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Relationship of Cholinesterase with Erythrocyte Index of Female Farmers in Vegetable Farming Area

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Reproductive and maternal health in female farmers, especially those exposed to pesticides, is an urgent issue in Indonesia. Pesticide exposure during agricultural activities can cause disorders in the reproductive system, pregnancy, and fetal development. This study aims to analyze the relationship between cholinesterase levels (an indicator of pesticide exposure) and erythrocyte indices (including Hb, MCV, MCH, and MCHC) in female farmers working in vegetable farming areas in Agam Regency, West Sumatra. A total of 33 female farmers divided into two groups, namely the pesticide-exposed group (17 people) and the control group (16 people), were used as research samples. The results showed that the group exposed to pesticides had lower cholinesterase levels than the control group, with a significant difference. In addition, there was a significant relationship between decreased cholinesterase levels and decreased MCHC and increased risk of anemia in the exposed group. This decrease in cholinesterase indicates the adverse effects of pesticide exposure on the hematological system, which has the potential to cause complications in reproductive health such as menstrual disorders, infertility, and pregnancy complications. Therefore, this study provides important evidence regarding the need for better health screening for female farmers in agricultural areas. Routine monitoring of cholinesterase levels and erythrocyte indices can be an effective preventive measure in protecting the reproductive and maternal health of women working in the agricultural sector.

Keywords: Peticide exposure, Farmer's health, Anemia, Iron.

INTRODUCTION

Reproductive and maternal health are vital aspects that affect women's quality of life and pregnancy outcomes. In Indonesia, special attention needs to be given to female farmers of reproductive age who are exposed to pesticides in their daily farming activities, considering the negative impacts that can arise on the reproductive system, pregnancy, and fetal development (Shammi et al., 2020; Atinkut Asmare et al., 2022). Pesticide exposure in women of childbearing age has been associated with various reproductive health disorders, including menstrual disorders, infertility, and pregnancy complications that have the potential to threaten the health of the mother and fetus.

The agricultural sector is one of the important sectors in the Indonesian economy, with thousands of farmers who depend on farming for their livelihoods (Wardhana & Ratnasari, 2022). Among these farmers, there are a large number of female farmers who play an active role in agricultural activities, especially in vegetable farming areas spread across various regions in Indonesia (Partasasmita et al., 2019). Female farmers have a double risk of exposure to pesticides, given their role not only as farmers but also as housewives and potentially as pregnant or breastfeeding mothers. They are often involved in various stages of pesticide use, from mixing, spraying, to cleaning equipment contaminated with pesticides (Gomes et al., 2021).

The use of pesticides in vegetable farming activities has become an inseparable part of controlling pests and plant diseases (Dewi et al., 2022). However, inappropriate use of pesticides can have various impacts on reproductive and maternal health for female farmers who have different biological vulnerabilities than male farmers. This vulnerability becomes more significant in terms of reproductive health, including hormonal disorders, pregnancy complications, and health risks to the fetus in female farmers of reproductive age.

One of the important parameters for assessing pesticide exposure in the human body is the activity of the cholinesterase enzyme (Gonçalves et al., 2021; Garmavy et al., 2023). This enzyme plays an important role in regulating nerve impulses and neurological functions of the body (Silma, 2021; Chen et al., 2024). Decreased cholinesterase activity can be an indicator of excessive exposure to organophosphate and carbamate pesticides (Sepahi et al., 2023), which have been associated with reproductive and maternal health disorders in women, including the risk of spontaneous abortion, premature birth, and congenital abnormalities.

Erythrocyte indices are hematological parameters consisting of Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) (Zhang et al., 2022). These parameters are important for assessing a person's health status and red blood cell function, which can be affected by exposure to chemicals including pesticides (Cestonaro et al., 2020; Jiménez-Penago et al., 2021; Leili et al., 2022). Optimal hematological status is essential for women's health, especially during pregnancy and lactation, where anemia can cause serious maternal and neonatal complications such as postpartum hemorrhage, preeclampsia, premature birth, and low birth weight.

Vegetable farming areas have special characteristics in terms of pesticide use. The frequency of pesticide spraying is higher compared to other types of farming, considering that vegetables are susceptible to pests and diseases, and the planting cycle is relatively short (Tudi et al., 2021). Previous studies have shown a relationship between pesticide exposure and various health disorders in farmers. However, studies that specifically examine the relationship between cholinesterase activity and erythrocyte indices in female farmers are still limited, especially in relation to reproductive and maternal health in vegetable farming areas (Abbasi-Jorjandi et al., 2020).

Understanding the relationship between cholinesterase activity and erythrocyte indices is important for assessing the impact of pesticide exposure on the reproductive and maternal health of female farmers. Changes in erythrocyte indices may indicate disruption of red blood cell formation or damage to existing red blood cells. Chronic pesticide exposure can affect the hematopoiesis process and cause changes in these hematological parameters (Tahir et al, 2021). These hematological disorders have serious implications for maternal health, as anemia during pregnancy is associated with an increased risk of maternal death, preterm birth, and low birth weight.

Monitoring the health of female farmers of reproductive age through examination of cholinesterase activity and erythrocyte indices can be an effective strategy in preventive efforts to protect reproductive and maternal health. This study can be a basis for developing more effective health risk prevention and control strategies, especially those related to reproductive health (Medithi et al., 2022). Factors such as length of work, frequency of exposure, use of personal protective equipment (PPE), and safe pesticide handling practices can affect the level of pesticide exposure in female farmers. Understanding these factors is important to identify high-risk groups, especially pregnant women or those planning pregnancy (Sapbamrer & Thammachai, 2020).

Sustainable and environmentally friendly agricultural systems are becoming increasingly important to reduce the negative impacts of pesticide use, especially on women's reproductive health. However, the transition to such agricultural systems requires time and support from various parties, while monitoring of farmers' health must still be carried out (Khan et al., 2023), with special attention to the reproductive health of women farmers.

Regular health checks, including examination of cholinesterase activity and erythrocyte index, need to be made a routine program to monitor the health of female farmers, especially those who are pregnant or planning a pregnancy. This can help early detection of health disorders due to pesticide exposure that can impact reproductive and maternal health (Lamangantjo & Jannah, 2024). Early intervention in female farmers with low cholinesterase activity or erythrocyte index disorders can prevent pregnancy complications and improve maternal and neonatal outcomes.

Research on the relationship between cholinesterase and erythrocyte indices in female farmers can provide scientific evidence needed for the development of occupational health and safety policies in the agricultural sector, with a focus on protecting reproductive and maternal health. The results of this study can also be the basis for more targeted interventions in efforts to improve the reproductive health of female farmers (Kori et al., 2019), such as education on safe pesticide use practices, provision of adequate PPE, and regular reproductive health checks.

Further research on the association between pesticide exposure and various health parameters, including cholinesterase and erythrocyte indices, is still needed, especially in the context of reproductive and maternal health. This will help in a better understanding of the mechanisms and impacts of pesticide exposure on the reproductive health of female farmers, as well as the development of more effective preventive strategies to protect maternal and child health in agricultural areas. This study is expected to contribute to efforts to improve the health and welfare of maternal women farmers, as well as provide a basis for more comprehensive reproductive health policies.

METHODS

Types of research

The type of research used is analytical observational research with a cross-sectional design. This type of research was chosen based on the purpose of the research, namely to find the relationship between two variables, namely cholinesterase levels and erythrocyte index (Pérez-Guerrero et al., 2024).

Research Location

This research was conducted in a vegetable farming area in Bahuhampu District, Agam Regency, West Sumatra Province.

Population and Sample

a. Population

Population is the whole of the research objects or objects to be studied (Notoadmodjo, 2005). In this study, the population came from two farmer groups:

1. The Ladang Laweh farmer group, which consists of 171 people, consists of 111 male farmers and 60 female farmers.

2. The Padang Luar farmer group consists of 50 people, consisting of 40 male farmers and 10 female farmers.

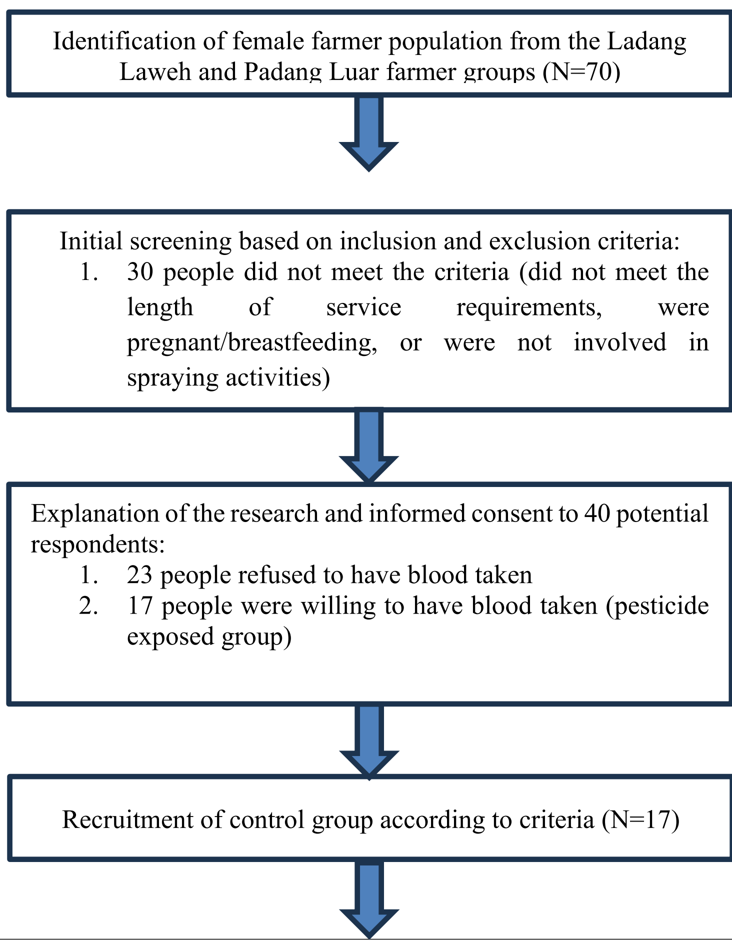
So the population in this study were all female farmers from the two farmer groups, totaling 70 people (60 people from Ladang Laweh and 10 people from Padang Luar).

b. Sample

The research sample was initially planned as a total population of 70 female farmers. However, after screening based on inclusion and exclusion criteria, only 40 people met the sample criteria. Of the 40 people, only 17 people were willing to have blood drawn as a group exposed to pesticides. For the control group, 17 people were initially determined according to the established criteria. However, on the day of blood collection in the Kratau Bangkaeh area, there was 1 respondent from the control group who did not come because he was bringing his child for treatment. Given that the duration of time from blood collection to centrifugation was very short, the researcher did not get a replacement for the respondent who did not come. Thus, the number of samples successfully collected in this study was 33 people, consisting of 17 people in the pesticide-exposed group and 16 people in the control group.

c. Sample Selection Flow

The following is the sample selection flow in this study:



Blood draw scheduling:
1. All respondents in the exposed group were present (17 people)
2. 1 person in the group was absent

↓

Total final sample: 33 people (17 pesticide exposed group + 16 control group)

d. Sample Criteria from Pesticide Exposed Groups
- Female farmers are not pregnant and not breastfeeding
- Have worked for at least 3 years in a vegetable farming area
- Participate in spraying activities or accompany your husband during spraying.
- Carrying out daily farming routines in the vegetable farming area of Banuhampu District
- Willing to participate in research

e. Sampling Criteria of the Control Group
- Do not carry out farming activities
- Living in a farming area
- Never do spraying activities or accompany your husband when spraying
- Not pregnant and not breastfeeding
- Willing to participate in research

Data collection technique

The data collection technique in this study was carried out by direct observation of the working environment conditions and pesticide use practices in agricultural areas. Furthermore, data collection through laboratory examination by taking blood samples for examination of cholinesterase levels, erythrocyte indices (including MCV, MCH, MCHC). Furthermore, data collection through questionnaires to obtain data on education and behavior of female farmers.

Data Analysis Techniques

Data analysis in this study used univariate and bivariate analysis. Univariate analysis is used to determine the frequency distribution of each variable. Bivariate analysis is conducted to determine whether the independent variable is related to the dependent variable. In this study, bivariate analysis uses the Chi-Square statistical test with a 95% confidence level with $\alpha = 0.05$.

RESULTS AND DISCUSSION

A. Univariate Analysis

1. Respondents' Education and Behavior

Table 1. Frequency Distribution of Respondents' Education Level

Education	Group				Total	
	Control		Exposed			
	f	%	f	%	f	%
Low	5	25.0	15	75.0	20	100
Tall	11	84.6	2	15.4	13	100
Amount	16	48.6	17	51.5	33	100

Based on the results of the study on respondents' education, it can be seen in table 4.1 that the percentage of exposure is higher in respondents with low education compared to higher education (75.0%: 15.4%). Education has the meaning: the process of changing the attitudes and behavior of a person or group of people in an effort to mature humans through teaching and training efforts, the process of action, how to educate (Komariah & Nihayah, 2023).

Education in this study is the level of schooling attended formally by the respondents. The low education in the pesticide-exposed group is because farming is a job that has been passed down from the respondents' parents with agricultural land that must be cultivated, so that most respondents have relied on their livelihoods from farming, and they pursue the profession as farmers. Meanwhile, from the control group, most respondents were highly educated, and in this study they were a society that was as heterogeneous as the pesticide-exposed group, but did not engage in farming activities. Respondents in the control group handed over the management of their agricultural land to others with a profit-sharing system, and they continued to college and pursued other professions as a livelihood.

Table 2. Frequency Distribution of Respondents' Health Behavior

Health Behavior	Group				Total	
	Control		Exposed			
	f	%	f	%	f	%
Negative	9	45.0	11	55.0	20	100
Positive	7	53.8	6	46.2	13	100
Amount	16	48.3	17	51.5	13	100

Based on the table, it can be seen that the percentage of exposure is higher in respondents with negative health behavior compared to positive health behavior (55.0%: 46.2%). According to Gardner & Lally (2023), health behavior is all activities or activities of a person, both observed and unobserved, related to health maintenance.

In this study, the aspects studied about health behavior include; habits of eating vegetables and fruits after spraying, habits of washing vegetables and fruits before eating, habits of washing hands after using pesticides, habits of eating at agricultural locations and habits of wearing personal protective equipment while at agricultural locations.

Based on the results of interviews with several farmers, negative behavior in respondents in the pesticide-exposed group was caused by respondents in this group being accustomed to the tradition of eating breakfast or lunch at the farm location, which was done to save time. In addition, they also often eat vegetables and fruits even after spraying, but they wash the fruits and vegetables first.

Then in terms of the use of personal protective equipment while in agricultural locations, most respondents said they rarely use personal equipment such as masks, because they consider wearing masks to be annoying so that respondents are not free to carry out farming activities. From the health behavior of respondents about washing hands before eating, all respondents said they washed their hands before eating.

Meanwhile, from the control group, most respondents had positive behavior. Based on the results of the interviews, most respondents said they always washed their hands before eating and after using pesticides such as insecticides in their homes. In addition, respondents sometimes used personal protective equipment when passing through agricultural locations, especially when farmers were spraying. However, a small number of respondents often ate vegetables and fruits after spraying by farmers, but all respondents said they washed the vegetables and fruits before eating them.

Negative respondent behavior can be changed by reading magazines, newspapers, listening to and watching news to get information about pesticides and their dangers to health and things that can be done to avoid these dangers (Zaller, 2020).

2. Respondents' Pesticide Levels (Cholinesterase)

Table 3. Frequency Distribution of Cholinesterase in the blood of respondents

Cholinesterase levels	**Group**			
	Control		**Exposed**	
	f	%	f	%
< from normal	3	18.7	13	76.5
Normal	13	81.3	4	23.5
Amount	16	100	17	100

The table above shows that cholinesterase below normal values are higher in the pesticide-exposed group compared to the control group 76.5% versus 18.7%. Based on the table, it can be seen that the level of cholinesterase below normal is higher in the pesticide-exposed group (76.5%) compared to the control group (18.7%). Cholinesterase is an enzyme needed for nerves to function properly. Exposure to organophosphates or carbamates can reduce cholinesterase levels.

The decrease in cholinesterase in the exposed group was mainly due to the use of organophosphate and carbamate pesticides which are popular because of their strong and fast pest control power. Improper washing of fruits and vegetables and pesticide drift can also cause a decrease in cholinesterase in the control group. Overall, the data showed that subnormal cholinesterase levels were much higher in the group directly exposed to pesticides, compared to the control group (Mdeni et al., 2022).

Decreased cholinesterase levels in women of reproductive age exposed to pesticides have important implications for maternal health. Previous studies have shown that pesticide exposure in women can have an impact on reproductive health, including increased risk of menstrual disorders, infertility, spontaneous abortion, and premature birth (Bretveld et al., 2006). For midwives and maternal health workers, understanding the risks of pesticide exposure is important in health promotion efforts and early screening of women of childbearing age in agricultural areas.

3. Respondent Erythrocyte Indices (Hb, MCHC, MCV, and MCH)

3.1. Frequency Distribution of Hb Levels

Table 4. Frequency Distribution of Respondents' Hemoglobin Levels

Hb levels	**Group**			
	Control		**Exposed**	
	f	%	f	%
Anemia	0	0	5	29.4
Normal	16	100	12	70.6
Amount	16	100	17	100

The table above shows that the percentage of respondents experiencing anemia was higher in the exposed group compared to the control group (29.4%: 0%). Hemoglobin is a pigment that makes blood cells red which will ultimately make human blood red. According to its function, hemoglobin is a medium for transporting oxygen from the lungs to body tissues. As we all know, oxygen is the most important part of the body's metabolism to produce energy. Hemoglobin also functions to carry carbon dioxide from metabolism from body tissues to the lungs to be released during breathing (Hsia, 2021).

Hemoglobin is a naturally colored pigment. Due to its iron content, hemoglobin appears reddish when bound to O2 and bluish when deoxygenated. Thus, fully oxygenated arterial blood appears red and venous blood that has lost some of its O2 in the tissues shows a bluish hue. The hemoglobin molecule consists of two parts, namely the Globin part which is a protein formed from four highly folded polypeptide chains and a non-protein nitrogenous group containing iron known as the heme group, each of which is bound to one polypeptide (Kumar et al., 2022).

In the adult human body, approximately 20-25 mg of iron is required daily for hemoglobin synthesis. Most of this iron is directly derived from the reuse of hemoglobin degraded from phagocytosed erythrocytes. Therefore, the exchange of iron in the transferrin iron pool is a very dynamic process, an iron atom spends only 90 minutes to 2 hours in the transferrin iron pool. Hemoglobin is a globular protein containing iron (Saboor et al., 2021).

When oxygen binds to one of the four heme groups in hemoglobin, the molecule changes from a tense form (low affinity for oxygen) to a relaxed form (which has a high affinity for oxygen). This allosteric change in the three-dimensional structure of the hemoglobin molecule facilitates the loading of the remaining three heme groups with oxygen. The amount of oxygen taken up and released by red blood cells depends on the partial pressure of oxygen. The greatest oxygen uptake occurs in the lungs where oxygen saturation is highest. In the tissues, the exchange of oxygen with carbon dioxide takes place, because the concentration of 02 is low and the concentration of CO2 is high (Rivers & Meininger, 2023). In addition, the impact of pesticides also affects the blood and cardiovascular systems in the form of impaired Hb synthesis, shortening the life of erythrocytes, reducing the number of red blood cells, anemia and hypertension (Shah et al., 2024).

From the description above, according to the researcher's opinion, hemoglobin that is below normal values in respondents from the exposed group is an impact of pesticides that have affected the blood and cardiovascular systems, thus disrupting Hb synthesis. In addition, to see the Fe status indirectly, it can be seen through hemoglobin, and this condition is due to farmers' daily exposure to pesticides.

Anemia in women of reproductive age exposed to pesticides requires special attention in the context of maternal health. Pre-pregnancy anemia increases the risk of pregnancy complications such as preterm birth, low birth weight, and postpartum hemorrhage (Okunade et al., 2024). The finding that 29.4% of women in the exposed group experienced anemia indicates the need for specific reproductive health interventions for female farmers. Midwives have a strategic role in anemia screening and education on nutrition and occupational safety practices for women in agricultural areas.

3.2. Frequency Distribution of MCHC Levels

Table 5. Frequency Distribution of Respondents' MCHC Levels

MCHC Level	Group			
	Control		Exposed	
	f	%	f	%
< from normal	3	18.7	13	76.5
Normal	13	23.5	4	23.5
Amount	16	100	17	100

The table above shows that the percentage of MCHC <normal is higher in the exposed group compared to the group (76.5%: 18.7%). MCHC below normal means that iron supplies have run out even though the hemoglobin value is still within normal limits, which is indicated by the presence of microcytic cells in the peripheral blood smear, even though the Mean Corpuscular Volume (MCV) and MCH values are still within normal limits. In this condition, it will cause the formation of smaller-sized human resources (microcytic) and in the microscope are paler in color (hypochromic).

A decrease in MCHC in women exposed to pesticides, although not yet showing clinical anemia, is an early indicator of impaired iron status that needs to be watched out for. This condition can develop into iron deficiency anemia which has a significant impact on women's reproductive health, including physical capacity, psychological well-being, and readiness for a healthy pregnancy (WHO, 2023). The role of midwives in preventive efforts is very important to identify this risk factor at an early stage through routine examination of erythrocyte indices in women of reproductive age in agricultural areas.

3.3. Frequency Distribution of MCV Levels

Table 6. Frequency Distribution of Respondents' MCV Levels

MCV Level	Group			
	Control		Exposed	
	f	%	f	%
< from normal	0	0	0	0
Normal	17	100	16	100
Amount	17	100	17	100

The table shows that no respondents had MCV below normal values. MCV (Mean Corpuscular Volume) is a measure of the average volume of red blood cells. A normal MCV value indicates that there is no problem related to the size of red blood cells, although there are disturbances in other red blood cell indices such as anemia and low MCHC in the exposed group. This shows that although pesticide exposure has an impact on decreasing several red blood cell indices, the size of the respondents' red blood cells is still within normal limits in both groups.

3.4. Frequency Distribution of MCH Levels

Table 7. Frequency Distribution of Respondents' MCH Levels

MCV Level	**Group**			
	Control		**Exposed**	
	f	%	f	%
< from normal	0	0	0	0
Normal	17	100	16	100
Amount	17	100	17	100

Based on the table, it can be seen that the respondents' MCH levels are 100% normal. MCH (Mean Corpuscular Hemoglobin) is the average amount of hemoglobin per red blood cell. A normal MCH value indicates that there is no problem related to the hemoglobin content in erythrocytes, although there are disturbances in other erythrocyte indices. This finding, together with the normal MCV results, indicates that although pesticide exposure has an impact on decreasing several erythrocyte indices, the size and hemoglobin content of respondents' red blood cells are still within normal limits in both groups (Hassanin et al., 2024).

B. Bivariate Analysis

1. Relationship of Cholinesterase with Erythrocyte Indices

Table 8. The relationship between cholinesterase in the blood and hemoglobin

Level Hemoglobin	**Group**				**Total**		**P Value**
	Normal		< from normal		n	%	
	n	%	n	%	f	%	
Normal	17	60.7	11	39.3	28	100	0.018
Anemia	0	0	5	100	5	100	
Amount	17	60.7	16	39.3	33	100	

The table shows that 60.7% of respondents with normal cholinesterase have normal hemoglobin. 100% of respondents with below normal cholinesterase have anemia. The results of the statistical test show a p value = 0.018, meaning that there is a significant relationship between cholinesterase and hemoglobin. Respondents with below normal cholinesterase mostly come from the pesticide-exposed group. Meanwhile, respondents with below normal cholinesterase from the control group did not experience anemia. Decreased cholinesterase indicates pesticide exposure. The impact of pesticides that affect the blood and cardiovascular systems, such as impaired hemoglobin synthesis, can cause anemia in exposed respondents.

These findings have important relevance in the context of women's maternal and reproductive health. The association between decreased cholinesterase and anemia in women of reproductive age exposed to pesticides indicates the need for comprehensive screening of women in agricultural areas as part of reproductive health services. Midwives, as the frontline in maternal health services, need to understand this association to identify women at risk of pregnancy complications due to pesticide exposure and anemia.

2. Relationship of Cholinesterase with MCHC

Table 9. The relationship between blood cholinesterase and MCHC

Level MCHC	Group				Total		P Value
	Normal		< from normal		n	%	
	n	%	n	%	f	%	
Normal	17	100	0	0	17	100	0,000
< from normal	0	0	16	100	16	100	
Amount	17	51.5	16	48.5	33	100	

The table above shows that 100% of respondents with normal cholinesterase have normal MCHC. 100% of respondents with below normal cholinesterase also have below normal MCHC. The statistical test produced a p-value = 0.000, meaning that there is a significant relationship between cholinesterase and MCHC. Respondents with below normal cholinesterase and MCHC are those who are exposed to pesticides. Below normal MCHC indicates iron deficiency even though hemoglobin is still normal, which can cause hypochromic microcytic anemia. Thus, it can be concluded that there is a significant relationship between decreased cholinesterase due to pesticide exposure and decreased MCHC, an indication of iron deficiency that can cause anemia (Mohamed et al, 2022).

3. Differences in Cholinesterase Between Pesticide-Exposed and Unexposed Groups

Table 10. Differences in Cholinesterase between pesticide-exposed and unexposed groups

Cholinesterase in the blood	**N**	**Mean**	**SD**	**P value**
Control group	16	11.14	1.95	0.002
Pesticide exposed group	17	9.27	1.23	

Table 10 shows that the average cholinesterase level of the group not exposed to pesticides was 11.14 ± 1.95 UI, while the group exposed to pesticides had an average of 9.27 ± 1.23 UI. The results of the statistical test produced a p-value = 0.002, meaning that there was a significant difference in the average cholinesterase between the two groups. The group exposed to pesticides had lower cholinesterase levels, indicating pesticide exposure. This is in accordance with the habits of female farmers in the exposed group who are routinely exposed to pesticides through spraying and accompanying their husbands when spraying. Even though they made efforts to prevent exposure such as washing their hands and consuming lime, there was still a decrease in cholinesterase. Meanwhile, the control group that was not exposed to pesticides had normal cholinesterase levels. Previous studies have also shown a relationship between the length of pesticide exposure and decreased cholinesterase (Santana et al., 2021).

Table 11. Difference in Erythrocyte Index between pesticide exposed and unexposed groups

Erythrocyte Index	**Pesticide Exposed Groups**			**Control Group**			**P value**
	n	Mean	SD	n	Mean	SD	
Hb (gr%)	17	11.9	1.13	16	12.5	0.67	0.080
MCV (%)	17	86.7	2.78	16	86.7	2.87	0.099
MCH (%)	17	30.7	2.16	16	30.5	2.11	0.082
MCHC	17	28.4	3.06	16	32.8	3.24	0,000

Table 11 shows no significant differences in mean hemoglobin (Hb), mean corpuscular volume (MCV), and mean corpuscular hemoglobin (MCH) between the pesticide-exposed and control groups. However, the mean corpuscular hemoglobin concentration (MCHC) was significantly lower in the exposed group (28.4 g/dL ± 3.06) compared to the control group (32.8 g/dL ± 3.24).

The decrease in MCHC in the exposed group, despite normal Hb levels, indicates iron deficiency. This may be due to the impact of pesticide exposure on iron regulation and the erythrocyte formation process. Although Hb levels were not significantly affected, lower MCHC indicates a disturbance in the incorporation of iron into hemoglobin in red blood cells (Hoenemann et al., 2021).

In the context of women's reproductive health, disorders in erythrocyte indices, especially MCHC, can be an early indicator of the risk of iron deficiency anemia which can affect maternal health. Women with disorders in erythrocyte indices due to pesticide exposure are at risk of pregnancy complications such as miscarriage, premature birth, and fetal growth disorders. Therefore, these findings emphasize the importance of the role of midwives in conducting comprehensive reproductive health screening for female farmers, including examination of erythrocyte indices and education on preventing pesticide exposure as an early prevention effort against pregnancy complications.

CONCLUSION

The findings of this study have important implications for midwifery practice and women's reproductive health in agricultural areas. Pesticide exposure as indicated by decreased cholinesterase levels is correlated with impaired erythrocyte indices, particularly decreased MCHC and the risk of anemia. These conditions can have an impact on long-term reproductive health, including fertility and the ability to have a healthy pregnancy. It is recommended that maternal health programs in agricultural areas include routine screening of cholinesterase levels and erythrocyte indices as part of reproductive health monitoring for women of childbearing age. Midwives and maternal health workers need to integrate education about the dangers of pesticide exposure and protective measures into primary health care for women in agricultural areas.

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