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## Factors Associated with Pesticide Exposure and Relationship with the Incidence of Anemia

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### Abstract

*The use of pesticides by farmers from year to year has increased. Excessive use can harm human health because it is toxic and less persistent in nature. every year as many as one million people will experience health problems due to pesticides and the prevalence continues to increase. There are many impacts resulting from exposure to pesticides including anemia which is a form of chronic effects from the use of pesticides (WHO, 2017). This systematic review aims to analyze and examine various literature that discusses anemia that occurs in farmers due to pesticides. The research method used is literature review with secondary data obtained from the Google Scholar database, PubMed with a span of 10 years. In order to obtain 8 scientific articles that can be analyzed. The results of a literature review of 8 research articles show that most farmers control pests on plants using pesticides. Factors that influence the incidence of anemia are not using PPE, duration of spraying, years of service, nutritional status, level of education, gender, exposure to pesticides. Human health is also an impact that is affected by excessive and continuous use and exposure to pesticides, especially for the farmers themselves. The body exposed to pesticides causes abnormalities in the blood profile because the pesticides themselves interfere with the organs that form blood cells and the body's immune system.*

**Keywords:** *Pesticide, Anemia, Farmers*

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## INTRODUCTION

Indonesia is an agrarian country with the majority of the population working in the agricultural sector. Not only that, Indonesia also holds the status of a maritime country with abundant sea wealth. Indonesia itself has vast agricultural land. Most of the people rely on the agricultural sector which provides a very high and very important contribution to their economic life. Farmers are often faced with all kinds of pest and weed attacks in the process. This problem certainly can affect agricultural output. Efforts made by farmers to avoid this and to improve the quality of agricultural products is to use pesticides. The Central Statistics Agency (BPS) in February 2022 recorded that 29.96% of the workforce or around 26.50 million people work in the agricultural sector. The data shows that the majority of the population works in the agriculture, forestry and fisheries categories (Central Bureau of Statistics, 2022).

Pesticide exposure is a serious problem that often occurs in agricultural communities in poor or developing countries. WHO reports that every year as many as one million people will experience health problems due to pesticides and the prevalence continues to increase in Indonesia, Nicaragua, Brazil, Vietnam, China, Cambodia, Bangladesh and India. In general, the groups most vulnerable to pesticide poisoning are children, women, workers in the informal sector, and poor farmers (WHO, 2017).

The use of pesticides by farmers from year to year has increased. Indonesia as a developing country as well as an agricultural country with a harvested area of 10,606,513 hectares in 2022 is a country with high pesticide users. Based on data for 2022, it is known that pesticide use data throughout Indonesia has reached 2420 brands registered at the Directorate of Fertilizers and Pesticides, Directorate General of Agricultural Infrastructure and Facilities (Directorate of Fertilizers and Pesticides, 2022).

One of the problems that cannot be separated from human life is the use of pesticides. The use of pesticides is synonymous with agriculture, but unknowingly the general public also uses pesticides such as mosquito coils. In general, vegetables are susceptible to plant-disturbing organisms (OPT) so that the use of chemical pesticides cannot be separated from farmers. There is an effect of pesticides on hemoglobin levels because these pesticides reduce the production or

increase the destruction of red blood cells. This causes methemoglobin to form in the red blood cells, causing hemoglobin to become abnormal and unable to carry out its function of delivering oxygen. The presence of methemoglobin in red blood cells causes hemoglobin to become abnormal and unable to carry out its function of delivering oxygen. The presence of methemoglobin in the blood will decrease Hb levels in the red blood cells resulting in hemolytic anemia.

There are many impacts resulting from exposure to pesticides such as cancer, infertility, disability and liver disease. Anemia is also a form of chronic effects from the use of pesticides. Anemia is a condition in which oxygen is not available for the body's tissues due to reduced mass of hemoglobin and erythrocyte mass circulating in the body so that they cannot carry out their proper functions (Pratama, Setiani and Darundiati, 2021). The body exposed to pesticides causes abnormalities in the blood profile because the pesticides themselves interfere with the organs that form blood cells and the body's immune system (Arwin and Suyud, 2018). The effect of pesticides on the health of farmers should be the concern of everyone, especially medical personnel. This is interesting to discuss and research.

The global prevalence of anemia occurred in 204 countries from 1990 – 2019. Based on research data conducted in 2020, there was an increase in total cases of anemia from 1.42 billion in 1990 to 1.74 billion in 2019. This study also shows 3 regions The highest contributors to anemia are West Africa, South Asia and Central Africa.

The prevalence of anemia in women of reproductive age (15-49 years) in Indonesia in 2019 was 31.2% with the most ages being 20-44 years. According to the 2018 Basic Health Research (RISKESDAS), the incidence of anemia in Indonesia in the 15-24 year-old youth group experienced anemia by 32.0% and was experienced more by women (27.0%) than men (20.0). %).

Anemia is a global health problem in developed and developing countries. Anemia is an indicator of nutrition and health in a country. Anemia is a condition in which the level of hemoglobin (Hb) in the blood is less than normal, which is different for each age group and sex, which can be caused by abnormalities in cell formation, bleeding, or a combination of the three. Anemia is a condition in which a person's body experiences a decrease or the number of red blood cells in the body is below normal limits. This can occur due to a lack of haemoglobin in the body, thereby affecting the amount of red blood cell production. (Ministry of Health, 2019).

Anemia is defined as a condition where the concentration of hemoglobin (Hb) or hematocrit is low based on a threshold value (reference) caused by low production of red blood cells (erythrocytes) and Hb, increased breakdown of erythrocytes (hemolysis), or excessive blood loss (Citrakesumasari, 2012). According to Proverawati (2012), symptoms of anemia include fatigue, decreased energy, weakness, shortness of breath and a pale face. Factors Affecting Hemoglobin (Hb) Levels According to Estridge and Reynolds (2013), hemoglobin levels are influenced by several factors including age, gender, altitude, physical activity, exposure to toxic chemicals, use of Personal Protective Equipment (PPE) ), Smoking, Nutrition.

## RESEARCH METHODS

This study uses the literature review method. Data collection and sources were carried out in April 2023. Data search tools were assisted by search engines namely Google Scholar and PubMed which used national and international journals. Search using the keywords "Pesticides, Anemia, Farmers". The word Pesticide was changed to pesticide, Anemia was changed to Anemia and the word Farmer was changed to Farmer in a search for international journals and found 8 national and international journals with a time frame of 2013-2023 (10 Years).

## RESULTS AND DISCUSSION

Table 1. Results of analysis of factors related to pesticide exposure and its relationship to the incidence of anemia

No	Year	Author Name and Title	Method	Results	Database
1	2023	Tasya Alifia Hanin  The relationship between exposure to pesticides and hemoglobin levels in farmers in Wonodadi Village, Gading Rejo District, Pringsewu Regency	The research design used was observational analytic with a cross sectional approach	The results of the bivariate analysis showed that exposure factors such as spraying frequency (p=0.001), completeness of PPE (p=0.030), and personal hygiene (p=0.043) were related to hemoglobin levels.	Google Scholar
2	2021	Ropen, Sugiarto and Parman (2021)  Factors Associated with the Incidence of Anemia in Vegetable Farmers	This study used a cross sectional design	There is a relationship between length of work (p=0.023) and use of PPE (p=0.012) with the incidence of anemia among farmers who spray.	Google Scholar
3	2019	Muhammad Asif Syed, Aneela Atta Ur Rahman, Muhammad Ilyas Siddiqui, Ashique Ali Arain (2019).  Pesticides and Chemicals as Potential Risk Factors of Aplastic Anemia: A Case–Control Study Among a Pakistani Population	A case-control study	Univariate analysis showed a significant association between the risk of developing AA and pesticide exposure (OR=3.59, 95% CI 2.57–5.02) compared to those who were not exposed. Analysis of the high-exposure group showed that they were 3 times more likely to experience AA than the controls (OR=3.4, 95% CI 2.2–5.2).	Pubmed
4	2019	Nunik Tri Utami1,	This type of	Chi Square protein analysis test	Google

		Suhartono2, Nikie Astorina Yunita Dewanti Factors Affecting the Incidence of Anemia in Farmers in Candi Hamlet, Bandungan District, Semarang Regency	analytic observational research with a cross-sectional design.	results: p value = 0.005 and PR = 6.000; 95% CI1.672-21.531. This means that there is a relationship between protein intake and the incidence of anemia.  The factor that has been proven to influence the incidence of anemia in Candi Hamlet, Bandungan District, is nutritional intake. Protein intake (p value = 0.005) with protein less than 100% RDA will be 6 times the risk of suffering from anemia. Iron intake (p value = 0.006) with iron less than 100% RDA will be 6 times the risk of suffering from anemia. Intake of vitamin C (p value = 0.047) with intake of vitamin C less than 100% RDA will be 3.67 times at risk of suffering from anemia. Intake of vitamin B12 (p value = 0.047) with intake of vitamin B12 less than 100% RDA will be 3.67 times at risk of suffering from anemia.	Scholar
5	2019	Maksuk, Dian Pratiwi, Maliha Amin, Suzanna (2019)  Hemoglobin level due to pesticide exposure on	This research is an analytic observational study with a cross- sectional research	The hemoglobin level of workers spraying weeds is determined by several variables, namely gender, education level, eating/drinking while spraying, use of personal protective	Google Scholar

		workers sprayer at palm oil plantation	design.	<p>equipment and decontamination after spraying. Therefore the use of personal protective equipment is highly recommended for workers exposed to pesticides.</p> <p>The hemoglobin level of oil palm plantation workers due to exposure to pesticides is influenced by several variables including education level, eating/drinking while spraying or at the spraying location. Even though hemoglobin levels were less than normal, only 26 workers out of 80 workers were found, this needs to be watched out for and periodic checks must be carried out. Therefore, checks for hemoglobin levels need to be carried out regularly by the health center and company clinics, besides that, the employee nutrition program is very important. at the company.</p>	
6	2018	Nurhikmah, Setiani and Darundiati (2018)  Relationship Between Pesticide Exposure And Hemoglobin Level And Erythrocyte Amount In	This type of research is analytic observational with a cross-sectional study design	There is a significant relationship between length of work and hemoglobin levels in farmers, there is a significant relationship between spraying frequency and hemoglobin levels, there is a significant	Google Scholar

		Horticultural Farmers In The District Of Paal Merah, Jambi City		relationship between pesticide doses and hemoglobin levels in farmers	
7	2018	Norsita Agustina, Norfai (2018)  Pesticide Exposure to Anemia in Horticultural Farmers	This research is an analytic survey with a cross sectional approach.	Variables that statistically have a significant relationship with the incidence of anemia in horticultural farmers are exposure to pesticides (independent variable) and nutritional status (confounding variable) with a value of $p \leq 0.05$	Google Scholar
8	2013	Siti Aisyah Kurniasih, Onny Setiani, Sri Achadi Nugraheni (2013)  Factors related to exposure to pesticides and their relationship to the incidence of anemia in horticultural farmers in Gombong Village, Belik District, Pemalang Regency, Central Java	This type of analytic observational research with a cross-sectional design.	Most of the respondents (67.5%) are adults (> 20 years), the most gender is male, namely 82.5%, most of them have basic education (92.5%), working period > 5 years is 90% and most nutritional status is normal as much as 77.5%.  Gender characteristics have a relationship with the incidence of anemia.  The results of the multivariate analysis showed that there was a relationship between exposure to pesticides and the incidence of anemia.	Google Scholar

Study results in literature review in 8 national and international journals with each research. Factors that influence the incidence of anemia/hemoglobin levels are not using PPE, duration of spraying, personal hygiene, years of service, nutritional status, level of education, gender, exposure to pesticides. Some of those factors are:

1. Not using PPE, duration of spraying and personal hygiene

Personal protective equipment, hereinafter abbreviated as PPE, is a tool that has the ability to protect a person whose function is to isolate part or all of the body from potential hazards in the workplace

(Permenakertrans, 2010). The use of PPE is adjusted to the use or danger that threatens the use of pesticides. From mixing, applying to cleaning the tools, you must wear PPE in the form of as much clothing as possible to cover your body, head coverings, masks, eye protection, waterproof gloves, and boots. Negligence in using PPE can expose the body to chemicals that can affect hemoglobin levels (Nasution, 2022). When spraying plants with pesticides so that plants avoid pests (Permenaker, 1986).

Research conducted by Tasya Alifia Hanin entitled Relationship between exposure to pesticides and hemoglobin levels in farmers in Wonodadi Village, Gading Rejo District, Pringsewu Regency, namely exposure to pesticides in the form of pesticide spraying frequency, completeness of PPE use and personal hygiene behavior related to hemoglobin levels of farmers in Wonodadi Village, Gadingrejo District, Regency Pringsewu and research conducted by Ropen, Sugiarto and Parman (2021) with the title Factors Associated with the Incidence of Anemia in Vegetable Farmers, namely there is a relationship between length of work ( $p=0.023$ ) and use of PPE ( $p=0.012$ ) with the incidence of anemia among farmers who spray.

## 2. Years of service

Working period also affects exposure to pesticides, the longer the farmer's working period means that the exposure received is more and more and accumulates in the farmer's body. This can put you at risk for symptoms of pesticide poisoning such as dizziness, nausea, shortness of breath and coughing after spraying (Samosir, Setiani and Nurjazuli, 2017). Minister of Manpower No. 03 of 1986 states that to prevent unwanted effects it is recommended not to exceed four hours per day in a week in a row when using pesticides. Workers managing pesticides should not experience exposure for more than 30 hours a week. The recommended time to make contact with pesticides is a maximum of 2 times a week. The more often farmers spray using pesticides, the greater the possibility of poisoning. Exposure to pesticides with frequent frequency and short time intervals causes pesticide residues in the human body to become higher. The longer accumulation of pesticides can cause symptoms of pesticide poisoning (Lucki, Hanani and Yunita, 2018).

Research conducted by Ropen, Sugiarto and Parman (2021) with the title Factors Associated with the Incidence of Anemia in Vegetable Farmers, namely There is a relationship between work period ( $p=0.023$ ) and use of PPE ( $p=0.012$ ) with the incidence of anemia in farmers who spray and Nurhikmah, Setiani and Darundiati's research (2018) entitled Relationship Between Pesticide Exposure And Hemoglobin Level And Erythrocyte Amount In Horticultural Farmers In The District Of Paal Merah, Jambi City, namely that there is a significant relationship between length of work and hemoglobin levels in farmers, there is a relationship there is a significant relationship between the frequency of spraying and hemoglobin levels, there is a significant relationship between pesticide doses and hemoglobin levels in farmers.

## 3. Pepticide Exposure

Every chemical has its own negative effect, so do pesticides. According to WHO data, 5,000-10,000 people per year experience very fatal impacts such as cancer, disability, infertility, liver disorders and blood profiles, and it is also reported that at least 20,000 people die from pesticide poisoning (Rangan, 2014).

Research conducted by Norsita Agustina, Norfai (2018) with the title Pesticide Exposure to the Incidence of Anemia in Horticultural Farmers, namely variables that statistically have a significant relationship with the incidence of anemia in horticultural farmers are exposure to pesticides (independent variable) and nutritional status (confounding variable). with a value of  $p \leq 0.05$

Research conducted by Muhammad Asif Syed, Aneela Atta Ur Rahman, Muhammad Ilyas Siddiqui, Ashique Ali Arain with the title Pesticides and Chemicals as Potential Risk Factors of Aplastic Anemia: A Case–Control Study Among a Pakistani Population, namely a significant relationship between the risk of developing AA with pesticide exposure (OR=3.59, 95% CI 2.57–5.02) compared to those not exposed.

#### 4. Nutritional status

The maturation and speed of red blood cell production by the spinal cord is greatly influenced by a person's nutritional status. Two vitamins that are particularly important for the maturation of red blood cells are vitamin B12 and folic acid. In addition, iron is also needed in the formation of hemoglobin and is an important element in the body. Iron is found in meat, nuts and green vegetables. Vitamin B12 is found in shellfish and seafood. Folic acid is synthesized in various plants and bacteria (Guyton, A. C., Hall, 2014). One of the nutrients which, if it is not sufficient, can cause anemia is iron. Iron intake plays a role in the formation of red blood cells. Insufficient intake of iron will increase the absorption of iron from food, mobilize iron stores in the body, reduce the transport of iron to the bone marrow, and lower blood levels.

In Maksuk Nunik Tri Utami<sup>1</sup>, Suhartono<sup>2</sup>, Nikie Astorina Yunita Dewanti's research with the title Factors Influencing Anemia in Farmers in Candi Hamlet, Bandungan District, Semarang Regency, namely the results of the Chi Square protein analysis test: p value = 0.005 and PR = 6.000 ; 95% CI 1.672-21.531. This means that there is a relationship between protein intake and the incidence of anemia. The factor that has been proven to influence the incidence of anemia in Candi Hamlet, Bandungan District, is nutritional intake. Protein intake (p value = 0.005) with protein less than 100% RDA will be 6 times the risk of suffering from anemia. Iron intake (p value = 0.006) with iron less than 100% RDA will be 6 times the risk of suffering from anemia. Intake of vitamin C (p value = 0.047) with intake of vitamin C less than 100% RDA will be 3.67 times at risk of suffering from anemia. Intake of vitamin B12 (p value = 0.047) with intake of vitamin B12 less than 100% RDA will be 3.67 times at risk of suffering from anemia.

#### 5. Education Level and Gender

The level of education is "a person's activity in developing abilities, attitudes, and forms of behavior, both for future life where through a certain organization or not organized". Under normal circumstances, men have higher hemoglobin levels than women. This is influenced by the physiological and metabolic functions of men who are more active than women. Women's hemoglobin levels fall more easily, because they experience regular menstrual cycles every 8 months. When women experience menstruation there is a lot of iron loss, therefore the need for iron in women is more than that of men (Estridge and Reynolds, 2013).

The prevalence of anemia in Asia reaches 191 million women aged 15-45 years and Indonesia ranks 8th with 7.5 million people. The prevalence of women of reproductive age who experienced anemia during 2011 was 29% (WHO, 2015).

Research conducted by Siti Aisyah Kurniasih, Onny Setiani, Sri Achadi Nugraheni (2013) with the title factors related to pesticide exposure and its relationship to the incidence of anemia in horticultural farmers in gombong village, belik sub-district, Pemalang district, Central Java, namely the majority of respondents (67, 5%) are adults (> 20 years old), the most gender is male, namely 82.5%, most of them have basic education (92.5%), working period > 5 years is 90% and the most nutritional status is normal as much as 77.5%. Gender characteristics have a relationship with the incidence of anemia. The results of the multivariate analysis showed that there was a relationship between exposure to pesticides and the incidence of anemia.

## CONCLUSION

Based on the systematic review that has been carried out using the literature review method, based on the results of the study, it was obtained 8 related research articles. nutritional status, education level, gender, exposure to pesticides.



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