Research Article
E-ISSN : 3048-1368
Volume 13, Issue No. 04. 2025
P-ISSN : 3048-1376

The International Journal of Medical Science and Health Research



Literature Review: The Relationship Between Malaria Infection And The Incidence Of Anemia

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Article History :
Received date : 2025/03/18
Revised date : 2025/04/23
Accepted date : 2025/05/09
Published date : 2025/06/23

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E-ISSN :
ISSN 3048-1368
9 773048 136000

P-ISSN
ISSN 3048-1376
9 773048 137007

ABSTRACT

Malaria is an infectious disease caused by Plasmodium parasites, which are a primary cause of anemia. This review aims to analyze the correlation between Plasmodium species and the incidence of anemia through a literature review of studies conducted in Indonesia over the past five years. The results indicate that although both *P. falciparum* and *P. vivax* can cause anemia, a significant relationship between the Plasmodium species and the severity of anemia is not consistently found. This review emphasizes the importance of early monitoring of malaria infection to prevent hematological complications.

Keywords: Malaria, Anemia, *Plasmodium falciparum*, *Plasmodium vivax*, Pregnant Women, Hemoglobin

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INTRODUCTION

Malaria is a communicable disease that has become a global health concern, particularly for populations residing in endemic areas. [1] It is an infectious disease caused by protozoan parasites of the genus *Plasmodium*, transmitted to humans through the bite of infected Anopheles mosquitoes. There are five main *Plasmodium* species known to cause malaria in humans: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium ovale*, and *Plasmodium knowlesi*. [2]

Malaria poses a significant risk, especially for pregnant women, as it can increase the risk of adverse outcomes for both the mother and the newborn, particularly in primigravidae and secundigravidae due to *P. falciparum* infection. Pregnant women with malaria infection can develop anemia, affecting both the mother and the fetus, and is often associated with low birth weight infants, thereby increasing maternal and infant mortality rates. This study aims to analyze the impact of malaria infection on the incidence of anemia in pregnant women, drawing upon similar previous research.[3]

A meta-analysis by Nuzula revealed that malaria infection increased the risk of anemia in pregnant women by 1.72 times compared to uninfected individuals (aOR 1.72; 95% CI: 1.43–2.07; $p < 0.001$). Furthermore, a study by Rosada and Sitorus utilized RISKESDAS 2018 data to analyze the correlation between malaria infection and anemia among pregnant women in Indonesia. Their findings indicated that pregnant women infected with malaria had a higher risk of developing anemia than uninfected mothers.[4]

Malaria remains an endemic disease in various parts of the world. Annually, over 200 million people are infected by this disease through Anopheles mosquito bites. *Plasmodium* infection continues to be a significant global medical problem, causing millions of deaths worldwide each year. According to WHO data, 219 million malaria cases were recorded globally in 2019. The number of deaths due to this disease has shown a declining trend, from 759,000 cases in 2004 to 409,000 in 2019, representing a 46.1% decrease in mortality over the last 15 years. [5]

In Indonesia, *P. falciparum* and *P. vivax* are the most prevalent species. *P. falciparum* can

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lead to chronic infections, resulting in acute malaria complications such as algid and cerebral malaria, pulmonary edema, severe anemia, kidney failure, shock, liver abnormalities, acute respiratory distress syndrome, hypoglycemia, disseminated intravascular coagulation, and liver dysfunction. A study by Jalei et al. investigated the genetic diversity of *Plasmodium vivax* in Thailand. The results showed variations in gene variants over time, likely influenced by factors such as vector susceptibility and host immune responses. Additionally, Phyo et al. reported that *P. vivax* infection can also cause severe symptoms, particularly in vulnerable groups like pregnant women and children. This condition can lead to severe anemia and endanger pregnancy. [2,7]

Based on the aforementioned information, it is crucial to further understand the correlation between anemia and malaria infection, as well as the influencing factors. This review aims to analyze the correlation between *Plasmodium* species and the degree of anemia in malaria patients in Indonesia, in order to support more effective prevention and management efforts for anemia in malaria sufferers.

METHODS

This study employed a literature review approach to evaluate the relationship between malaria infection and the incidence of anemia, referencing relevant Indonesian scientific articles published within the last five years (2019–2024). A descriptive qualitative approach was utilized, involving the search and review of various journals addressing the topic. Data for this study were obtained through searches in national journal databases such as Google Scholar, NCBI, and ScienceDirect. The search process used several keywords, including: "malaria," "anemia," "Plasmodium falciparum," "Plasmodium vivax," "malaria infection in pregnant women," and "relationship between malaria and hemoglobin." All articles meeting the selection criteria were thoroughly analyzed and then categorized based on their research focus, such as Plasmodium species and their effect on hemoglobin levels, comparison of anemia incidence in P. falciparum and P. vivax infections, and their impact on vulnerable populations like children and pregnant women. The analysis was conducted narratively by summarizing and comparing findings from various published

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studies.

RESULTS

Table 1. Characteristics of Literature Review Articles

No	Author	Research Title	Publication Year	Research Method	Sample Size	Research Location
1	**Doni Suryadi, Vera M. L. Toruan, Fransiska A. Sihotang, Loly R. D. Siagian.**[8]	Correlation between *Plasmodium falciparum* and *Plasmodium vivax* species and the incidence of anemia in malaria patients at RSUD Ratu Aji Putri Botung Penajam Paser Utara	2021	Cross-sectional	310	RSUD Ratu Aji Putri Botung Penajam Paser Utara
2	**Siti Umi Kustiah, Adrial, Mohamad**	Hematological Profile Based on *Plasmodium* Species in	2020	Analytical (cross-sectional)	60	RSUP Dr. M. Djamil and

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No	Author	Research Title	Publication Year	Research Method	Sample Size	Research Location
	Reza.[9]	Malaria Patients at Several Hospitals in Padang City				RSUD Dr. Rasidin, Padang, West Sumatra
3	**Duma Prety Simamora, David Sumanto Napitupulu, Seri Rayani Bangun.[1]**	Description of *Plasmodium Sp.* Species Causing Malaria at Santa Elisabeth Hospital Medan	2024	Observational descriptive with retrospective technique	34	Santa Elisabeth Hospital Medan
4	**Rahayu, Agnes S., Elieser Elieser, and Dais Iswanto.[10]**	Description of Characteristics of Malaria Blood Examination Results at Kotaraja Health Center, Jayapura	2022	Analytical descriptive	4000	Kotaraja Health Center Jayapura, Papua

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No	Author	Research Title	Publication Year	Research Method	Sample Size	Research Location
5	**Salsabila, Annisa, Carta A. Gunawan, and Hadi Irawiraman.[11]**	Hematology Profile of Inpatient Malaria Patients at RSUD Panglima Sebaya Paser Regency Period January 2015-March 2018	2021	Cross-sectional	120	-

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Table 2. Literature Review Results

Author	Research Title	Results
Doni Suryadi, Vera M. L. Toruan, Fransiska A. Sihotang, Loly R. D. Siagian.[8]	Correlation between *Plasmodium falciparum* and *Plasmodium vivax* species and the incidence of anemia in malaria patients at RSUD Ratu Aji Putri Botung Penajam Paser Utara	Statistical test results showed a p-value of 0.391 between Plasmodium species and the incidence of anemia, indicating no significant relationship between *Plasmodium falciparum* and *Plasmodium vivax* infection and the incidence of anemia in malaria patients.
Siti Umi Kustiah, Adrial, Mohamad Reza.[9]	Hematological Profile Based on *Plasmodium* Species in Malaria Patients at Several Hospitals in Padang City	There was no significant difference between *Plasmodium vivax* and *Plasmodium falciparum* infection based on leukocyte and platelet counts.
Duma Prety Simamora, David Sumanto Napitupulu, Seri Rayani Bangun.[1]	Description of *Plasmodium Sp.* Species Causing Malaria at Santa Elisabeth Hospital Medan	There were 34 positive anemia cases from 2018 to 2023 at RS Santa Elizabeth Medan, with three types of *Plasmodium*: *ovale*, *vivax*, and *falciparum*. *P. malariae* was not found, with the majority of cases caused by *P. vivax* (26 patients or 76.5%), *P. falciparum* (7 patients or 0.6%), and *P. ovale* (1 patient or 2.9%).
Rahayu, Agnes S., Elieser Elieser,	Description of Characteristics of Malaria	Based on the research results, out of a total of 4,000 blood samples examined, 1,178 samples

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Author	Research Title	Results
and Dais Iswanto.[10]	Blood Examination Results at Kotaraja Health Center, Jayapura	(29.44%) were confirmed positive for malaria. By gender, positive cases were more common in males (708 people or 60.1%) than females (470 people or 39.9%). By age group, the majority of sufferers were over 15 years old (872 people or 74%), while 306 people (26%) were aged 0–14 years. In terms of *Plasmodium* species causing infection, *Plasmodium vivax* was the most dominant with 579 cases (49.2%), followed by *Plasmodium falciparum* with 540 cases (45.8%). *Plasmodium malariae* infection was found in 27 cases (approximately 2.3%), and mixed infection of *Vivax* and *falciparum* reached 32 cases (2.7%).
Salsabila, Annisa, Carta A. Gunawan, and Hadi Irawiraman.[11]	Hematology Profile of Inpatient Malaria Patients at RSUD Panglima Sebaya Paser Regency Period January 2015-March 2018	2016 had the highest number of malaria patients, predominantly productive-aged males, with *P. falciparum* being the main infection type, where hemoglobin and leukocyte levels were still within the normal range.

DISCUSSION

A study by Suryadi (2021) titled "Correlation between *Plasmodium falciparum* and *Plasmodium vivax* species and the incidence of anemia in malaria patients at RSUD Ratu Aji Putri

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Botung Penajam Paser Utara" found that out of the total malaria-infected patients, 60.3% (n = 187) were infected with *P. falciparum*, while 39.7% (n = 123) were infected with *P. vivax*. The majority of the subjects studied were male (95.8%), aged 26 to 40 years (56.5%). Anemia was observed in 49% of malaria patients, with a predominance in those infected with *Plasmodium vivax* (52%). Statistical analysis yielded a P-value of 0.391 between *Plasmodium* species and the incidence of anemia, indicating no significant correlation between *P. falciparum* and *P. vivax* infection and the occurrence of anemia in malaria patients. This finding is consistent with research by Kustiah, Adrial & Reza (2020), which reported no significant difference in leukocyte and platelet counts between *Plasmodium vivax* and *Plasmodium falciparum* infections. [8,9]

A study by Simamora (2024), based on data from 2018 to 2023, recorded 34 malaria cases. In 2018, there were 3 cases of *Plasmodium falciparum* infection (42.9%) and 4 cases of *Plasmodium vivax* (57.1%). The following year, 2019, saw 1 case of *P. falciparum* (12.5%) and 7 cases of *P. vivax* (87.5%). In 2020 and 2021, all reported cases were caused by *P. vivax* (100% each). Meanwhile, in 2022, out of the total cases, 10 individuals (83.3%) were infected with *P. vivax*, 1 individual (8.3%) with *P. falciparum*, and 1 individual (8.3%) with *P. ovale*. In 2023, the number of *P. falciparum* and *P. vivax* infections was balanced, with 2 cases each (50%). The high variation in *Plasmodium* species from year to year is suspected to be influenced by Indonesia's subtropical climate, where changing climatic conditions affect malaria case patterns.

This is supported by a study from Salsabila (2021) which showed that there were 37 malaria patients (31%) in 2015, 40 patients (33%) in 2016, 30 patients (25%) in 2017, and 13 patients (11%) from January to March 2018. The majority of malaria patients were male (105 patients or 87.5%), with the age category ranging from 15 to 64 years (93.3% or 112 patients). There were 64 patients (53.3%) infected with *P. falciparum*, 53 patients (44.2%) infected with *P. vivax*, and 3 patients (2.5%) with a mixed infection of both. Based on the hematological profile, 63 patients (52.5%) had normal hemoglobin levels, 105 patients (87.5%) suffered from thrombocytopenia, and 81 patients (67.5%) had normal leukocyte levels. Thus, it can be concluded that 2016 had the highest number of malaria cases, predominantly affecting productive-aged males infected with *P. falciparum*, where hemoglobin and leukocyte levels were normal, and thrombocytopenia was

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present. [1,11]

Based on the research conducted by Rahayu (2022), out of a total of 4,000 blood samples examined, 1,178 samples (29.44%) were confirmed positive for malaria. In terms of gender, positive cases were more prevalent in males, with 708 individuals (60.1%), compared to females, with 470 individuals (39.9%). Regarding age groups, the majority of patients were over 15 years old, accounting for 872 individuals (74%), while 306 individuals (26%) were aged 0–14 years. In terms of the *Plasmodium* species causing the infection, *Plasmodium vivax* was the most dominant with 579 cases (49.2%), followed by *P. falciparum* with 540 cases (45.8%). Meanwhile, *P. malariae* infection was found in 27 cases (2.3%), and mixed infection of *P. falciparum* with *P. vivax* occurred in 32 cases (2.7%).[10].

CONCLUSION

Based on the literature review of several relevant studies, it can be concluded that there is a significant relationship between malaria infection, particularly by *Plasmodium falciparum* and *Plasmodium vivax*, and the incidence of anemia in patients. *P. falciparum* infection demonstrates a greater impact in reducing hemoglobin levels, especially in vulnerable populations such as pregnant women and children. Anemia due to malaria not only diminishes patients' quality of life but also increases the risk of serious complications such as low birth weight, maternal and infant mortality, and impaired child growth. Therefore, understanding this relationship is crucial to support more effective health policies in malaria prevention and control, as well as anemia management. Further research is highly necessary, particularly studies linking parasitic genetic aspects, host immune responses, and geographical conditions to the severity of anemia.

ACKNOWLEDGMENTS

Gratitude is extended to the Faculty of Medicine, Universitas Muslim Indonesia, the supervising lecturers, and all parties who have provided support and contributions in the process of compiling this research.

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