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Parasite Density Of Plasmodium Falciparum And Lymphocyte Profile In Hospitalized Falciparum Malaria Patients At Jayapura Regional General Hospital, 2024–2025

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Abstract

Background: Falciparum malaria remains a serious clinical threat in Papua because the increasing burden of Plasmodium falciparum parasites can worsen the immune response and disrupt the hematological profile of hospitalized patients. Objective: This study aims to analyze the association between Plasmodium falciparum parasite density and lymphocyte percentage in hospitalized falciparum malaria patients at Jayapura Regional General Hospital during 2024–2025. Methods: The study used an observational analytical design with a cross-sectional approach based on medical record data. Samples were obtained through total sampling, from an initial population of 603 to 525 patients who met the inclusion and exclusion criteria. Data were analyzed descriptively and bivariately using the Spearman correlation test. Results: Most patients were adults, 322 people (61.3%), male, 275 people (52.4%), with a mean total lymphocyte percentage of 19.086±10.79%. The Spearman test showed a weak negative correlation between parasite

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density and lymphocyte percentage (r=-0.199; p<0.001). Conclusion: An increase in parasite burden tends to be accompanied by a decrease in lymphocyte percentage. This study provides preliminary local evidence on the immune-hematological profile of hospitalized falciparum malaria based on two years of hospital data in the endemic region of Papua, relevant for strengthening local clinical malaria laboratory interpretation.

Keywords: Parasite density; Lymphocytes; Falciparum malaria; Inpatients; Plasmodium falciparum

INTRODUCTION

Falciparum malaria remains an important clinical problem in Papua as a malaria-endemic region. Infection with Plasmodium falciparum produces serious effects on patients because it can progress into a severe condition requiring hospital monitoring. The severity of this disease is determined not only by the presence of the parasite but also by parasite density in the blood. High parasite density relates to the risk of clinical complications and can worsen a patient's condition (Alam et al., 2021). Infection with Plasmodium falciparum also triggers an inflammatory response through immune mediators such as TNF-α, IL-6, IFN-γ, and IL-8 (Alfaki et al., 2023; Morang'a et al., 2024). This response can differ by age and sex, so laboratory interpretation needs to consider patient characteristics (Bohli et al., 2026). Falciparum malaria in hospitalized patients in Papua requires serious attention so that directed monitoring of parasitemia and blood parameters becomes necessary.

Falciparum malaria infection affects the hematological condition of patients. The clinical condition of falciparum malaria patients gradually worsens during care at the hospital or at home. Laboratory examination of falciparum malaria patients shows marked changes in hemoglobin, platelet, leukocyte, and lymphocyte levels (Elkhalifa et al., 2021). These changes are important because they can reflect the body's response to infection and the severity of the parasite burden. A study by (Onohuean et al., 2023) shows that laboratory outcomes in P. falciparum infection can differ according to a patient's biological condition, so the interpretation of blood results cannot be separated from the clinical context. Research by (Saleh et al., 2023) also affirms that hematological parameters and immune mediators play a role in describing the dynamics of the body's response in falciparum malaria. The lymphocyte percentage therefore needs to be examined as part of the leukocyte profile that can help read a patient's immune response to an increasing parasite burden during hospitalization.

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The lymphocyte percentage is one of the complete blood count parameters frequently available in falciparum malaria patients, yet its clinical meaning does not always receive special attention. Lymphocytes play a role in the adaptive immune response to Plasmodium falciparum infection, particularly through T-cell and B-cell activity (Antwi-Baffour et al., 2025). Changes in leukocyte count, including lymphocytes, can relate to parasite density and reflect the dynamics of the immune response during malaria infection (Nugraha et al., 2025). The role of lymphocytes becomes increasingly important because T-cell subpopulations are known to be involved in immune mechanisms that can influence the course and severity of malaria(Sharma et al., 2024). Beyond the cellular response, falciparum malaria infection also triggers inflammatory mediators such as IFN-γ, IL-6, and TNF-α that relate to the immune response against the parasite (Alfaki et al., 2023; Morang'a et al., 2024). This condition shows that lymphocytes cannot be viewed merely as a routine figure in laboratory results. The lymphocyte percentage therefore needs to be interpreted as part of the immune-hematological profile that can help read a patient's response to the burden of falciparum malaria infection.

The assessment of lymphocyte percentage becomes more meaningful when linked to parasite density as a measure of infection burden. The parasite density of Plasmodium falciparum describes the number of parasites in the blood and can indicate the biological pressure on a patient's immune system. In severe malaria, parasite biomass and host-response markers relate to disease severity, so both are important in clinical assessment (Varo et al., 2025). An increase in parasitemia also relates to changes in leukocyte count in malaria patients, indicating the involvement of a cellular response to the infection burden(Nugraha et al., 2025). Immunologically, P. falciparum infection can be accompanied by changes in peripheral lymphocytes and their subpopulations as part of the dynamics of the body's response to the parasite (Antwi-Baffour et al., 2025)(Antwi-Baffour et al., 2024). The relationship between parasite density and lymphocyte percentage has not been explained specifically in hospitalized patients in Papua. Analysis of falciparum malaria patients at Jayapura Regional General Hospital is therefore needed to clarify this biological association within the endemic-region context.

The association between parasite density and lymphocyte percentage needs to be placed within the context of malaria services in Papua. This region continues to show a substantial malaria burden, including in Jayapura, so hospital clinical data become important for reading the disease pattern in patients who require care (Fauziah et al., 2026). Environmental factors in Papua also continue to play a role in maintaining malaria transmission risk, so inpatient cases cannot be separated from the local endemicity context (Ashar et al., 2025). On the clinical side, research in

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West Papua shows that malaria can be accompanied by hematological changes, including anemia, thrombocytopenia, and changes in other blood cells (Jiero & Pasaribu, 2021). Earlier hospital-based findings in Papua also affirm that malaria can impose a meaningful clinical and hematological burden on patients presenting to health facilities (Douglas et al., 2013). Within this context, the 2024–2025 data from Jayapura Regional General Hospital hold important value because they derive from real service practice, not merely community surveys. These data can be used to observe the immune-hematological pattern of hospitalized falciparum malaria patients, particularly the relationship between the parasite density of Plasmodium falciparum and lymphocyte percentage.

Hospital data in endemic regions are important not only for recording cases but also for assessing clinically meaningful relationships between laboratory parameters. Studies in Papua have linked parasite density with hematological parameters in Plasmodium vivax and Plasmodium falciparum infection, but the lymphocyte percentage has not been positioned as a primary focus in hospitalized patients (Kurniawan et al., 2020). Research in West Papua also shows that malaria can be accompanied by hematological changes, but the discussion has not specifically linked parasite density with lymphocytes in hospital services (Jiero & Pasaribu, 2021). Outside Papua, hematological studies of falciparum malaria affirm changes in blood indices and leukocytes, but those findings have not addressed the local evidence needs of Jayapura Regional General Hospital (Elkhalifa et al., 2021). Meanwhile, changes in peripheral lymphocytes in P. falciparum infection have been reported as part of the immune response, but have not been directly linked with parasite density in hospitalized patients in Papua (Antwi-Baffour et al., 2024). The current limitation in scientific evidence lies in the absence of a local, inpatient-data-based study assessing the relationship between the parasite density of Plasmodium falciparum and lymphocyte percentage. This study addresses that limitation by drawing on the medical records and routine laboratory results of Jayapura Regional General Hospital during 2024–2025.

Building on that problem and the limitation in scientific evidence, this study aims to analyze the association between the parasite density of Plasmodium falciparum and lymphocyte percentage in hospitalized falciparum malaria patients at Jayapura Regional General Hospital during 2024–2025. The results are expected to provide preliminary local evidence on the immune-hematological profile of falciparum malaria within the hospital-service context of the endemic region of Papua. The findings can also serve as a basis for strengthening the interpretation of routine laboratory examinations in the clinical assessment of hospitalized falciparum malaria patients.

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RESEARCH METHOD

This study is an analytical observational study with a cross-sectional design based on retrospective medical record data. The study was conducted at the Regional General Hospital of Jayapura in June 2026 using inpatient data from the 2024–2025 period. The study population was all hospitalized patients diagnosed with falciparum malaria recorded at Jayapura Regional General Hospital during that period. The sample was obtained using the total sampling technique, namely all patients who met the inclusion criteria and did not fall under the exclusion criteria. Of the 603 patients identified, 525 patients met the criteria and were analyzed. The inclusion criteria covered hospitalized patients diagnosed with falciparum malaria, with complete age and sex data, documented malaria examination results, and complete blood count results containing the lymphocyte percentage. The exclusion criteria covered patients with incomplete medical records, non-falciparum malaria, coinfections that can affect lymphocytes such as dengue fever, HIV, sepsis, or tuberculosis, and a history of immunosuppressant use.

The independent variable of the study was the parasite density of Plasmodium falciparum, namely the number of parasites per microliter of blood based on laboratory examination results recorded in the medical records. The dependent variable was the lymphocyte percentage, namely the proportion of lymphocytes relative to total leukocytes based on complete blood count results. The characteristic variables covered age and sex. Age was grouped into children 0–17 years, adults 18–59 years, and elderly over 60 years, while sex was categorized as male and female. Data collection used a standardized extraction sheet covering patient code, year of care, age, sex, falciparum malaria diagnosis, parasite density, and lymphocyte percentage. The data were rechecked to ensure completeness, diagnostic suitability, and consistency of laboratory values before analysis.

Data analysis used SPSS version 32. Univariate analysis was used to describe patient characteristics, parasite density, and lymphocyte percentage in the form of frequency, percentage, mean, and standard deviation. Bivariate analysis was conducted to assess the correlation between the parasite density of Plasmodium falciparum and lymphocyte percentage. The Spearman test was used because the analysis was directed at the relationship between two numerical variables not assumed to be normally distributed. A p-value <0.05 was declared statistically significant, while the correlation coefficient was used to assess the direction and strength of the relationship.

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RESEARCH RESULTS

The results show that of the 525 hospitalized falciparum malaria patients at Jayapura Regional General Hospital during 2024–2025, the adult age group was the largest with 322 patients (61.3%). The children's group was recorded at 150 patients (28.6%), while the elderly group numbered 53 patients (10.1%). By sex, male patients numbered 275 people (52.4%) and female patients numbered 250 people (47.6%). This distribution describes the composition of hospitalized falciparum malaria patients by age and sex within the study population (Table 1).

The proportion of adult patients was the largest in this study's data. The elderly group was the smallest. The difference in the number of male and female patients was not large, with a difference of 25 patients. This composition shows the basic distribution of hospitalized falciparum malaria patients analyzed in the study.

Table 1. Characteristics of hospitalized falciparum malaria patients at Jayapura Regional General Hospital during 2024–2025

Characteristic	Category	n	%
Age	Children (0–17 years)	150	28,6
	Adults (18–59 years)	322	61,3
	Elderly (>60 years)	53	10,1
	Total	**525**	**100,0**
Sex	Male	275	52,4
	Female	250	47,6
	Total	**525**	**100,0**

The mean lymphocyte percentage in hospitalized falciparum malaria patients differed by age group and sex. By age group, the highest mean lymphocyte percentage was found in children at 23.453±12.81%, followed by the elderly at 19.730±11.56%, and adults at 16.946±8.87%. The mean lymphocyte percentage across all patients was recorded at 19.086±10.79%. By sex, females had a mean lymphocyte percentage of 20.039±11.20%, while males had 18.220±10.34%. A summary of the mean and distribution of lymphocyte percentage by patient characteristics is presented in Table 2.

By sex, the mean lymphocyte percentage in females was higher than in males. Females had a mean lymphocyte percentage of 20.039±11.20%, while males had 18.220±10.34%. The standard deviation in the female group was also slightly larger than in males. These data show the

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distribution of the mean lymphocyte percentage across each patient characteristic group.

Table 2. Lymphocyte percentage of falciparum malaria patients by age and sex

Characteristic	Category	n	Mean lymphocyte percentage (%)	Standard deviation
Age	Children(0–17 years)	150	23,453	12,81
	Adults (18–59 years)	322	16,946	8,87
	Elderly (>60 years)	53	19,730*	11,56
	Total	**525**	**19,086**	**10,79**
Sex	Male	275	18,220	10,34
	Female	250	20,039	11,20
	Total	**525**	**19,086**	**10,79**

Bivariate analysis was conducted to assess the association between the parasite density of Plasmodium falciparum and lymphocyte percentage in 525 hospitalized falciparum malaria patients. The Spearman test obtained a correlation coefficient of -0.199 with a p-value <0.001. This coefficient indicates a negative correlation direction between parasite density and lymphocyte percentage. The complete correlation test results are presented in Table 3.

The strength of the correlation was in the weak category based on the coefficient obtained. The p-value <0.001 shows that the test result was statistically significant. The bivariate result in this study shows a weak negative correlation between the parasite density of Plasmodium falciparum and lymphocyte percentage in hospitalized falciparum malaria patients.

Table 3. Correlation between the parasite density of Plasmodium falciparum and lymphocyte percentage

Variables analyzed	n	Statistical test	Correlation coefficient (r)	p-value	Interpretation
Parasite density of *Plasmodium falciparum* and lymphocyte percentage	525	Spearman rho	-0,199	<0.001	Weak negative correlation, statistically significant

Overall, this study's results show that hospitalized falciparum malaria patients at Jayapura

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Regional General Hospital during 2024–2025 came more from the adult age group and slightly more from males. The lymphocyte percentage showed variation by age and sex, with a total mean of 19.086±10.79%. The correlation analysis revealed a statistically significant negative relationship between the parasite density of Plasmodium falciparum and lymphocyte percentage, with a weak correlation strength.

DISCUSSION

The findings of this study show that hospitalized falciparum malaria at Jayapura Regional General Hospital during 2024–2025 had a clear clinical-laboratory pattern. Patients came more from the adult age group and were slightly more dominant among males. The mean total lymphocyte percentage was recorded at 19.086±10.79% and varied by age and sex. The results revealed a significant negative correlation between the parasite density of Plasmodium falciparum and lymphocyte percentage, although the strength of the relationship was weak. This pattern shows that an increase in parasite burden relates to a decrease in lymphocyte percentage, but that change is likely also influenced by other clinical and biological factors. The findings align with recent evidence that hospitalized falciparum malaria has a clinical and immunological spectrum influenced by the magnitude of the parasite burden and the host response. In adult patients with severe malaria, clinical manifestations can involve several disturbances. Those effects include impaired consciousness, systemic complications, and poorer outcomes, so hospitalized patients need to be viewed as a group with higher clinical risk (Boushab et al., 2021). Recent studies also show that assessing parasite burden through biomass indicators can strengthen understanding of malaria severity compared with observing peripheral parasitemia alone (Konadu et al., 2026). On the immunological side, Plasmodium falciparum infection relates to increased inflammatory mediators that play a role in the body's response to the parasite and to disease severity (Alfaki et al., 2023). That variation in immune response can be influenced by clinical conditions and other biological factors, so the relationship between parasite density and immune parameters is not always statistically strong (Cuamba et al., 2026). This aligns with the present study's result, namely a significant but weak negative correlation between the parasite density of Plasmodium falciparum and lymphocyte percentage. This preliminary finding supports the view that the lymphocyte percentage needs to be read as part of the immune-hematological profile, not as a single standalone marker.

The proportion of adult patients reaching 61.3% shows that hospitalized falciparum malaria at Jayapura Regional General Hospital was recorded more in the productive age group.

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This finding aligns with reports on adult severe malaria patients in Mauritania, which show that the adult group remains an important part of the clinical burden of falciparum malaria in hospitals (Boushab et al., 2021). In other endemic regions, case distribution can also differ by age structure, exposure pattern, and health-service characteristics, including among symptomatic patients at urban health facilities (Hodson et al., 2022). The dominance of the adult group in this study likely relates to mobility, work activity, and the chance of contact with transmission environments, although those factors were not measured directly. The difference from studies highlighting children as the vulnerable group can be explained by differences in study population, transmission level, and type of service facility (Suttrisno, et al., 2025). Because these data come from hospitalized patients, the results are more accurately read as a hospital case distribution, not as malaria incidence in the general community. The adult age group is an important characteristic in this study's data, but it cannot be used alone to infer population risk without the support of community data.

In this study, male patients were recorded as slightly more numerous than females, namely 52.4% versus 47.6%. This difference does not indicate strong dominance but still shows that hospitalized falciparum malaria cases were found more among males in the 2024–2025 data of Jayapura Regional General Hospital. This pattern can relate to differences in daily activity, mobility, and the chance of contact with malaria transmission environments. In endemic regions, males often have higher outdoor activity, so that the likelihood of exposure to the vector can increase. This explanation cannot be confirmed directly because the study did not assess occupation, nighttime-outing habits, bed-net use, or patient exposure location. The difference by sex in this study is therefore more accurately read as a distribution of hospitalized patients, not as evidence that males have a higher infection risk than females.

The proportion of male patients in this study was slightly higher than females, namely 52.4% versus 47.6%. This pattern aligns with recent studies showing that malaria distribution in health facilities can display a higher male proportion, although the size of the difference can vary between regions (Eya et al., 2025). The difference by sex in malaria relates not only to biological factors but can also be influenced by activity, mobility, risk perception, and health-service-seeking behavior (Ngutu et al., 2025). Malaria biomarker studies also show that age and sex can influence the clinical-laboratory profile of patients, so biological characteristics need to be considered when reading variation in findings (Bohli et al., 2026). The difference in proportion between males and females in this study was relatively small, so it is insufficient to state strong dominance of a particular sex. The sex difference in this study is therefore more accurately understood as a

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distribution of hospitalized patients, not direct evidence that males have a higher falciparum malaria risk than females.

The variation in lymphocyte percentage in this study shows that the immune-hematological response of falciparum malaria patients was not uniform across each characteristic group. The highest mean was found in children at 23.453±12.81%, followed by the elderly at 19.730±11.56%, while the adult group had the lowest mean at 16.946±8.87%. This pattern shows that the adult group, which also formed the largest proportion in the study, had a relatively lower lymphocyte percentage than the other age groups. By sex, females showed a higher mean lymphocyte percentage than males, namely 20.039±11.20% versus 18.220±10.34%. This difference can reflect biological variation, infection phase, degree of parasitemia, or the distribution of peripheral immune cells at the time the blood examination was performed. This result needs to be read carefully because the study used lymphocyte percentage, not absolute lymphocyte count. The finding is not yet sufficient to conclude clinical lymphopenia, but it still provides a preliminary picture of variation in the lymphocyte profile of hospitalized falciparum malaria patients.

The lymphocyte percentage in this study displayed a differing immune-hematological pattern across characteristic groups of falciparum malaria patients. The highest mean was found in children at 23.453±12.81%, while the adult group showed the lowest mean at 16.946±8.87%; in the sex category, females had a higher mean than males. This pattern aligns with malaria biomarker studies showing that age and sex can influence a patient's laboratory profile, including blood parameters related to the infection response (Bohli et al., 2026). A comparative study on falciparum malaria also affirms that initial blood parameters can differ by endemicity context, prior exposure, and disease severity (Von Wedel et al., 2025). Those differences may relate to infection phase, parasite burden, immune status, and the distribution of peripheral immune cells at the time the blood examination was performed. Other factors such as nutritional status and coinfection can also influence hematological parameters in Plasmodium falciparum infection, so the change in lymphocyte percentage cannot be explained by a single factor (Sumbele et al., 2021).

This study's results show a significant negative correlation between the parasite density of Plasmodium falciparum and lymphocyte percentage in hospitalized falciparum malaria patients. The value r=-0.199 with $p<0.001$ shows that an increase in parasite density tends to be followed by a decrease in lymphocyte percentage, although the strength of the relationship was weak. This finding is important because it places lymphocytes as part of the immune-hematological response

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that can change as the parasite burden increases. Biologically, that relationship can relate to inflammatory activation, redistribution of peripheral immune cells, and changes in the body's response during the acute infection phase. The weak correlation shows that the lymphocyte percentage is likely influenced not only by parasite density but also by other clinical and biological factors not fully assessed in this study.

The difference in lymphocyte percentage by age and sex is insufficient to explain the change in immune-hematological response in falciparum malaria patients. The factor closer to the infection process is parasite density, because this variable describes the magnitude of the Plasmodium falciparum burden in the blood. In this study, parasite density correlated negatively with lymphocyte percentage ($r=-0.199$; $p<0.001$), so higher parasitemia tended to be accompanied by a lower lymphocyte percentage. This finding aligns with hematological studies of falciparum malaria that report changes in blood indices and leukocyte components during Plasmodium falciparum (Elkhalifa et al., 2021) infection. Immunologically, the infection burden can also influence the body's response to parasite antigens, including the humoral response in P. falciparum(Abad et al., 2022). infection. That relationship does not stand alone, because parasite density and immune response can be influenced by host condition, exposure history, and accompanying coinfection (Cuamba et al., 2026; Matambisso et al., 2022). The weak correlation in this study is therefore more accurately understood as a sign of the involvement of parasite density in the change of lymphocyte percentage, not as a single explanation for the entire immune-hematological dynamics of the patient.

This study's findings reinforce that falciparum malaria relates to immune-hematological changes, not merely parasite infection. The negative correlation between the parasite density of Plasmodium falciparum and lymphocyte percentage shows that an increase in parasite burden tends to be followed by a decrease in lymphocyte percentage, although the relationship was weak. The low correlation strength shows that the change in lymphocytes is likely also influenced by other factors, such as clinical severity, patient characteristics, examination method, and hospitalization status. This study's contribution lies in providing local evidence from Jayapura Regional General Hospital during 2024–2025 on the relationship between parasite density and lymphocyte percentage in hospitalized falciparum malaria patients in the endemic region of Papua.

Consistent with a different study stating that surveillance analysis in Papua shows malaria is not evenly distributed, local data remain important for understanding the disease pattern at each health facility (Fadilah et al., 2022). In Mimika, environmental factors and residential

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conditions have also been reported to relate to malaria risk, reinforcing the importance of reading data based on the endemic-region context (Lusiyana, 2024). On the clinical side, recurrent malaria in Papua relates to increased morbidity and the risk of readmission, so laboratory assessment in malaria patients retains important value in hospital services (Dini et al., 2020). Hematological studies of malaria patients outside Papua also show that malaria infection can be accompanied by decreased hemoglobin, platelets, and changes in leukocytes (Agena et al., 2022; Asmerom et al., 2020). In that position, this study provides a local contribution because it specifically assesses the relationship between the parasite density of Plasmodium falciparum and lymphocyte percentage in hospitalized patients at Jayapura Regional General Hospital during 2024–2025. This contribution still needs to be read proportionally, because the results show a statistically significant but weak relationship.

Proportionally, this study's results position the lymphocyte percentage as part of reading the immune-hematological profile of falciparum malaria patients, but not as a single marker for assessing infection burden. The significant yet weak correlation shows that the parasite density of Plasmodium falciparum relates to the change in lymphocyte percentage, with the possible involvement of other clinical and biological factors. The scope limitation of this study relates to the use of a retrospective, medical-record-based design, so the analysis was directed at laboratory variables routinely available in hospital services. Within that scope, this study positions parasite density and lymphocyte percentage as two parameters that can be read simultaneously in hospitalized falciparum malaria patients. Subsequent studies can broaden the immune-hematological reading through absolute lymphocyte count, lymphocyte subpopulation profiles, inflammatory markers, and patient clinical outcomes. That approach can enrich understanding of the relationship between parasite burden and immune response in falciparum malaria. This finding still provides important preliminary local evidence for strengthening the laboratory interpretation of hospitalized falciparum malaria in Papua.

CONCLUSION

This study shows that hospitalized falciparum malaria at Jayapura Regional General Hospital had a clear clinical-laboratory pattern. The sample was dominated by the adult age group, with the male proportion slightly higher than the female. The mean total lymphocyte percentage was 19.086±10.79%, and its value differed by age and sex. The main analysis found a significant negative correlation between the parasite density of Plasmodium falciparum and lymphocyte percentage ($r=-0.199$; $p<0.001$). This means that an increase in parasite density tends to be

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followed by a decrease in lymphocyte percentage. The weak correlation strength shows that the relationship is not singular. This finding needs to be understood as a statistical relationship, not as evidence of cause and effect. Parasite density likely acts together with other clinical and biological factors. Scientifically, this study provides preliminary local evidence from the endemic region of Papua. The lymphocyte percentage can be considered in reading the immune-hematological profile of hospitalized falciparum malaria patients, while still attending to other clinical and laboratory parameters.

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