Risk Factors for Contamination of Pesticide Residues in Women's Breast Milk Farmers in Agricultural Areas

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ABSTRACT

Pesticides are all chemicals, and other materials, including bodies and viruses, serve as controls for pests and weeds' growth. Acute and chronic pesticide exposure can harm human health and affect the environment. The vulnerable group to pesticide exposure is female farmers, especially breastfeeding, due to pesticides' lipophilic characteristics. This study aimed to identify the pesticide residue contamination in women farmers' breast milk in agricultural areas and analyze the risk factors. In the study, we use quantitative descriptive as its method with a cross-sectional approach. A sample of 10 female farmers was selected using the purposive sampling technique. Data on risk factors were obtained by interview using a questionnaire, and pesticide residues in breast milk were measured by GC-MS/MS and LC-MS/MS. Spearman rank correlation tests and ordinal logistic regression are used to analyze data. The results showed that all of the respondents' breast milk was contaminated with organochlorine pesticide (p'p DDE) with a concentration of > 0.001 mg/kg. Statistical test results prove that nutritional status / BMI with pesticide residue concentration has a significant relationship (p-value = 0.000). In conclusion, excess body mass index is a risk factor for pesticide residue contamination in female farmers in agricultural areas.

Keywords: Pesticides, Breast Milk, p'p DDE, Body Mass Index

BACKGROUND

Pesticides are all chemicals, and other materials, including bodies and viruses, serve as controls for pests and weeds' growth (Kementrian Pertanian RI, 2014). The use of pesticides in the agricultural sector is the largest sector in Indonesia (Aghnia Purnama Putri, 2019). Acute and chronic exposure to pesticides can affect the environment and cause health problems (Pamungkas, 2016). World Health Organization (WHO) data shows about one million people are severely intoxicated from coming into contact with pesticides. Each year between 0.4% and 1.9% of deaths from pesticide exposure (Eddleston, 2020). Long-term exposure to pesticides can lead to cancer, respiratory disorders, reproductive disorders, and neurodegenerative disorders such as Parkinson's, Alzheimer's, and amyotrophic (Mostafalou & Abdollahi, 2013). Exposure to babies before birth can lead to congenital disabilities and impaired central nervous system function (Mostafalou & Abdollahi, 2013).

Pesticides are categorized into four main categories: organochlorine, organophosphates, carbamate, and pyrethroids (Prieto Garcia et al., 2012). Organochlorine is one of the most dangerous pesticides for humans because it is a stable chemical that is very persistent in the environment and potentially accumulates in adipose tissue. Organochlorine lipophilic and persistent properties cause fatty tissue to be stored for an extended period and then released into the blood circulation. According to (Mrema et al., 2013), the half-life of organochlorine, such as DDT, can last approximately 50 years in the human body. On the contrary, according to (Sparling, 2016) The half-life of organochlorines such as DDT, DDE, and DDD in the environment is 15 years, and aldrin and toxfen are 365 days and nine days, respectively. In humans, its metabolites mainly affect the central nervous system, where enzymatic nerve membranes and electrophysiological properties will be altered, and such changes can lead to changes in the kinetic flow of $K+$ and $Na+$ through nerve cell membranes and can result in death from severe poisoning and seizures due to apnea (Hakeem et al., 2016).

The dangers of pesticide use are influenced by exposure and toxicity and other factors such as life history, characteristics, and time of application. Exposure to pesticides occurs directly in farmer workers and their farmer families, including wives (farmers' women) and children. One of the most vulnerable groups of female farmers is nursing mothers. The risks of pesticide exposure that can be experienced by women who breastfeed farmers are washing clothes contaminated with pesticides, storing used pesticide tools, and involvement in post-harvest such as processing crops. This allows pesticides to enter through the mouth, skin contact, and inhalation and food chain mechanisms (Hassaan & El Nemr, 2020).

Exposure to pesticides has been widely studied, especially looking at orientation in the workplace, namely by measuring the content of pesticides in blood, urine, adipose tissue, and breast milk. Breast milk is a good sample, and the best indicator measures the concentration of pesticide residue contamination in nursing mothers because the primary receptor of pesticides is fat tissue. The concentration of pesticide residues in breast milk can also be used to detect pesticides in the environment (Cahyaningrum et al., 2018). This study aimed to see the content and analyze the risk factors of pesticide residue contamination in female farmers' breast milk in agricultural areas. The selected agricultural area is Banyuwangi Regency, East Java. Based on data from the Central Bureau of Statistics of East Java in 2018-2020 recorded 89.10% of informal workers worked in the agricultural sector, and in Banyuwangi regency, as many as 332,093 people (19.13%) people's livelihoods are in the farming sector (Statistik, 2018).

METHODS

The research was conducted in the Puskesmas Sempu Banyuwangi regency's area using quantitative descriptive research methods and cross-sectional approaches. A total sample of 10 female farmers met the exclusion inclusion criteria and was selected using purposive sampling techniques. The inclusion criteria include nursing mothers, aged 18-40 years, have a livelihood as farmers, extended breastfeeding (0-6 months), last time exposed to pesticides no more than four weeks, able to communicate well, and willing to sign an informed consent sheet as a respondent. Exclusion criteria include health conditions that are not possible at the time of research when the research is no longer residing in the specified research site or moving residential address outside the research area and not pleased to be a respondent. This research has obtained a research ethics license issued by the Ethics Committee of the Faculty of Dentistry, University of Jember (No.1109/UN25.8/KEPK/DL/2021).

Data collection is obtained directly from respondents collected after approving and signing the research approval sheet. The data were collected by interviewing respondents using questionnaire sheets and documentation. The independent variable data were covering knowledge levels, attitudes, practices. And the moderator variables, including age, nutritional/BMI status, and education., The variable bound in the form of pesticide residue concentration in breast milk was taken by collecting breast milk samples directly as much as 50 ml and measured pesticide residue levels using the GC-MS/MS and LC-MS/MS methods the Laboratory of PT Saraswati Indo Genetech Sidoarjo. The data obtained were analyzed using SPSS 25 program. Spearman rank correlation test and ordinal logistic regression are used for statistical tests because they have a confidence level of 95%.

RESULTS

Based on interviews with respondents about individual characteristics and behavioral measurements can be seen in Table 1. As many as 60% of respondents are <25 years old, 50% with excessive nutritional status / BMI, 80% graduate from high school, have 20% less knowledge level, 90% are positive, and 70% do good working practices. As many as 50% of respondents showed a high average concentration of pesticide residues.

Table 1 Frequency Distribution of Characteristics of Respondents Variable Age, Nutritional Status / BMI, Education, Level of Knowledge, Attitude, Practice and Average Concentration of Pesticide Residues in Breast Milk

Characteristics of Respondents	n	%
Age		
< 25 years	6	60
> 25 years	4	40
Nutritional status/BMI		
Malnutrition Status (<17.0-18.5)	0	0
Normal Nutritional Status (18.5-24.9)	5	50
Overnutrition Status (>25.00)	5	50
Education		
No School	0	0
Graduated elementary school	1	10
Graduated from junior high school	0	0
Graduated high school	8	80
Scholars	1	10

Level of Knowledge		
Good (76-100%)	4	40
Enough (56-75%)	4	40
Less (30-55%)	2	20
Attitude		
Positive attitude (51-100)	9	90
Negative attitude (0-50)	1	10
Practice		
Good Practice (75-100%)	7	70
Sufficient Practice (56-74%)	2	20
Practice Less (0-55%)	1	10
Average Concentration of Pesticide Residues		
Moderate (0.001-<0.0012)	1	10
Medium (0.0013-<0.0017)	4	40
High (>0.0018)	5	50
Total Respondents	10	100

Description: n = Number of Respondents % = Percentage of Respondents, Source : Primary Data, 2020
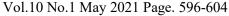
Laboratory data are checking the content of pesticide residues in 10 breast milk samples, known all breast milk samples detected organochlorine residues p'p DDE with a concentration of more than 0.001 mg/kg. The results of cross-tabulation of each variable with the concentration of pesticide residues in breast milk can be reviewed in the following table: (Table 2)

Table 2 Cross Tabulation Variable Age, Nutritional Status / BMI, Education, Level of Knowledge, Attitudes, Practices With Pesticide Residue Concentrations In Breast Milk

Variables	Category	Concentration of Pesticide Residues In Breast Milk							Correlation Coefficient	P Value
		Moderate *	%	Medium **	%	High ***	%	Total		
Age	<25 years	0	0,0	3	30,0	3	30,0	60,0	-0,118	0,746
	>25 years	1	10,0	1	10,0	2	20,0	40,0		
Nutritional status/BMI	Normal 18.5-24.9)	1	10,0	4	40,0	0	0,0	50,0	0,962**	0,000
	Over (>25)	0	0,0	0	0,0	5	50,0	50,0		
Education	Graduated elementary school	0	0,0	0	0,0	1	10,0	10,0	-0,602	0,065
	Graduated high school	0	0,0	4	40,0	4	40,0	80,0		
	Scholars	1	10,0	0	0,0	0	0,0	10,0		
Level of Knowledge	Good (76-100%)	0	0,0	3	30,0	1	10,0	40,0	0,222	0,537
	Enough (56-75%)	1	10,0	0	0,0	3	30,0	40,0		

	Less (30-55%)	0	0,0	1	10,0	1	10,0	20,0		
Attitude	Positive (51-100)	1	1,0	4	40,0	4	40,0	90,0	0,321	0,366
	Negative (0-50)	0	0,0	0	0,0	1	10,0	10,0		
Practice	Good (75-100%)	0	0,0	3	30,0	4	40,0	70,0	-0,348	0,325
	Enough (56-74%)	1	10,0	0	0,0	1	10,0	20,0		
	Less (0-55%)	0	0,0	1	10,0	0	0,0	10,0		

Source: Primary Data, 2020

Description
*Moderate   : Concentration (0.001-<0.0012)
**Medium   : Concentration (0.0013-<0.0017)
***High   : Concentration (>0.0018)
Value α = 0,05 (Rank spearman correlation)

Table 2 showed the highest concentration of p'p DDE> 0.001 mg/kg was found in respondents in the age category <25 years, and it was known that 50% of respondents with excess body mass index had a p'p DDE concentration> 0.001 mg/kg. Educational variables show that 10% of graduate respondents have low P'p DDE concentrations, although statistically, it has not been proven significant. Variable levels of knowledge do not affect pesticide residues' concentration with a concentration of p'p DDE> 0.001. It can be interpreted that the level of expertise, both high and low, is not directly related to the attention of pesticide residues in breast milk in accordance with statistical tests. The attitude variable indicates respondents with a concentration of p'p DDE> 0. 001 mg/kg 90% be positive, although statistically, it has no significant effect. It can be interpreted that the change in attitude affects the concentration of p'p DDE, while the practice is known that 70% of respondents who practice good detect p'p DDE with concentration> 0.001 mg/kg. It can be concluded that it does not affect the concentration of pesticide residues in breast milk by insignificant statistical tests.

Testing of pesticide residue contamination in women's breast milk farmers in agricultural areas using ordinal regression with a summary of the results as follows: (Table 3)

Table 3 Summary of Ordinal Regression Test Results

Free Variables/Moderators	Bound Variable	Ordinal Regression Test Results			
		Estimate	*P-Value*	95% Confident Interval	
Age	Concentration of Pesticide Residues in Breast Milk	0,490	0,693	-1,947	2,928
Nutritional status/BMI		-39,894	0,000	-39,894	-39,894
Education		53,985	0,995	-16,309	16,417
Level of Knowledge		-0,726	0,667	-4,031	1,578
Attitude		-18,304	1,000	-18,304	-18,304
Practice		2,128	0,447	-4,608	4,608

Source: Primary Data, 2020

DISCUSSION

Based on the results of the analysis of age variables using the spearman rank correlation test, it is known that age variables are not significantly proven to the concentration of pesticide residues. Most female farmers with age category <25 years with nutritional status / BMI have a significant relationship and influence on regression tests. This can be interpreted as the more significant the body mass index, the higher the concentration of p'p DDE. The results of this study are reinforced based on the opinion of (Kurniasih et al., 2013), the worse the nutritional status/BMI, the lower the hemoglobin level, so that the worse the nutritional status of a person will inhibit the body's decreased endurance and increase sensitivity to infection. Poor dietary state causes limited protein in the body, this can affect the formation of cholinesterase enzymes, as it is known that organochlorine analyte (p'p DDE) is lipophilic and can be stored in fat tissues and breast milk and the half-life of DDE in the body is 15 years, so the higher the BMI, the more fatty tissues contain p'p DDE and detected higher in breast milk. Statistically, it proved significant.

Research conducted by (Colborn et al., 1994) explained that breast milk exposed to organochlorine pesticides and consumed by children could cause children who consume breast milk to be exposed to the same compounds. This is because breast milk contains much fat and organochlorine compounds are lipophilic. Research (Kartini et al., 2019) proves that stunting events are more experienced by students with positive pesticide metabolites.

The variables of formal education can be used as a benchmark to more easily give an opinion or respond to something obtained from outside, the high level of education does not close the possibility of becoming more logical in opinion or responding compared to lower formal education even though it is statistically not proven significant. Knowledge level variables do not have a significant influence; a high level of knowledge will not positively affect if not applied in the workplace. The conclusion of this study is contrary to the research of (Cahyaningrum et al., 2018) stated that the higher the knowledge of farmers, the smaller the concentration of P'p DDE, and the lower the level of knowledge about pesticides is associated with suicide, poisoning, dangerous risks due to contact with pesticides, and the number of morality figures in many farms in developed countries. According to (Ayu Ariyana Mulyani, 2018) stated that individual factors influence the cause of suicide were in the face of more closed community problems and cannot give decisions on the issues faced, economic factors in which in old age many are affected by chronic diseases and still have to work hard and social aspects, lack of mobility and far from family, so the level of knowledge with pesticide residue concentrations is not related to the attention of pesticide residues and the incidence of death in some regions agriculture.

Variable attitudes and practices are statistically nothing that happens well with pesticide residues. Breast milk that has p'p DDE levels can cause health problems for breastfed babies. As it is known that breast milk is an essential food to explore its nutritional needs in the first six months because breast milk contains carbohydrates, proteins, minerals, and fats easily for babies (Maria M, Apolonia Antonilda Ina, 2020). The intake of nutrients is significant for the safety and health of the baby (Nojiri et al., 2020).

Women farmers were exposed to pesticides while doing activities in the rice fields and the house yard due to pesticide spraying and crop processing. Respondents stated that if farmers are or will do spraying, they decide to go first or go to a location far enough away, then return after the farmer finish spraying. Simultaneously, the pesticide sprayed into the air will be carried by the wind and hit that is not the target and will pollute the soil and the surrounding environment. Working in the rice fields and the house's yard, women farmers are vulnerable to pesticide exposure.

According to (Muhammad Sarwar, 2015), pesticides can enter the body during mixing, application, or cleansing. The most common route of pesticide exposure to the body through dermal contamination. It happens during pesticide mixing or splashing, touching pesticide-contaminated equipment, using contaminated clothing, or touching surfaces containing pesticide residues. The second common pesticide route is through breathing, which occurs while working near powder, or steam, and the last route of pesticide exposure is by ingestion, due to accidentally drinking pesticides that have been put in bottles, cups, or containers of unlabeled beverages (including cans or bottles of soft drinks). This study is similar to the previous research by Cahyaningrum et al. (2018), which reported that DDT attached to the soil and leeks would experience evaporation due to the sun's heat. Women farmers in the rice fields can accelerate DDT through inhalation even though there is no spraying.

Evaporation of DDT in the air can also occur due to the impact of evaporation from contaminated soil and water and storage cycles. The evaporation will repeatedly occur several times. The involvement of women farmers in the cultivation of shallots is in planting seeds, maintaining crops such as cleaning pests or weeds, and processing crops such as cleaning and choosing shallots. Because organochlorine properties are stable and do not decompose if exposed to heating or chemical, organochlorine compounds can bind to the organic matter contained in soil molecules, and soil residues attached to shallots can enter the female body farmers if not balanced safety practices in work (Cahyaningrum et al., 2018).

The use of PPE is necessary to protect themselves from pesticide exposure. The statement was reinforced by (Yarpuz-Bozdogan, 2018). Farmers use pesticides to protect the quality and quantity of crops. However, the chemically contained pesticide affects human health and the environment. Therefore, appropriate PPE at all stages of pesticide handling is important to minimize the negative effects of pesticides. In this study, there was an inappropriate use of PPE by farmers before, during, and after using pesticides. Therefore both acute and chronic poisoning due to frequent exposure to pesticides was common.

The Department of Agriculture has done counseling on using pesticides by providing information on how to work by determining the appropriate dose of pesticides, personal protective equipment, and disposing of pesticide waste, then making observations to rice fields. Still, not all farmers in the Banyuwangi regency are members of a farmer association/groups, making them lack information about counseling. Increasing the knowledge for the farmer is beneficial to pay more attention to the risk of exposure to pesticides and change women farmers' attitude and behavior to the potential dangers that exist if appropriately implemented (Sulistiyono et al., 2008).

CONCLUSION

This study can detect pesticide residue p'p DDE content in women's breast milk farmers in agricultural areas, and the risk factor that influences the contamination of pesticide residues in female farmers is body mass index. The more body mass index, the higher the p'p DDE concentration. The policy of application and extension that has been applied in agricultural areas in Banyuwangi regency has not been effective in improving workplace safety and the addition of information in the use of pesticides. Further studies could be conducted using samples from blood, hair, or other body parts and studying pesticide residues in the environment such as water and soil.

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