DETERMINANTS OF BLOOD CHOLINESTERASE LEVEL IN EMPLOYEES AT AN OIL PALM PLANTATION

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Abstract
Purpose: The use of pesticides is one of the farmers effort to reduce pest disturbances. However, the use of pesticides has an adverse effect on health. This study aims to analyze the determinants that affect blood cholinesterase levels at oil palm plantation employees.
Methods: This research was conducted using cross-sectional design. The population were all employees who worked in the spraying, fertilizing, and pesticide and fertilizer warehouse sections worked on oil palm plantations. The study sample consisted of 230 employees were selected by simple random sampling. Data were collected by using questionnaires and direct interviews regarding age, work period, nutritional status, and the use of personal protective

equipment (PPE). Blood cholinesterase level was measured using the Tintometer Kit. Data analysis used Multiple Logistic Regression.

Results: The results showed that there were two variables as determinant for blood cholinesterase levels, age (p=0.005) and the use of personal protective equipment (p=0.013), and there were two variables that were not determinant/risk factor for blood cholinesterase levels, years of service (p=0.424) and nutritional status (p=1.0).This study shows the importance of paying attention to age and the habit of using PPE for the activities related to pesticides in the workplace.

Conclusion: The determinant factors of blood cholinesterase levels in employees of oil palm plantation are age and the use of PPE

Keywords: *cholinesterase,age, nutritional status, personal protective equipment, work period*

I. INTRODUCTION

Agriculture is one of the employment sectors in Indonesia. Even though there is a decreasing trend, the number of employees working in this sector is still 40% out of all employees. Plantation as the Local Own-Source Revenue (PAD) has become a primary sector in many regencies in Indonesia. One of the people's economic bases in Indonesia is agriculture. Agriculture also becomes a determinant of defense and even food sovereignty, yet in this fertile land, the majority of people depending on agricultural livelihood still cannot increase their standard of living to be more prosperous[(1)]. This sector is inextricably linked to many kinds of agricultural practice, for instance, the application of pesticides aiming at eliminating pests for improving the total crops.

Organophosphate pesticide (OP) is a type of pesticide widely recommended in the agricultural sector due to its characteristic that is easy to decompose in the earth[(2)]. The use of this group of pesticides is still considered common in Indonesia for eradicating pests. However, the pesticide application leads to anxiety due to its ability in eradicating pests and causing direct poisoning in farmers or consumers who consume the crops sprayed with this pesticide group[(3)]. Being poisoned because of pesticides contributes one-third of the overall total of global mortality with the incident rate of being poisoned due to organophosphate pesticides in the world reaching one million cases annually[(4,5)]. It is estimated around 385 million cases of pesticide poisoningthat unintentionally happen annually all over the world with a mortality rate of 11,000 deaths. Based on the agricultural population over the world of around 860 million, it is approximately 44% of farmers being poisoned with pesticides annually. The biggest case is estimated to happen in South Asia, followed by Southeast Asia and East Africa related to unintentional non-fatal pesticide poisoning[(6)].

Some pesticide poisoning cases found in Indonesia were that out of 30 pest control workers in Sleman Regency, 14 of them were reported (46.66%) to have poisoning symptoms. Kulon Progo has 210 poisoning cases with physical and clinical examinations and 50 people of them were examined in the laboratory resulting in 15 people (30%) were positively poisoned. Based on the cholinesterase activity examination conducted in The technical implementation unit for the office of industrial hygiene, ergonomy, work environment, and occupational

safety and health (*UPT Balai Hiperkes dan KK*) of Bali Province in 2013, the prevalence for farmers in Bali with pesticide poisoning was 41%[(7)].

Pesticides can cause poisoning since this substance can enter the body in some ways, namely through the skin (dermal), respiration (inhalation), or mouth (oral). Furthermore, this substance will be absorbed in the body and metabolism. The pesticide that enters the body will inhibit acetylcholinesterase or the enzyme found in the central nervous system and peripheral system. Acetylcholinesterase functions in the neurotransmitter hydrolysis of acetylcholineinto acetate and choline; thus, if it is blocked, acetylcholinewill be accumulated in the receptor and it will extend the excitatory effect of cholinergic neurons at pre-and postganglionic[(8)]. Acetylcholine accumulation can trigger the abnormality of cholinergic compound performance in both the central nervous system and peripheral nervous system. In acute poisoning cases, the clinical symptoms can be headache, salivation, lacrimation, diarrhea, nausea, vomit, tachycardia / bradycardia, respiratory depression, narrowing of the respiratory tract (airway constriction), loss of consciousness (fainting), convulsions, meiosis up to muscle disorders[(9)].

Several factors that can affect the level of pesticide poisoning, such as spray duration, spraying activity, and personal hygiene with pesticide poisoning symptoms, the amount of pesticide, pesticide dosage, spray time, knowledge level, the use of PPE (Personal Protective Equipment) and spray method[(10-15)]. The use of personal protective equipment is known to be able to decrease the poisoning rate due to pesticide exposure as in a study conducted by Mirrezaei reporting that the use of appropriate personal protective equipment plays an important role in decreasing the damage level of cholinesterase[(16)]. A study by Andarini reported that there was no significant correlation between work period and cholinesterase level[(17)]. The correlation between age and cholinesterase level is known significant; old farmers have a lower cholinesterase level[(18)]. A study conducted by Handayani stated that nutritional status did not affect the pesticide poisoning incidence[(19)].

The Regulation by the Ministry of Manpower No.Per-03/Men/1986 Article 2 paragraph 2a mentioned that the duration of using pesticides is not recommended to be more than four hours per day in a week consecutively to protect us from adverse events of using pesticides. The workers who manage pesticides may not be exposed for more than 5 hours per day and 30 hours per week. Meanwhile, WHO requires conducting medical examination every week, such as the examination of cholinesterase level of the blood, and has established the spraying duration using pesticides while working, namely 5-6 hours per day[(20)].

The measurement of pesticide exposure duration can be calculatedusing the following formula, work hour is multiplied by spraying frequency. Work hour is defined as the required duration to work dealing with pesticides while spraying frequency is the intensity of spraying pesticides.The longer the work hour, the more frequent the spraying and the higher the possibility to be exposed to pesticides. The workers who work dealing with pesticides for a long duration will have chronic poisoning. It means that the longer someone works, the more the pesticides being absorbed in the body leads to a decrease in cholinesterase activity. The

work period can be explained specifically based on the exposure duration. Work duration is the duration of someone works as a farmer. Someone who works in an environment containing pesticides will have a higher possibility to be exposed and a higher possibility of poisoning. It is caused by an increased number of contact and the amount of pesticide being absorbed in the body.

PT X is a company operating in the plantation sector and processing of CPO (Crude Palm Oil) that has been established since 2006. To perform the official statement of Laws number 23 of 1992 that each workplace shall perform occupational health to prevent health disorders in employees, families, society, and surrounding environment and identify the negative effects caused by the work environment, PT. X monitors the employees' health by conducting medical checks to employees in the form of an examination of the changes in the blood cholinesterase level to know how far the effect of the work environment on employees' health. PT. X also facilitated the employees with PPE. Nevertheless, in reality, PPE is not always worn by the employees while working and most employees are found not wearing PPE. In 2018, it was recorded 50 poisoning cases due to organophosphate pesticides (OP) in pesticide spraying farmers. Based on the elaboration, the objective of this study was to analyze the effect of age, work period, nutritional status, and the use of PPE on the cholinesterase blood level of oil palm plantation employees.

II. METHOD

The type of this study was a quantitative study using a cross-sectional studydesign[21]. A cross-sectionalstudy is a study that identifies the effect of independent variables and dependent variables by observing both of them simultaneously (measured at the same time). The dependent variable in this study was blood cholinesterase level in farmers. Meanwhile, the independent variables comprised age, work period, nutritional status, and the use of PPE by employees.

The population in this study was all employees of 570 people in spraying division, fertilization, and the warehouse for pesticides and fertilizer worked in oil palm plantation at PT X. The total sample used in this study was 230 people taken using a simple random sampling from the total population. The examination of blood cholinesterase level to the respondents was held using Tintometer Kit.

The data collection technique in this study was conducting an interview[22]; it is a process to collect information by conducting a face-to-face question and answer session with the respondents using a questionnaire. An interview is a method used for data collection, whereby a researcher collects descriptions or information orally from the research targeted persons (respondents) or has a face-to-face conversation with people[21].The interview technique in this study was used for collecting data related to age, work period, nutritional status, and the use of PPE.

The data and source of data in this study used primary data. Primary data are the data that directly provide data to the researcher. The primary data of the interview used a questionnaire for age, work period, nutritional status, and the use of PPE.

The investigated dependent variable was the activity of cholinesterase level in the farmers' blood. The blood sample was taken from the fingers' tip (index finger, middle finger, or ring finger) by pricking using a lancet. The amount of collected blood was 0.01cc; then, it was poured into a test tube and shaken carefully. 0.05ml ACP was added into the tube and shaken carefully. Subsequently, the content inside the tube was moved into the cuvette available in the comparator. This cuvette was placed in the right-hand compartment of the comparator, and the same color as in the disc was sought. Further, the percentage of cholinesterase shown on the comparator in the Tintometer kit was observed. Each basic color expressed the percentage of (%)cholinesterase activity: Normal (>75%-100%), mild pesticide poisoning (>50% - 75%), moderate pesticide poisoning (>25% - 50%), and severe pesticide poisoning (0% - 25%). The independent variables were age, work period, nutritional status, and the use of PPE collected through an interview using a questionnaire as the instrument.

Univarate analysis is aimed at analyzing the variables related to individual characteristics descriptively by using frequency distribution and its proportion. The univariate analysis in this study would be applied to each research variable coveringage, work period, nutritional status, and the use of PPE. Meanwhile, bivariate analysis was aimed at identifying the effect of two variables, namely independent variable and dependent variable. The statistical test used in this study wasa Chi-Square test. Multivariate analysis is a processing method using two variables or more against a certain object or person simultaneously. Therefore, regression analysis was used. The collected data were distributed in the form of a table and narrated. This study have been approved by Health Research Ethics Committee, Faculty of Public Health,

III. FINDINGS

This study was conducted at PT "X" specifically for employees who were directly in contact with pesticides. They were employees in the spraying division, fertilizer division, and warehouse division with a total of 570 employees. The total collected respondent was 230 employees selected by using a simple random sampling.

Table 1 showed that the dominant of respondents' age is 149 young people (<35 years old), the mean age is 32 years old. The youngest is 16 years old and the oldest is 61 years old. Based on the working period, most of them are new employees (131 people/57%) by the average of the work period is 2 years. The newest is <1 year, and the longest is 8 years. The distribution of the nutritional status shows that most of the respondents in a normal status (18.5-22.9 kg/m^2) (151 people/65.7%), the average nutritional status is 22.2 kg/m^2. The lowest value is 15.31 kg/m^2 and the higher value is 37.56 kg/m^2. Table 1 also shows that most of the respondents use the PPE (192 people/83.5%). Based on the blood cholinesterase level, most of them are in the normal category (>75%) (218 people/94.8%) by an average of 95.48%. The lowest level of blood cholinesterase is 62.5% and the higher is 100%.

Table 2 shows the result of bivariate analysis for the data of this study that is conducted using crosstabswith a chi-square test (X^2).The statistical result of bivariate analysis with a chi-square test in the Fisher's Exact Test value for age showed a significant correlation(p=0.001) with the respondents' blood cholinesterase level.It indicates that age (≥35 years old) is a determinant of blood cholinesterase level in the respondents. Table 2 also shows that the statistical result of bivariate analysis using a chi-square test in the Continuity Correction value for the work period shows no significant correlation (p=0.424) with the respondents' blood cholinesterase level.It means that the work period (≥5 years) is not the determinant of blood cholinesterase level in the respondents. Moreover, the statistical result for nutritional status showed no significant correlation (p=1.0) with the respondents' blood cholinesterase level.It indicates that nutritional status (abnormal) is not the determinant of blood cholinesterase level in the respondents. Meanwhile, for the use of PPE, it was significantly correlated (p=0.006) with the respondents' blood cholinesterase level. It means that the use of PPE is the determinant of blood cholinesterase level in the respondents.

The variables that could be made as the candidate variable for multivariate analysis were the variables that had been analyzed bivariately and had a p-value of <0.25. Of four research variables, two candidate variables were included in multivariate analysis, namely age and the use of PPE. Table 3 shows the analysis result using the Multiple Logistic Regression test with the Enter method; it shows that the old respondents (≥35 years old) are at risk of having an abnormal blood cholinesterase level of 9.1times higher than the young respondents (<35 years old). Besides, the respondents who did not use PPE were at risk of having an abnormal blood cholinesterase level of 4.8higher than the respondents who used PPE. The result shows that the determinants of cholinesterase level are age and the use of PPE. The single dominant variable as the determinant of cholinesterase level in this study was age (≥ 35 years old) with an OR value of 9.1 at a 95% CI (1.92 – 43.71).

The multiple logistic regression equation modeling was used for predicting the possibility of an abnormal blood cholinesterase level. Based on the calculation result of the probability event equationfrom the result of the multiplelogisticregression analysis above, it shows that old respondents (≥35 years old) and those who do not use PPE have a probability of abnormal blood cholinesterase level of 71.37%.

IV. DISCUSSION

Based on the multivariate analysis using the Multiple Logistic Regression test with the Enter method at a confidence indicator of 95%, it is proven that two variables are known as the determinants of abnormal blood cholinesterase level. It can be seen as follows. From the study result, old age (>35 years old) is at risk of experiencing pesticide poisoning. Age becomes one of the risk factors of cholinesterase level. As people getting older, the work duration with pesticides is getting longer, indicating that the probability of being exposed to pesticides is getting bigger.

The body's metabolism functions in someone will also be decreasing as he/she is getting older and he/she will have a big possibility of being poisoned. Physiologically, the human body's immune system will be weakening as people get older, while the incidence of pesticide poisoning is stringly affected by the human body's immune system factor. As someone gets older, the internal organ function is also decreasing. For instance, liver or kidney disease can affect the cholinesterase level of the blood. The liver and kidney play a role in primary physiological function as antitoxin and a neutralizing agent for chemical substances entering the body.

From the result, it is also known that 71 old people (87.7%) have a normal cholinesterase level even though the number is less than young people (147 people/98.7%). It explains that there is another factor that can affect the decrease in the cholinesterase level. For example, old people with good nutrient intake will support their body's immune system to be better and, on the other hand, young people with poor nutrient intake will affect their organ performance and their body's immune system will also be decreasing. From the study result, 2 young people (1.3%) were found to have an abnormal cholinesterase level.

The result of a study conducted by Karanth, using mice as the animal model is known that old mice are more sensitive to acute toxicity of organophosphate insecticides[(23)]. Biotransformation during maturity and aging becomes an important thing in distinguishing sensitivity related to age towards pesticides. Immature and too old animals generally have lower biotransformation capacity, such as having a mono-oxygenize level depending on lower Cytochrome P450[(24)].

A similar result is stated by Hermawan that blood cholinesterase activity in guava farmers in Pesaren village, Sukorejo Sub-district, Kendal regency with a result stating that age has a substantial correlation with cholinesterase level in the farmers' blood[(25)]. The pesticide exposure in farmers can be decreased by using sufficient personal protective equipment. Based on the Regulation of the Indonesian Ministry of Manpower and Transmigration Number Per.08/Men/VII/2010, personal protective equipment (PPE) is equipment having the ability to protect someone and functions to isolate some or the entire body from the potential hazards in the workplace[(26)]. PPE will protect employees from direct contact with pesticides while spraying or while preparing pesticides. The risk of pesticide poisoning can be avoided if the employees use complete personal protective equipment.

The result of this study is in line with a study conducted by Budiawan stating that there is a correlation between the use of personal protective equipment (PPE) and cholinesterase level in shallot farmers in Ngurensiti, Pati[(27)]. A study by Fajriani reported that there is a significant correlation between the use of complete PPE and cholinesterase level in farmers' blood[(28)]. The same result is reported in a study conducted by Samosir stating that there is a correlation between the habit of using PPE and balance disorders in farmers of horticulture in Sumberejo village, Ngablak sub-district, Magelang regency[(7)]. Farmers with a habit of using PPE have a risk of more than 2.5 times higher to have balance disorders than the farmers who use complete personal protective equipment. It is in line with a theory proposed by Sartono

stating that pesticide poisoning can occur because of excessive pesticide entering the body or because of ignoring the occupational security, health, and safety procedure and insufficient work equipment[29].

The use of PPE is significantly correlated with pesticide poisoning symptoms and becomes the risk factor. If this condition continues to happen, it can lead to more serious health problems[30]. PPE, consisting of gloves, masks, work clothing, work shoes, respirator, goggles, and face shield, is an important component for employees' safety and a reliable method that can be used for preventing and minimizing the negative effects of pesticides[31]. PPE can help employees to avoid direct contact with pesticides. PPE should be used for minimizing the side effects of pesticides on health. These harmful effects from pesticides cannot fully be eliminated by using PPE but the risk of damaging health can be decreased extensively[32].

Based on the multivariate analysis using the Multiple Logistic Regression test with the Enter method at a confidence interval of 95%, it is proven that there are two variables that are not the determinants of abnormal blood cholinesterase level. They are as follows. The work period was the duration since the respondents becoming active as employees of an oil palm plantation until the study was conducted. The duration of the work period contributes to the decrease in cholinesterase level. The employees with a longer work period had a higher risk of having pesticide poisoning[33].

Pesticide exposure in a long time will lead to hazardous chemical substance accumulation in the body and cause health problems in the body. The longer the body is being exposed to pesticides, the quantity of toxic pesticide that enters the body will be accumulated and affect the farmers' health; with the impact of being poisoned, it will be felt slowly by the farmers' body and even lead to death. If the farmers' work period is longer, the cholinesterase level will be lower, and as a result, the poisoning risk will be higher, and more toxic substances enter the body[34]. People with direct and long contact with pesticides have a higher risk to be exposed. An increased risk of exposure is the cause of pesticide accumulation on clothes, the skin, and boots after spraying in the field and the inhalation exposure through the spraying residue and water spraying[35].

Nonetheless, this study collected a result that work period was not the risk factor of an abnormal blood cholinesterase level. It means that the hypothesis stating that employees' work period is correlated with abnormal blood cholinesterase level is rejected. This result is in line with a study by Lestari about the correlation between work period and blood cholinesterase level in employees who spray pesticides for oil palm plantation, stating that there is no significant correlation between work period and blood cholinesterase level[36]

Theoretically, according to Sastrawijaya, someone's work period is one of the factors affecting the decrease in cholinesterase level of the blood, whereby the longer the work period, the lower the cholinesterase level of the blood that will be at risk of being exposed to pesticide poisoning[37]. If the pesticide is absorbed in the body, it can bind the cholinesterase

of the blood. Consequently, the blood cholinesterase level will be decreasing and it causes pesticide poisoning that can be detected by the symptoms and complaints felt by the farmers after spraying[38]. The cholinesterase activity in the blood can be made as an indication of pesticides in the blood[39].

It is different from a study conducted by Tutu reporting a significant correlation between work period and cholinesterase activity[40]. Another study conducted by Istianah on the correlation between work period, spraying duration, types of pesticide, the use of PPE, and the management of pesticides with the poisoning incidence in farmers in Brebes stated that there was a significant correlation between work period and blood cholinesterase level[41]. One of the factors causing no correlation between work period and the incidence of pesticide poisoning is a large number of employees with a new work period in the company that is investigated. However, they have worked in other oil palm companies.

The lower the body weight compared to the standard weight (height-weight table), the higher the serum cholinesterase level and vice versa[42]. It indicates that someone with an overweight condition will have a lower cholinesterase level. From the result, it is known that nutritional status is not the determinant factor of blood cholinesterase level. This study is in line with a study conducted by Gustiana entitled the correlation between nutritional status and HB level with the activity of rice farmers' blood cholinesterase level in Sidanegara urban village, Cilacap, in 2007, collected a result that there was no correlation between nutritional status and the cholinesterase activity[43].

However, a different result is reported in a study conducted by Akbar entitled the correlation between work period, nutritional status, pesticide management method, and personal hygiene with the cholinesterase activity in farmers in Alahan Panjang in 2018, stating that the variables that are correlated with the cholinesterase activity in vegetable farmers are work period and nutritional status[44]. This study showed that employees with either normal or abnormal nutritional status were prone to experience an increase in their blood cholinesterase level, indicating that abnormal nutritional status may not show low cholinesterase activity. It is because of each person's various (employee) immunities; even though the nutritional status is normal but the immunity is low, the person will be easy to be exposed to pesticides and it will lead to low blood cholinesterase level (poisoning)

V. CONCLUSION

This study reveals that age and the use of PPE are the determinants of blood cholinesterase level in employees of oil palm plantation with the following values: age (p=0.005), OR=9.1, 95% CI=1.92-43.71, and the use of PPE (p=0.013), OR=4.8, 95% CI=1.39-16.71 and two variables are not the determinants of blood cholinesterase level, namely work period (p=0.424) and nutritional status (p=1.0). This study shows the importance of a habit of using PPE while doing activities related to pesticides in the workplace.

The limitation in this study is that the researcher shall use an observation sheet other than a questionnaire. The researcher must collect representative answers and employees' honesty in

answering questions, especially on the habit of using PPE while doing activities related to pesticides in the workplace. Besides, the possibility of information bias can happen in the data collection using questionnaires with the question target on the independent variable to know the information from the respondents related to a behavior of using PPE.

VI. SUGGESTIONS

Employees in the company need to keep their hygiene after having contact with pesticides, especially before drinking and eating as well as washing clothes after spraying. The company needs to ensure the use of complete PPE while working as recommended either on the pesticide label or from the company's HSE division. Strict supervision needs to be applied by the company, especially towards the health condition of employees who are exposed to pesticides based on the result of the cholinesterase test.

Therefore, prevention and medical treatment actions can be performed as early as possible. The company can rotate the employees who are exposed to pesticides to the division with no contact with pesticides. Suggestion for the next researcher is that this study does not reveal other determinant factors that are not reached in this study. It is important to be investigated further considering that blood cholinesterase level is affected by several risk factors (multifactorial causes).

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Table (1) : **The Characteristics of Employees in Oil Palm Plantation**

Characteristics	**Category**	**n**	**Percentage (%)**
Age	Old	81	35.20
	Young	149	64.80

Work period	Long	99	43.00
	New	131	57.00
Nutritional Status	Abnormal	79	34.30
	Normal	151	65.70
The use of PPE	Use	38	16.50
	Do not use	192	83.50
Blood cholinesterase Level	Abnormal	12	5.20
	Normal	218	94.80
Total		230	100.0

Table (2) : **The Correlation Analysis of Blood Cholinesterase Level of Employees in Oil Palm Plantation**

Characteristics	**Category**	**Blood Cholinesterase Level**				**Total**		***p*-value**
		Abnormal		**Normal**				
		n	**%**	**n**	**%**	**n**	**%**	
Age	Old	10	12.30	71	87.70	81	100	0.001*
	Young	2	1.30	147	98.70	149	100	
Work period	Long	7	7.10	92	92.90	99	100	0.424
	New	5	3.80	126	96.20	131	100	
Nutritional Status	Abnormal	4	5.10	75	94.90	79	100	1.00
	Normal	8	5.30	143	94.70	151	100	
The use of PPE	Use	6	15.80	32	84.20	38	100	0.006*
	Do not use	6	3.10	186	96.90	192	100	
Total		12	94.8	218	5.20	230	100	

***the candidate variable for multivariate analysis by p-value<0.025*

Table (3) : **The Result of Multivariate Analysis**

No.	**Determinants**	***p*-value**	**OR**	**CI 95%**	
				Lower	**Upper**
1	Age	0.005	9.10	1.92	43.71
2	The use of PPE	0.013	4.80	1.39	16.71