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The Relationship of *Plasmodium sp* Density to Platelet Count and Hemoglobin Levels in Malaria Patients at Bhayangkara Hospital TK I Pusdokkes Police Kramat Jati, Indonesia

***Dewi Inderiati[1], Nısa Oktapıa[1], Wadhatun Nida[1], Zuraida[2], Desi Hariutami[2]**

[1]Medical Laboratory Technology, Polytechnic of Health, Ministry of Health, Jakarta III, Jakarta Indonesia. [2]Mohammad Husni Thamrin University, Faculty of Health, Health Analyst Study Program, Jakarta Indonesia.
*Email: dregina.biomedic@gmail.com. DOI: 10.31964/mltj.v10i2.613

Abstract: Malaria is an acute and chronic disease. Globally, as many as 247 million positive cases of malaria were reported in 84 malaria-endemic countries. Indonesia is a malaria-endemic country with a total of 443,530 cases with a malaria prevalence of 89% reported from Papua province. This study examined the correlation between *Plasmodium sp* density platelet count and hemoglobin levels. The type of research used in this study was observational analytics with a cross-sectional study approach design. The sample and population in this study were malaria-positive patients who had their platelet count and hemoglobin levels checked as recorded in the report from Bhayangkara Hospital Tk I Pusdokkes Polri Kramat Jati, Indonesia, namely using medical record data from months January to December a total of 54 samples with data analysis in this study using descriptive univariate analysis and bivariate analysis using the Fisher Exact test. This study showed that the density of *Plasmodium sp* with the number of platelets had a significant result, namely 0.088, which indicates that the density of *Plasmodium sp* does not affect the platelet count. In contrast, the density of *Plasmodium sp* with hemoglobin levels had a significant result, namely 0.023, which indicated a lower Hb level of malaria sufferers. The higher the level of *Plasmodium* density.
Keywords: Hemoglobin level; malaria patients; *Plasmodium sp* density; platelet count.

INTRODUCTION

Malaria is an acute or chronic disease caused by protozoa of the genus Plasmodium and is transmitted through mosquito bites. Anopheles females are infected by the genus Plasmodium. Therefore, mosquito bites cause parasites to enter and settle in the liver and infect red blood cells. This can cause symptoms including fever, chills, nausea, vomiting, muscle aches and headaches, and can cause manifestations in the form of anemia, thrombocytopenia, and enlarged spleen (Fitriany & Sabiq, 2018). The malaria parasite species that exist in Indonesia are *Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae,* and *Plasmodium ovale* is the most common cause of malaria in Indonesia (Rahayu et al., 2017).

Malaria is a global disease, so the government is implementing an elimination program, including in Indonesia, until 2030. Globally, 247 million positive cases of malaria were reported in 84 malaria-endemic countries. Indonesia is a country with endemic malaria, with a total of 443,530 cases; 89% of positive malaria cases were reported from Papua Province (WHO, 2023). Based on national prevalence data, the elimination of malaria cases shows a decline; in 2021, there are 304,607 API numbers

Corresponding Author: Dewi Inderiati
Medical Laboratory Technology, Polytechnic of Health, Ministry of Health, Jakarta III, Jakarta Indonesia.
E-mail: dregina.biomedic@gmail.com

(Annual Parasite Incidence) of 1.12%. Of this number, 94% came from Papua, West Papua and NTT (WHO, 2021).

Parasite density and type *of Plasmodium are among* the agent and host factors that influence the severity of the disease in malaria sufferers. The species causing the density of malaria parasites in the blood plays an important role in determining the manifestation, mortality rate and severity of infection. The higher the density of parasites in the blood, the more severe the clinical manifestations and severity of the infection (Mosso & Song, 2020).

A person affected by malaria will experience hematological disorders such as anemia, leukocytosis and thrombocytopenia, which are influenced by the level of regional endemicity, hemoglobinopathy background, demographic factors and immunity, but this is not yet known with certainty because the pathogenesis process is still being researched (Ayu & Permata, 2020). Hematological changes are the most common complications in malaria infection, including hematological parameters that are of concern to malaria patients, namely hemoglobin levels, platelet counts and leukocyte counts because they cause various diseases, especially anemia, leukopenia, leukocytosis (Elieser & Iswanto, 2021). *Plasmodium falciparum* infects all types of red blood cells so that anemia can occur in the acute and chronic phases. *P. vivax* And *P. ovale* only infects young red blood cells, which account for only 2% of all red blood cells, whereas *P. malariae* infects old red blood cells, which account for only 1% of all red blood cells (Wahyuni, 2018).

Decreased platelet counts in malaria patients can be caused by immune-mediated lysis, sequestration in the spleen, bone marrow disease, phagocytosis by macrophages and increased absorption of parasites in the spleen (Kustiah et al*.*, 2020). Thrombocytopenia in malaria sufferers often does not show symptoms, but in severe malaria, the degree of thrombocytopenia will be more visible. The presence of malaria parasites in erythrocytes causes abnormalities in the hematological system of malaria sufferers (Ratunanda et al*.*, 2021).

A decrease in hemoglobin levels in malaria sufferers indicates a significant decrease or increase in the number of erythrocytes in malaria sufferers, which is caused by *Plasmodium*. The occurrence of this condition is caused by several mechanisms, including hemolysis factors, damage to erythrocytes by parasites, temporary inhibition of erythropoiesis, erythrophagocytosis, and inhibition of excretion (Kurniawan et al*.*, 2020). Destruction of erythrocytes by *Plasmodium* and autoantibodies can inhibit the regeneration of erythrocytes in the bone marrow, and this maturation defect can last up to three weeks after the parasitemia disappears. This is also one of the causes of a decrease in hemoglobin (Longgo, 2019).

Based on research conducted by Ayu and Permata in 2020, there is a significant correlation between parasite density *Plasmodium sp* and platelet count (Ayu & Permata, 2020). Meanwhile, based on research by M. Reza, et al in 2020, *Plasmodium sp* with the number of platelets, there was no significant difference, so there was no correlation.

Based on research conducted by Irawan (2017), infection was found *in P. falcifarum* as much (80.2%) compared with *P. vivax* as much as (19.2%), with the clinical picture of erythrocyte numbers and hemoglobin levels there was no significant correlation between the two types *Plasmodium* (Irawan et al*.*, 2017). Ayu and Permata et al*.* (2020) research, from 38 research subjects, it was found that the average parasite density in subjects suffering from malaria was 4,088 parasites/µL, the average hemoglobin was 13 *g/dL* obtained with a value *p*= 0.00, thus indicating a

significant correlation between parasite density and hemoglobin count (Ayu & Permata, 2020).

Bhayangkara Tk I Pusdokkes Polri Kramat Jati Hospital is one of the hospitals in the East Jakarta area. Bhayangkara Hospital Tk I Pusdokkes Polri Kramat Jati is the highest referral hospital for POLRI members and their families, where many of them are still sent to malaria-endemic areas.

There has not been much research on the relationship between *Plasmodium sp* density, platelet count, and hemoglobin levels, especially among respondents who are active members of the Indonesian National Police and their families. This study aims to analyze the relationship between *Plasmodium sp* Density, Platelet Count, and Hemoglobin Levels in malaria patients at the Bhayangkara Hospital Class I, Pusdokkes Polri Kramat Jati.

MATERIALS AND METHODS

This research was conducted using analytical observation using a cross-sectional approach and a consecutive sampling method, namely sampling, where members of the population who were found and met the inclusion and exclusion criteria were included in the research sample. This research was conducted in April-May 2024 at the National Police Hospital Laboratory, Kramat Jati, East Jakarta and medical record data at the Bhayangkara Tk I Polri Kramat Jati Hospital, data taken for the period January 2022 to December 2023.

The researcher applied for research permission to the Binfung section of Bhayangkara Hospital Tk I Kramat Jati Police Health Center. After obtaining research permission, an ethical review was carried out by the research ethics committee of Bhayangkara Hospital Tk I Pusdokkes Polri Kramat Jati until the researcher received a certificate of passing the ethical review. This research has received ethical permission from the Research Ethics Commission with number KET/EC-36/IV/2024/RS.BHAY.TK.I dated March 24, 2024. During the research, researchers paid attention to the principles of information ethics to respect human rights, humanity, beneficence and non-maleficence. Using the inclusion and exclusion criteria, researchers selected and collected data on malaria-positive patients in the laboratory unit and medical records at the Bhayangkara Tk I Polri Kramat Jati Hospital. Inclusion criteria in this study were malaria-positive patients who underwent hemoglobin examination at the National Police Hospital. Meanwhile, the exclusion criteria for this study were malaria patient preparations that were damaged and, therefore, unfit to be observed microscopically.

Record the required data and summarize the data in tabular form. 60 patients were identified as positive for malaria, while those who met the inclusion criteria were 54 data. So, the total data is 54 data. Number of parasites by reading thin blood smear slides of malaria preparations using 10% Giemsa staining. Read using an Olympus microscope. Microscopically, malaria parasite density is categorized as low (1–100/100 fields of view) and high (≥1/field of view).

Platelet and hemoglobin examination using a Sysmex XN-1000 hematology instrument. Platelet <150.000/µL (Thrombocytopenia), 150.000-400.000/µL (Normal platelet); ≥ 12 g/dL (Normal hemoglobin), < 12g/dL (Abnormal hemoglobin). The data This research uses categorical data, then using the Fisher Exact Test, test result data is made in tabular form and described in narrative form.

RESULTS AND DISCUSSION

This research was carried out in the Medical Records Unit and Laboratory of Bhayangkara Hospital Tk I Pusdokkes Polri Kramat Jati with the research subjects being patients who were positively infected with malaria, both species *Plasmodium falciparum, Plasmodium ovale, Plasmodium malariae, Plasmodium vivax* whatever *Plasmodium* mix. Data on examination results for 54 malaria patients who had their platelet counts checked from January 2022 to December 2023 are as follows:

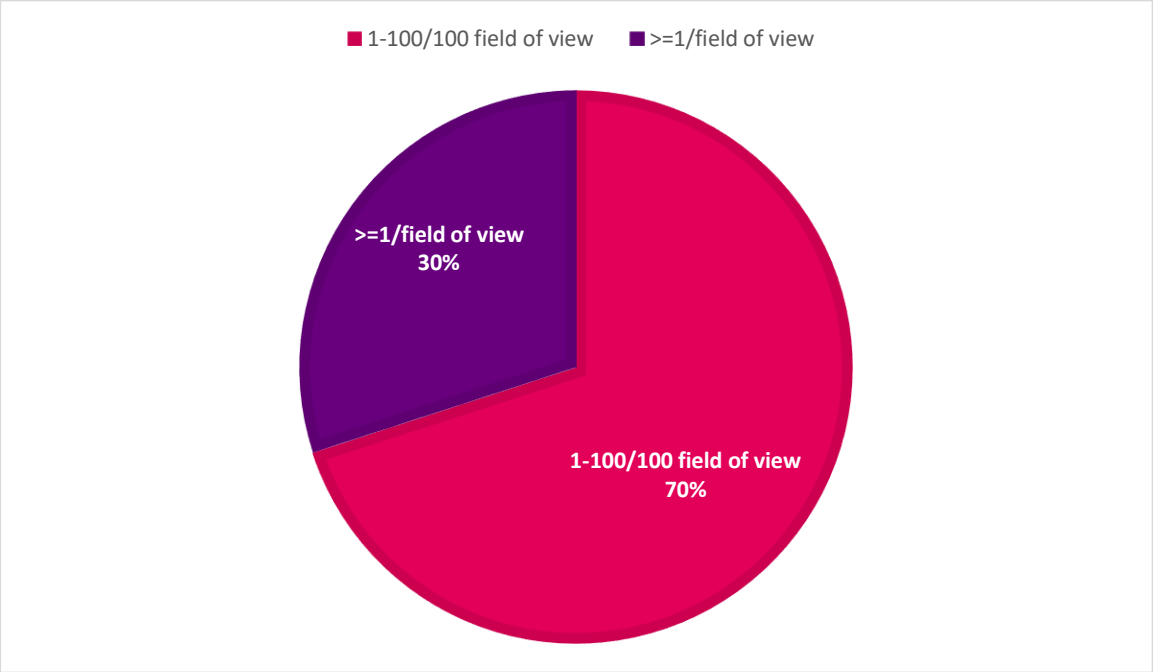

Figure 1. Malaria Density

The results of Figure 1 show that based on parasite density, 38 (70%) malaria patients had 1-100/100 field of view, and 16 (30%) malaria patients had >=1/ field of view.

Table 1. Frequency Distribution Based on Hemoglobin Group and Platelet Count

Variabel	Hemoglobin		Platelets	
	Frequency	Percent	Frequency	Percent
Normal	11	20,4	8	14,8
Abnormal	43	79,6	46	85,2
Total	54	100,0	54	100,0

The results of Table 1 show that of the 54 malaria samples, 11 (20.4%) had normal hemoglobin levels, and 43 (79.6%) had abnormal hemoglobin levels. Of the platelet count of 54 malaria patients, 8 (14.8%) patients were normal, and 46 (85.2%) were abnormal.

Table 2. Relationship between Hemoglobin Levels and Platelet Counts on Malaria Density

Variabel	Malaria density				p Value
	1-100/100 field of view		≥1/ field of view		
	n	%	n	%	
Hemoglobin					
normal	11	20,37%	0	0%	0,022
Abnormal	27	50%	16	29,63%	
Platelets					
normal	8	14,81%	0	0%	0,088
Abnormal	30	55,56%	16	29,63%	

The results of Table 2 show that the 54 malaria samples had a malaria density of 1-100/100 field of view with normal hemoglobin levels of 11 (20.37%) and abnormal 27 (50%). In contrast, the malaria density was ≥1/ field of view with normal hemoglobin levels of 0. (0%) and abnormal 16 (29.63%). Of the 54 malaria samples, the malaria density was 1-100/100 field of view with normal platelet levels 8 (14.81%) and abnormal 30 (55.56%). In contrast, the malaria density was ≥1/ field of view with normal platelet levels 0 (0%) and abnormal 16 (29.63%).

Malaria is an acute or chronic infectious disease caused by Plasmodium infection, which attacks erythrocyte cells. The discovery of asexual forms in the blood characterizes it. Malaria can attack everyone, both men and women, in all age groups, from babies to adults (Anggriyani et al*.*, 2023).

Based on research results for malaria case data for 2022-2023, 54 patients tested positive for malaria at Bhayangkara Hospital Tk I Pusdokkes Polri Kramat Jati. Indonesia at Figure 1. A person can be found to be infected with malaria by carrying out a physical examination to see symptoms such as fever, chills, headache and muscle aches. Then, a laboratory examination is carried out to confirm the diagnosis, such as a Malaria blood smear and hematology to see the number of platelets (Stauffer W, Fischer PR., 2003).

The study showed that 79.6% of respondents had abnormal hemoglobin levels (Table 1). This occurs when hemoglobin levels decrease the number of erythrocytes that rupture due to *Plasmodium sp* infection; the more the number of parasites that infect, the more erythrocytes rupture, this will lead to anemia (Kurniawan et al*.*, 2019). The results of this study by Azizah et al (2023) showed the higher parasitemia worsens the hamatological condition. Parasitemia plays a role independently in the severity of anemia. (Azizah et al, 2023). Several mechanisms that can cause anemia in malaria infections are the destruction of infected erythrocytes, decreased erythrocyte production in the bone marrow, and phagocytosis of infected erythrocytes (Ayu & Permata, 2020). Parasites of the *Plasmodium sp* type attack young red blood cells and can cause intravascular hemolysis in parasitized erythrocytes; as a result of hemolysis, anemia occurs.

Anemia is a symptom that is often found in malaria infection. Anemia in malaria can be caused by excessive lysis of infected and uninfected erythrocytes by *Plasmodium sp* in the peripheral circulation so that the lifetime of erythrocytes becomes shorter (Longgo, 2019). Destruction of erythrocytes by Plasmodium and autoantibodies can inhibit the regeneration of erythrocytes in the bone marrow, and

this maturation defect can last up to three weeks after the parasitemia disappears; this is also one of the causes of decreased hemoglobin and anemia (Salsabila et al., 2021). According to research results from Perez (2015) in Brazil which shows that the average patient with falciparum malaria experiences anemia when the patient comes to the hospital on the 3rd to fifth day, and vivax malaria patients experience it on the 3rd day after the onset of symptoms, (Perez et al., 2015).

Based on the results of Table 2, the Fisher Exact analysis test shows a relationship between *Plasmodium sp* density and hemoglobin levels with a p-value of 0.022 ($p<0.05$). Moreover, there is no relationship between *Plasmodium sp* density and platelet count with a p-value of 0.088 ($p>0.05$). This aligns with research conducted by Ayu and Permata (2020), which showed a significant decrease in hemoglobin levels with increasing parasite density (Ayu & Permata, 2020). Agustin's research (2022) shows a significant negative correlation between parasite density and hemoglobin levels; this means that a higher parasite density level causes a decrease in hemoglobin values in malaria patients. The density of malaria parasites in the blood plays an important role in determining the infection's manifestation, mortality and severity. The denser the parasite density in the blood, the more serious the infection. Patients with the highest parasite density also have the highest mortality rate. In addition, excessive hemolysis of parasitized red blood cells in malaria infection can cause anemia (Agustin et al., 2022).

Based on Ratunanda's research (2021), there is an increase in anti-thrombocyte IgG antibodies in patients with malaria, which activates the platelet membrane, causing platelet ejection by the reticuloendothelial system in the spleen. Meanwhile, the condition of patients who have a normal platelet count is thought to be influenced by the patient's immune complex and erythrocyte structure so that the destruction of platelets in circulation is not too significant. The ability of the bone marrow to perform thrombopoiesis can also cause malaria patients to have a normal platelet count (Ratunanda et al., 2021). Statistically, there is sufficient evidence to suggest that there is a relationship between the density of Plasmodum Sp and hemoglobin levels so that it can be concluded that there is a relationship between the density of Plasmodum Sp and hemoglobin levels at Bhayangkara Tk I Pusdokkes Polri Kramat Jati Hospital. This study still contains weaknesses due to many shortcomings and limitations, such as not seeing the various stages of the parasite, limitations in finding information about the origin that is not available in medical record data, and not conducting repeated malaria identification checks when the results of the patient's hemoglobin and platelet levels increase so that it cannot be known.

A more significant effect exists between increasing *Plasmodium sp* density and hemoglobin levels in malaria patients. Patients with high parasitemia can be treated aggressively to prevent further complications, such as bleeding or hypoxia. This study can help identify population groups more susceptible to serious malaria complications so that more intensive monitoring can be carried out.

CONCLUSION

Hemoglobin levels in malaria patients at the Bhayangkara Tk I Hospital, Pusdokkes Polri Kramat Jati, in 2022-2023, the following results were obtained: There were 54 cases of malaria screening at the Bhayangkara Tk I Hospital, Pusdokkes Polri Kramat Jati. 79.6% of hemoglobin levels and 85.2% of platelet values were abnormal. There is a relationship between hemoglobin levels and malaria density with a p-value of 0.022, and there is no relationship between platelet values and malaria density with a p-value of 0.088. There is a need to increase malaria knowledge on preventing it

and the dangers of mobility to endemic areas through outreach and education activities before leaving for work. It is necessary to treat malaria sufferers entirely so that there is no further transmission or relapse. There needs to be further research with different types of research designs and variables to find out other factors related to malaria.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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