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Comparative Analysis of Erythrocyte Sedimentation Rate (ESR) in Patients with *P.falcifarum* and *P.vivax* Malaria at Biak General Hospital

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ABSTRACT

P.falciparum and P.vivax infections elicit an immune response manifesting as inflammation, which is typified by alterations in various hematological parameters, including ESR. The objective of this study was to analyze the disparities in ESR values between P. falciparum and P. vivax infections. The study design employed an analytical approach, utilizing a cross-sectional study design. The population and sample consisted of 20 malaria patients at Biak General Hospital, including 9 confirmed P.falciparum infections and 11 P.vivax infections. The mean ESR values for P.falciparum infection were 32.8 mm/1 hour for males and 40.5 mm/1 hour for females. For P. vivax infection, the values were 36.4 mm/1 hour for males and 45.8 mm/1 hour for females. The ESR comparison between P. falciparum and P. vivax exhibited a significance value of 0.08>0.05, and the ESR comparison based on positivity level demonstrated a significance value of 0.253>0.05. A thorough examination of the results reveals that there is no statistically significant difference in the ESR values between P.falciparum and P.vivax infections in patients suffering from malaria.

INTRODUCTION

Malaria continues to represent a significant global health challenge, particularly in tropical and subtropical regions. The etiological agent of the disease is the Plasmodium parasite, which is transmitted to humans through the bite of an infected female Anopheles mosquito. The species *P. falciparum and P. vivax* are the two primary etiological agents of malaria in humans. P. falciparum is recognized as the causative agent of severe malaria, which is characterized by high morbidity and mortality rates. In contrast, *P. vivax* is typically associated with milder forms of malaria. However, it has been observed to recur due to the dormancy of hypnozoites in the liver (WHO, 2023). *P.falciparum* and *P.vivax* infections have been observed to induce an immune response manifesting as inflammation, which is typified by alterations in various hematological parameters. Among these, the erythrocyte sedimentation rate (ESR) has

been identified as a notable indicator. The ESR parameter quantifies the rate of erythrocyte sedimentation in a test tube over a designated period (mm/hour), serving as a non-specific predictor of inflammation or infection (Pincus, M. R., Abraham, N. Z., & Carty, 2021). An increase in ESR values occurs due to elevated levels of fibrinogen, immunoglobulins, and acute-phase proteins such as C-reactive protein (CRP) produced during the infection process (Brigden, 2020). A body of research has demonstrated that the values of ESR can be subject to variation depending on the species of Plasmodium that is responsible for the infection. *P.falciparum* infections are frequently associated with a more severe inflammatory response in comparison to *P.vivax* infections. This discrepancy is attributed to the more aggressive pathogenic mechanisms exhibited by *P.falciparum*, including the adhesion of infected erythrocytes to blood vessel endothelium (cytoadherence) and elevated production of pro-inflammatory cytokines (Clark, I. A., Alleva, L. M., Mills, A. C., & Cowden, 2020). However, other studies have reported that *P. vivax* can also trigger significant inflammatory responses, particularly in cases with complications (Anstey, N. M., Russell, B., Yeo, T. W., & Price, 2021). The differential pathogenicity between *P.falciparum* and *P.vivax* infections is believed to impact ESR levels; however, comparative data between these two species remains scarce. The objective of this study is to conduct a comparative analysis of ESR levels in patients with *P. falciparum* and *P. vivax* infections, to enhance our comprehension of the inflammatory response that is elicited. These findings are expected to serve as clinical considerations in assessing the severity of infection and managing therapy more appropriately, provide epidemiological and clinical data that can be used by policy makers in species-based malaria control planning and support the development of malaria management guidelines that take into account laboratory parameters such as ESR.

METHOD

The research design that was implemented involved the use of cross-sectional analytics. The study population and sample consisted of 20 malaria patients at Biak Regional General Hospital, comprising 9 cases of Plasmodium falciparum infection and 11 cases of P. vivax infection. All participants provided informed consent, and the study was approved by the IIK Bhakta Ethics Committee with registration number 452/FTMK/EP/III/2023. The identification of Plasmodium species is achieved through the implementation of thin and thick smear methods, followed by a meticulous interpretation. A positive result is indicated by the presence of 1–10 parasites per 100 fields of view in blood smears, 11–100 parasites per 100 fields of view in blood smears, 1–10 parasites per 1 field of view in blood smears, or >10 parasites per 1 field of view of a blood smear (Chairland, Lestari E, 2011). The examination of ESR was conducted using the Microsed system ESR analyzer with whole blood specimens collected in 3.8% sodium citrate vacutainer tubes. The data obtained were analyzed using a series of analytical procedures in SPSS 25.0. These procedures included normality and homogeneity tests, as well as the *Kruskal-Wallis* comparison test. The P-value threshold used for the analysis was set at <0.05.

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RESULT

1) Description of ESR test results for malaria patients at Biak General Hospital.

Table 1. Description of ESR test results for malaria patients at Biak General Hospital

Plasmodium	Sex	Mean (mm/1jam)	Max (mm/1 jam)	Min (mm/1jam)	Level of positivity			
					+4	+3	+2	+1
Falciparum	Male (n=5)	32,8	62	13	60%	-	20%	20%
	Female (n=4)	40,5	74	19	75%	25%	-	-
Vivax	Male (n=5)	36,4	104	8	20%	40%	20%	20%
	Female (n=6)	45,8	71	15	16,7%	16,7%	66,6%	-

Source: Primer Data

Table 1 shows that 75% of infections were *P.falciparum* with a grade of 4+, while 66.6% were *P.vivax* infections. The average ESR values for *P.falciparum* infections were 32.8 mm/1 hour for males and 40.5 mm/1 hour for females. For *P.vivax* infections, the values were 36.4 mm/1 hour for males and 45.8 mm/1 hour for females.

2) ESR test results based on the Level of positivity

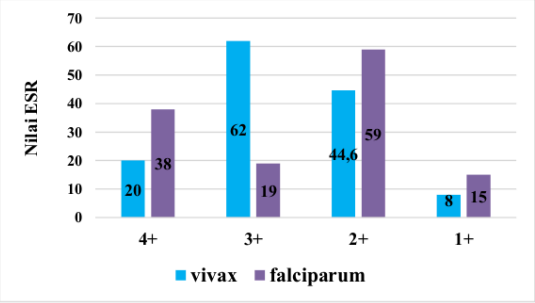

Figure 1. ESR test results based on the Level of positivity

Figure 1 Shows that positive infections 2 and 3 experienced a significant increase. They reached 59 and 62 (mm/1 hour).

3) Comparison of ESR values based on *Plasmodium* species *(falciparum and vivax)* and the Level of positivity

Table 2. Results of ESR values comparison tests based on Plasmodium species (falcifarum and vivax) and Level of positivity

Variabel	N	sig
Spesies *Plasmodium*	20	0,08>0,05
Derajat Positivitas	20	0.253>0,05

Source : Primer Data

Table 2 shows that there is no difference in ESR values between *P.falciparum* and *vivax* infections, with a significance level of 0.08 > 0.05. Furthermore, the Level of positivity does not affect ESR values in malaria caused by *P.falciparum* and *vivax*, with a significance level of >0.05.

DISCUSSION

The mean ESR values in P. falciparum infections exhibited a notable increase, with an average of 32.8 millimeters per hour in male subjects and 40.5 millimeters per hour in female subjects. In the P. vivax infection group, the mean ESR also increased, with 36.4 millimeters per hour in men and 45.8 millimeters per hour in women. The results obtained demonstrate that there is an increase in ESR in malaria caused by the falciparum and vivax species, and they confirm that ESR functions as a biomarker for inflammation caused by infection. As reported in previous studies, an increase in ESR values was observed for P. falciparum at 77.79 mm/hour and for P. vivax at 82.19 mm/hour (Al, 2013). In contrast, ESR values in uncomplicated malaria cases were 34.4 mm/1 hour and in severe malaria, 39.2 mm/1 hour (Roy S, Saha D, Ahmed R, 2024). The increase in ESR is attributable to the inflammatory process during infection or the presence of parasite inclusion bodies within human erythrocytes (Patil, Asha, Vivek Raghavan Muduthan, Kunder, 2019). An alternative hypothesis proposes the utilization of ESR as an early marker for malaria, typhoid fever, and dengue fever infections (Harrison, 2015).

The results of the ERS test, based on the Level of positivity and the type of Plasmodium species, provide varied images. In positive 1, the ESR value exhibited a standard average for both P. vivax and P. falciparum infections. Groups positive 2 and 3 exhibited a substantial increase, reaching 59 and 62 millimeters per hour, respectively. Conversely, positive 4 demonstrated a decline, although it remained above the standard range at 38 millimeters per hour. This phenomenon has been observed in other studies as well, where ESR increased significantly to 70 millimeters per hour at moderate infection levels (positive 3), and positive 4 decreased to 44 millimeters per hour (Kadeq Novita Prajawanti, Siti Zaetun, 2019).

The results of the comparison test reveaESR no statistically significant differences in ESR values based on Plasmodium species type or positivity level, with a p-value greater than 0.05. This finding suggests that the observed increase in ESR in this study was not influenced by P. falciparum or P. vivax positivity levels. However, the ESR values of P. falciparum and P. vivax both increased, indicating the presence of inflammation. These results are consistent with previous findings that indicated no statistically significant difference in ESR values based on the number of parasites found in peripheral blood smears ($p = 0.932 > 0.05$). This

discrepancy can be attributed to the non-specific nature of ESR, which has been observed to increase in a wide range of inflammatory conditions. Consequently, there is a possibility of obtaining false-positive results (elevated values in the absence or presence of inflammation) when comparing ESR to C-reactive protein. Furthermore, a gradual rise in ESR during the acute phase may result in false-negative outcomes in the initial stages of the inflammatory or infectious process (Harrison, 2015). However, it is imperative to maintain a medical perspective when encountering an escalation in ESR cases, particularly in regions where P. falciparum and P. vivax infections induce substantial alterations in hematological parameters (Al, 2013).

CONCLUSION

Individuals infected with P. falciparum and P. vivax both exhibit an increase in ESR, and there is no significant difference in ESR values between the two species of Plasmodium. To improve the accuracy of inflammatory prognosis, ESR can be combined with other inflammatory variables, such as Neutrophil-to-Lymphocyte Ratio (NLR) and C-Reactive Protein (CRP).

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