarcane plantation worker

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INTRODUCTION

Paraquat is the most commonly used pesticide and is most commonly associated with human poisoning. (Terry AV, 2012). Paraquat can accumulate in the body through inhalation, digestion, and skin contact (Smith MN, et al., 2017). Pesticides are used in agriculture to kill plant pests. The World Health Organization (WHO) states that one to five million cases of pesticide poisoning occur in agricultural workers. The highest case reached 20,000, some of which were fatal in developing countries (Rusma et al., 2016). Mild pesticide poisoning is characterized by fatigue, weakness, dizziness, blurred vision, and nausea. While severe pesticide poisoning causes diarrhea, abdominal cramps, tremors, breathing problems, and severe hypotension, which if not treated immediately can lead to death (Ramli et al., 2015) The National Poison Information Center recorded 771 cases of pesticide poisoning in Indonesia in 2016, and it is expected to increase every year. In some areas of Indonesia, this figure is particularly high. The results of cholinesterase enzyme monitoring in 347 agricultural workers in Central Java showed that 35.73% and 23.64% of them experienced severe poisoning (Anam et al., 2015).

One of the factors that affect the level of pesticide poisoning is the length of pesticide spraying, the longer the farmer is exposed to pesticides, the more pesticides enter his body (Wiryanta, 2002), while the incomplete use of Personal Protective Equipment (PPE) will increase the absorption of pesticides through the skin of farmers (John HR et al., 1999). The tool used to spray pesticides is a sprayer. This tool sprays pesticide liquid through a pipe or hose and is released in the form of droplets or granules (Annafiyah et al., 2021). According to research conducted by Ramli et al (2015), of 43 farmers who received spraying for 3 to 6 hours, 32 people (74.4%) experienced anemia, and 11 people (25.6%) did not experience anemia. However, research (Puspoayu et al., 2018) found a relationship between personal protective equipment and hemoglobin levels, with a correlation value of 0.789, indicating a strong positive relationship between them and hemoglobin levels. In other words, the more personal protective equipment used, the more hemoglobin levels will also increase.

Anemia occurs when the number of circulating red blood cells or hemoglobin cannot carry oxygen to all body tissues. Anemia includes decreased hemoglobin levels, red blood cell counts, and macrocrit levels (Hendrayana et al., 2020). In 2015, the World Health Organization (WHO) defined anemia as low levels of hemoglobin in the blood. Hemoglobin is an important component of red blood cells that binds oxygen. Low hemoglobin levels cause the body's cells to not get enough oxygen, resulting in symptoms of anemia such as fatigue, weakness, and lethargy (Shinta & Sonata, 2019)Pesticide poisoning can cause liver and kidney disorders and low levels of hemoglobin in red blood cells which can cause anemia. Chemical compounds such as dimethyl dithiocarbamate (DDC), sulfur, and nitrite contained in pesticides in high levels can cause anemia because they can stop the function of superoxide dismutase, reduce glutathione function, and produce sulfhemoglobin and methemoglobin in red blood cells (Kelner et al., 1986.

One of the “x” sugarcane plantation centers in South Sumatra Province is Ogan Ilir Regency. Ogan Ilir Regency with a sugarcane plantation area of around 18,213 Ha, and sugarcane production reached 1,03,958 tons and sugar production reached 49,352 tons. The processed sugarcane products produced include granulated sugar and molasses. In the initial survey, interviews were conducted with pesticide sprayers who used pesticides with the type of paraquat herbicide with the ideal temperature for sugarcane plants ranging from 24 ° C - 34 ° C and spraying time 3-5 hours in one day with a dose of paraquat herbicide 2 liters / ha, obtained an assessment that the low awareness of farmers in using Personal Protective Equipment (PPE) can affect their own health, complaints that are often felt by farmers include fatigue, itching, shortness of breath, dizziness and eye irritation. Based on the initial survey, it is necessary to identify the use of pesticides with further laboratory tests to ascertain the presence or absence of pesticide residues in the blood. Laboratory testing was carried out by examining hemoglobin levels in workers who sprayed pesticides at locations around the sugar cane plantation “x”. This study aims to evaluate the relationship between pesticide use and hemoglobin levels (Disbun Prov. South Sumatra, 2023).

METHOD

This study is a descriptive study to find the correlation of paraquat pesticide exposure in the blood. Quota sampling technique as many as 51 samples (Sugiyono, 2016). In addition to data from laboratory tests and questionnaires, in-depth interviews were also conducted with workers and company management to clarify several research variables.This research was conducted in October 2024 - December 2024. The research location is in the Sugarcane Plantation of Ogan Ilir Regency, with the distance to the plantation location from the Bandung Series highway around ± 13 km. The area of sugarcane plantations in Ogan Ilir Regency is around 18,213 Ha, consisting of 5 divisions that have been planted with immature sugarcane, plasma areas, nursery areas, and office areas and sugarcane processing factory

areas.Blood samples of pesticide sprayers were taken through the vein of 1/3 of the arm using a 3 cc syringe with an angle of 15◦c and the hole facing up. Samples were stored in vaculab plain blood tubes and given the respondent's name and sample code (in accordance with KEMENKES regulation No.1406/MENKES/SK/XI/2002).

This study proposes two variables, namely independent and dependent. The independent variables consist of age, sex, length of service, education, personal protective equipment (PPE), length of spraying, frequency of spraying, spraying time, spraying dose and amount of mixture. Meanwhile, the dependent variable was the use of paraquat pesticide. Data analysis used univariate, bivariate and multivariate analysis. Bivariate analysis used Chi-Square test, while multivariate analysis used logistic regression test. Data were interpreted based on the significance value (p-value). In addition, multivariate analysis used the logistic regression test with backward LR to find the best regression model where the variables included in the multivariate analysis were variables with a p-value <0.05. The most dominant variable is seen from the results of multivariate analysis with the smallest p-value and a very large wald value. This research has received ethical clearance from the Ethics Committee of the Department of the Faculty of Public Health, Sriwijaya University, No. 405/UN9.FKM/TU.KKE/2024.

RESULT

Hemoglobin concentrations measured in blood samples of workers spraying sugarcane plantation “x” in Ogan Ilir District are presented in the following table:

Table 1.
Analisis univariat distribusi frekuensi karakteristik (n=51)

Characteristics	f	%
Age		
Productive Working Age 15- 64 Years	50	98,0
Non-productive working age > 64 years	1	2,0
Sex		
Male	45	88,2
Female	6	11,8
Length of Service		
New <= 5 Years	22	41,3
Long > 5 Years	29	56,9
Education		
Not in School	2	3,9
SD	19	37,3
SMP	8	15,7
SMA	21	41,2
Higher Education	1	2,0

The results of the univariate analysis above show that of the 51 respondents, the number of workers whose productive working age is 15-64 years as many as 50 people (98%) and workers aged >64 years as many as 1 person (2.0%) with male sex as many as 45 people (88.2%), and female sex as many as 6 people (11.8%). While the working period > 5 years as many as 29 people (56.9%), new < 5 years as many as 22 people (41.3%), and the majority of high school education as many as 21 people (41.2%).

Table 2.
Univariate Analysis of Frequency distribution of Pesticide (Paraquat) Use

Behavior	f	%
Personal Protective Equipment		
Incomplete < 5	11	21,6
Complete >= 5	40	78,4
Duration of Spraying		
Poor > 4 hours a day	34	66,7
Good <=4 hours a day	17	33,3
Spraying Frequency		
Poor if >2 times/week	5	9,8
Good if <= 2 times/week	46	90,2
Spraying Time		
Not Suitable	7	13,7
Suitable	44	86,3
Spraying Dosage		
Not Appropriate	1	2,0
Appropriate	50	98,0
Amount of Mix		
Poor if >4 mix types	1	2,0
Good if <= 4 mix types	50	98,0

The results of the Univariate analysis above show that of the 51 respondents it was found that the use of personal protective equipment (PPE) was mostly incomplete as many as 11 people (21.6%), complete 40 people (78.4%), the length of spraying in the bad category was 34 people (66.7%), good as many as 17 people (33.3), The frequency of spraying was poor at 5 people (98.8%), good at 46 people (90.2%), the time of spraying was not suitable at 7 people (13.7%), suitable at 44 people (86.3%), the dose of spraying was not suitable at 1 person (2.0%), suitable at 50 people (98.0%), and the amount of pesticide mixture was poor at 1 person (2.0%), bad at 50 people (98.0%).

Table 3.
Univariate analysis of the distribution of *hemoglobin levels*

Hemoglobin Level	f	%
Abnormal	17	33,3
Normal	34	66,7

The results of the univariate analysis above show that out of 51 respondents, there were 17 respondents with abnormal hemoglobin levels (33.3%), 34 people (66.7%) were normal.

Table 4.
Bivariate Analysis of pesticide use (paraquat) on Hemoglobin levels in sugarcane plantation workers "X"

Pesticide (Paraquat) Use	Hemoglobin Levels		Total	P	OR
	Poisoning f (%)	Normal f (%)	f (%)		95% CI
Personal protective equipment					
Incomplete if < 5	9 (81,8)	2 (18,2)	11 (100,0)	),000	18,000
Complete if >= 5	8 (20,0)	32 (80,0)	40 (100,0)		(3,233 – 100,212)
Duration of spraying					
Bad if > 4 hours a day	15 (44,1)	19 (55,9)	34 (100,0)	),028	5,921
Good if <= 4 hours a day	2 (11,8)	15 (88,2)	17 (100,0)		(1,168 – 30,019)
Spraying frequency					
Poor if > 2 times/week	3 (60,0)	2 (40,0)	5 (100,0)	),318	3,429

Pesticide (Paraquat) Use	Hemoglobin Levels		Total	P	OR
	Poisoning f (%)	Normal f (%)	f (%)		95% CI
Good if <= 2 times/week	14 (30,4)	32 (69,6)	46 (100,0)		(0,515 – 22,837)
Spraying time					
Not Applicable	4 (57,1)	3 (42,9)	7 (100,0)	),203	3,179
Applicable	13 (29,5)	31 (70,5)	44 (100,0)		(0,622 – 16,244)
Spraying dose					
Not Appropriate	1 (100,0)	0 (0,0)	1 (100,0)	),333	-
Appropriate	16 (32,0)	34 (68,0)	50 (100,0)		
Number of mixtures					
Poor if > 4 types of mixtures	1 (100,0)	0 (0,0)	1 (100,0)	),333	-
Good if <= 4 types of mixtures	16 (32,0)	34 (68,0)	50 (100,0)		

**Uji Chi-square*

Based on the results of a study of 51 respondents, it was found that several factors influence the hemoglobin levels of workers exposed to pesticides. The use of complete Personal Protective Equipment (PPE) proved to be important, with 80.0% of respondents who used 5 or more types of PPE having normal hemoglobin levels, while only 18.2% of those who used less than 5 types of PPE were normal. Spraying duration of more than 4 hours per day increased the risk of hemoglobin disorders, with 44.1% of respondents having abnormal levels, compared to 11.8% in those working 4 hours or less. The frequency of spraying was also influential, with 60.0% of respondents who sprayed more than twice a week having abnormal hemoglobin levels. Spraying at non-recommended times (11:00-15:00) showed 57.1% abnormal hemoglobin levels, while at safe times (before 11:00 or after 15:00) only 29.5%. Appropriate pesticide doses (0.5-1.5 kg/ha) were associated with 68.0% normal hemoglobin levels, while inappropriate doses caused impairment in 100% of respondents. Finally, mixing more than 4 pesticides increased the risk, with 100% of respondents who mixed more than 4 pesticides having abnormal hemoglobin levels. In conclusion, the use of complete PPE, lower duration and frequency of spraying, and the use of appropriate pesticide dosage and mixture can reduce the risk of disturbances in workers' hemoglobin levels.

Table 5.
Analysis Results of Logistic Regression Multivariate

					95% C.I.for EXP(B)	
	Variables	B	Sig.	Exp(B)	Lower	Upper
Initial model Hemoglobin levels	Use of PPE	22,190	0,999	4861584,592	0,000	-
	Duration of Spraying	1,581	0,090	4,860	0,782	30,189
	Spraying Time	-19,977	0,999	0,000	0,000	-
	Constanta	-2,497				
Final model Hemoglobin levels	Duration of Spraying	1,779	,032	5,921	1,168	30,019
	Constant	-2,015				

Based on the results of the multivariate analysis in Table 5, of the three main factors affecting hemoglobin levels, the multivariate analysis of three factors (PPE use, spraying duration, and spraying time) showed that spraying duration was the most significantly influential factor. Farmers who sprayed for more than 4 hours a day had a 5.92 times higher risk of having abnormal hemoglobin levels compared to farmers who sprayed for 4 hours or less (OR=5.921; p=0.032; 95% CI: 1.168-30.019). This indicates that prolonged exposure duration may cause disturbances in blood components, including hemoglobin.

DISCUSSION

The results of the above analysis show that out of the 51 respondents surveyed, workers who did not use the full range of PPE had a higher rate of abnormal hemoglobin levels. A total of 81.8% of those who used less than 5 personal protective equipment had abnormal hemoglobin levels, compared to only 20.0% of those who used 5 or more personal protective equipment. Chi-Square test results (p = 0.000) showed a highly significant relationship, with an OR value of 18, which means that workers who are incomplete in using PPE are at 18 times greater risk of having abnormal hemoglobin levels. Previous research by Puspoayu et al. (2018) also confirmed a strong positive relationship between the use of PPE and hemoglobin levels, with a correlation of 0.789. The length of time spraying pesticides is also a factor that affects hemoglobin levels. Of the 51 respondents, workers who sprayed more than 4 hours a day had higher abnormal hemoglobin levels. A total of 44.1% of workers spraying more than 4 hours a day had abnormal hemoglobin levels, while only 11.8% of those working less than 4 hours. Chi-Square test showed a p value = 0.028, which means there is a significant association between the length of spraying and hemoglobin levels with an OR value of 5.921.

This means that workers who spray longer are at almost 6 times greater risk of having abnormal hemoglobin levels. Research by Ramli et al. (2015) also showed that the length of exposure to pesticides is closely related to the incidence of anemia in farmers, the longer the spraying, the greater the risk of poisoning. However, the frequency of spraying did not show a significant relationship with hemoglobin levels. From the survey results, 60.0% of workers who sprayed more than twice a week had abnormal hemoglobin levels, while 30.4% of workers who sprayed less frequently experienced the same. However, the Chi-Square test yielded a p value of 0.318, indicating that spraying frequency did not significantly affect hemoglobin levels. This result is in line with the findings of Kurniasih et al.'s study, which also found no association between spraying frequency and anemia. Similarly, the time of spraying did not find a significant relationship with hemoglobin levels. In sugarcane plantation "X," 57.1% of workers who sprayed at inappropriate times (after 11:00 am or in the afternoon before 3:00 pm) had abnormal hemoglobin levels.

However, the Chi-Square test results showed a p value = 0.203, which means there is no significant relationship between spraying time and hemoglobin levels. Research by Nella et al. (2016) also showed similar results, where spraying time was not directly related to the incidence of anemia. The dose of pesticide used by workers also did not show a significant relationship with hemoglobin levels. In this study, workers who used inappropriate doses of pesticides (more than 1.5 kg/ha) had only 10.0% abnormal hemoglobin levels. Meanwhile, among those who used the correct dosage, 32.0% had abnormal hemoglobin levels. However, the Chi-Square test yielded a p value = 0.333, indicating that pesticide dosage did not significantly affect hemoglobin levels. Previous research by Hotang et al. (2020) showed that pesticide dosage was associated with poisoning in farmers, but this study did not find a similar relationship. Meanwhile, the number of pesticide mixtures was also not associated with hemoglobin levels. Of the 51 respondents, workers who used more than 4 types of pesticide mixtures only had 10.0% abnormal hemoglobin levels, while in workers who used 4 or more types, 32.0% experienced the same thing. Although there is a difference in percentage, the Chi-Square test results (p = 0.333) showed no significant relationship between the number of pesticide mixtures and hemoglobin levels. Research by Reni et al. (2023) stated that the use of more types of pesticides can increase the risk of poisoning, but this study did not find the same evidence.

CONCLUSION

Based on the results of research on 51 respondents of sugar cane plantation workers, it can be concluded that there is a significant relationship between the use of complete Personal Protective Equipment (PPE) and normal hemoglobin levels. Workers who do not use complete PPE have an 18 times greater risk of experiencing abnormal hemoglobin levels. In addition, the length of time spraying pesticides also had a significant effect on hemoglobin levels. Workers who sprayed more than 4 hours per day had almost 6 times greater risk of abnormal hemoglobin compared to those who sprayed less than 4 hours. However, several other factors such as frequency of spraying, time of spraying, dose of pesticide used, as well as the amount of pesticide mixture did not show a significant relationship with hemoglobin levels. This suggests that while pesticide exposure remains a risk, personal protection and duration of exposure are the main factors influencing the hemoglobin condition of workers.

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