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ANALYSIS OF NUTRITIONAL STATUS IN TODDLERS AND MALARIA INCIDENCE

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ABSTRACT
Poor nutritional status in toddlers and the high incidence of malaria are two major health issues that continue to be significant challenges in Indonesia, particularly in tropical regions such as Papua. Children's health is heavily influenced by these two factors, where malnutrition can weaken the immune system, making them more vulnerable to infectious diseases like malaria. Toddlers with poor nutritional status, such as stunting and undernutrition, are more likely to contract malaria, which in turn worsens their health condition and can lead to various long-term complications. This study aims to explore the relationship between the nutritional status of toddlers and malaria incidence at Kimi Health Center in Nabire Regency in 2024. Using a descriptive-analytic approach with a cross-sectional design, The population of this study consists of 804 toddlers at Kimi Health Center, with 118 samples selected using purposive sampling. The instrument used in this study is a standardized questionnaire, which includes questions about the respondents' characteristics and factual information regarding their condition, as well as the results of laboratory malaria tests with positive results, the study will analyze data using the Kendall Tau test. The findings highlight that poor nutritional status, including conditions like Protein-Energy Malnutrition (PEM), increases the risk and severity of malaria, impairing the immune response and exacerbating complications such as anemia. Conversely, excess nutrition, such as obesity, can also compromise immunity, increasing malaria risk. Nutrient deficiencies, such as in iron, vitamin A, and zinc, further affect immune function and vulnerability to malaria. Improving nutritional status is crucial for reducing the risk and impact of malaria, particularly in endemic areas like Nabire.

Keywords: malaria; nutritional status; toddlers

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INTRODUCTION

Malaria is a contagious disease caused by a microorganism called Plasmodium. Plasmodium infects humans through the transmission vector of the Anopheles mosquito. Along with HIV/AIDS and tuberculosis, malaria control is part of the Sustainable Development Goals (SDGs), a global goal to be achieved by 2030 (BKPP Kemenkes RI, 2023). Malaria remains one of the most common infectious diseases worldwide, with an estimated 229 million cases in 2019. Some countries, particularly in the Sahel region of West Africa, report unchanged malaria rates (de Wit et al., 2021). According to the World Health Organization (WHO) World Health Report, in 2017, there were 219 million reported cases of malaria globally, compared to 214 million in 2015 and 239 million in 2010. The significant decrease in malaria incidence from 2015 to 2019 was largely attributed to the heavy malaria burden in 18 countries, including South Sudan (Idris et al., 2022)

In Indonesia, malaria remains a major public health issue. In 2020, an estimated 241 million malaria cases were reported worldwide, with an estimated 627,000 deaths attributed to malaria. In 2010, according to the Annual Parasite Incidence (API) report, the malaria rate in Indonesia was 1.8 per 1,000 people, rising to 1.96 per 1,000 people in 2011. However, it

decreased significantly to 0.84 per 1,000 people by 2019. In 2020, the malaria rate increased to 0.93 per 1,000 people, with 250,644 reported malaria cases, of which 86% (216,380 cases) were in Papua Province (Malik & Waheed, 2024).

Malaria morbidity can be assessed by the Annual Parasite Incidence (API) per 1,000 people, which is calculated by determining the proportion of malaria-positive patients to the at-risk population in a particular area. Indonesia successfully reduced its API to less than 1 from 2015 to 2020. However, in 2021, the API increased to 1.1 per 1,000 people, with Papua, West Papua, and East Nusa Tenggara being the provinces with the highest malaria API. This is consistent with the large number of districts in these provinces with high endemic status. The high API in Papua Province, at 80.05 per 1,000 people, is significantly higher than the national average and contributes substantially to the national API. A total of 91.2% of provinces in Indonesia have reduced the malaria API to below 1 per 1,000 people(Kemenkes RI, 2022). In Papua, the districts of Keerom, Jayapura, Mimika, Sarmi, and Boven Digoel report high malaria cases, while Nabire has a relatively high malaria incidence rate, with an API of 17 per 1,000 people compared to the national rate of 1 per 1,000 people (Palumpun, 2021). In Papua, specifically Nabire, there were 52,511 clinical malaria cases in 2016, with 10,345 testing positive for malaria. In 2017, there were 86,265 cases, with 5,126 positive malaria cases. In 2018, there were 26,135 clinical malaria cases, with 2,481 testing positive for malaria (Manihuruk, 2022).

In Nabire in 2022, there were 1,061 pregnant women (31.19%) and 603 toddlers (3.56%) screened for malaria. Of these, 48 toddlers (7.96%) and 5 pregnant women (0.47%) were diagnosed with malaria. The highest malaria cases in toddlers in Nabire were reported in the Kimi health center, with 24 cases (17.52%), while the highest cases for pregnant women were reported in the SP 1 Kalibumi health center, with 3 cases (1.51%). Malaria transmission in infants under one year can occur through blood transfusions or congenital transmission from mother to fetus through the umbilical cord if the mother has malaria. Children under five years old are at relatively low risk, as passive immunity decreases over time, and severe malaria typically affects children aged 1-4 years or up to five years old. This is because the immune response to malaria develops more slowly in younger children(Kinansi et al., 2021; P2M, 2022). Increasing malaria rates are associated with social habits such as staying outside at night or traveling to endemic areas, as well as environmental factors such as poor housing and sanitation, which can contribute to malaria transmission (Madayanti et al., 2022). Malaria infection can lead to anemia because many red blood cells are destroyed by Plasmodium. In severe cases, malaria can cause coma, organ failure, and death. For pregnant women, untreated malaria can lead to miscarriage, premature birth, low birth weight (LBW), and stillbirth (Apay et al., 2022; Manihuruk, 2022).

The increasing density of Anopheles mosquitoes is driven by stagnant water sources such as drains, fish ponds, swamps, and rivers, which serve as breeding grounds for the mosquitoes. Additionally, tightly sealed homes are linked to a higher incidence of malaria. The toddler years are a critical period in life and require serious attention. During this time, toddlers need to obtain adequate nutrients from their daily food intake to ensure proper growth and development. Nutritional status refers to the condition resulting from the balance between nutrient intake and the body's nutrient requirements for metabolism. Each individual has different nutritional needs depending on age, gender, daily activity levels, weight, and other factors (Madayanti et al., 2022; Popang et al., 2022) In Papua, the provinces with the highest rates of severe underweight and underweight are East Nusa Tenggara, while the lowest rates

are found in Bali. In Papua, the prevalence of severe underweight is 2.1%, and the prevalence of underweight is 7.2%(Kemenkes RI, 2023)

In Papua Province, the highest proportion of children with very poor nutritional status (BB/U) is found in Puncak Jaya, at 21.13%, while the lowest is in Merauke and Jayawijaya, both with 0%. In Nabire, the proportion of children with very poor nutritional status is 3.22%. For undernutrition, the highest rates are found in Boven Digoel (35.91%), while the lowest rates are in Yahukimo, Intanjaya, and Deyai (0%). In Nabire, the rate of undernutrition is 11.05%. The highest proportion of children with good nutritional status is in Yahukimo (100%), followed by Nabire (76.03%). The highest proportion of overweight children is in Pegunungan Bintang (67.17%), while in Nabire, the proportion is 9.70% (Dinkes Papua, 2022) Nutritional status can be influenced by various factors, including internal factors (genetics, infectious diseases, age, psychological factors, or anxiety) and external factors such as food consumption, physical activity, income, parental education, family size, environment, healthcare, and education. The COVID-19 pandemic has caused significant changes, particularly in the lifestyle of Indonesian people, including children (Nopihartati et al., 2023).

Malnutrition is one of the factors that increase susceptibility to infectious diseases, particularly in children. Children from healthy environments with good nutritional status tend to have better health. In contrast, malnutrition in children, particularly in poor environments, increases morbidity and vulnerability to infectious diseases like diarrhea, respiratory infections, malaria, and tuberculosis due to poor weather and living conditions (Fitriyatun & Putriningtyas, 2021). Nutritional status is related to malaria incidence due to immune system vulnerability. Malnutrition can alter the immune response. Children (0-15 years old) are more susceptible to malaria parasite infections, especially malnourished children. Malaria infections tend to be more severe in younger children due to their immature immune systems. In older children, infections are linked to decreased immunity, often due to underlying conditions . According to a study by Munizar et al., (2015) there is a relationship between nutritional status and susceptibility to malaria, as people with poor nutrition living in malaria-endemic areas are more prone to malaria infection(Ramdany & Samaran, 2019). Based on the background description above, the purpose of this research is to determine the relationship between the nutritional status of toddlers and the incidence of malaria at Puskesmas Kimi in 2024

METHOD

The type of research conducted is descriptive analytic research using a cross-sectional approach. This type and design aim to reveal the relationship between Nutritional Status in Toddlers and the Incidence of Malaria in Puskesmas Kimi, Nabire District. The research was carried out at Puskesmas Kimi in Teluk Kimi District, Nabire, from April to July 2024. The population in this study consists of all toddlers in the working area of Puskesmas Kimi, totaling 804 toddlers. The population of this study consists of 804 toddlers at Kimi Health Center, with 118 samples selected using purposive sampling. The instrument used in this study is a standardized questionnaire, which includes questions about the respondents' characteristics and factual information regarding their condition, as well as the results of laboratory malaria tests with positive results. Data analysis was conducted using the Kendall tau test.

RESULT

Characteristics of Toddlers

Table 1.
Characteristics of Toddlers

Characteristics Of The Toddler	f	%
Age		
Baduta (12-24 Month)	54	45.8
Balita (25-60 Month)	64	54.2
Sex		
Male	66	55.9
Female	52	44.1
Birt Weight History		
Low Birth Weight (<2500 gr)	14	11.9
Normal (>=2500 gr)	104	88.1
Birth Length History		
Short (<45 cm)	3	2.5
Normal (45-50 cm)	115	97.5

Table 1, it was found that among the toddlers in this study, 54 children (45.8%) were aged 12-24 months, and 64 children (54.2%) were aged 25-60 months. The characteristics of the toddlers based on gender were as follows: 66 boys (55.9%) and 52 girls (44.1%). Regarding birth weight history, 14 toddlers (11.9%) were born with low birth weight (LBW), while 104 toddlers (88.1%) were born with normal birth weight (above 2500 grams). For birth length history, 3 toddlers (2.5%) had a history of short birth length (<45 cm), and 115 toddlers (97.5%) had a normal birth length (45-50 cm).

Age of the Toddler's Mother

Table 2.
Characteristics of the Age of Toddler's Mothers

Characteristics of the Mother	f	%
Age		
< 20 Year	2	1.7
20-35 Year	101	85.6
>35 Year	15	12.7
Education		
Elementary School	7	5.9
Junior High School	23	19.5
Senior High School	77	65.3
Diploma & Bachelor	11	9.3
Employemnt		
Not Working	96	81.4
Farmers	1	0,8
Private Employess	14	11.9
Small Bussines	3	2.5
Civil Servant/Army/Police	4	3.4
Income		
<2 milion IDR/month	37	31.4
2-4 milion IDR/month	40	33.9
4-7 milion IDR/month	34	28.8
>7 milion IDR/month	7	5.9
Housing Type		
Permanent	21	17.8
Semi-Permanent	59	50.0
Woden	38	32.2

Based on the data presented in Table 2, it can be concluded that the majority of mothers of toddlers at Kimi Health Center are aged between 20-35 years (85.6%), with the predominant education level being high school or its equivalent (65.3%). Most mothers (81.4%) are not working or are housewives. Regarding family income, the majority of respondents (33.9%) earn between 2-4 million IDR per month, and most families live in semi-permanent houses (50%).

Research Variables

Table 2.
History of Malaria in Children Under Five Years Old (Balita) in the Last Year

Variable	f	%
Malaria		
Yes	45	38.1
No	73	61.9
Nutritional Status		
Underweight	37	31.4
Normal	72	61.0
Overweight	9	7.6

Based on Table 3, it is shown that the history of malaria among children under five years old (balita) in the past year was 45 (38.1%). Additionally, among children with nutritional problems based on the categories of weight-for-age (BB/U), height-for-age (TB/U), and weight-for-height (BB/TB), 37 (31.4%) were categorized as undernourished, 72 (61.0%) had normal nutritional status, and 9 (7.6%) were classified as overweight.

Analysis of the Relationship Between Nutritional Status of Toddlers and the History of Malaria Incidence

Table 3.
Relationship Between Nutritional Status and History of Malaria

Nutritional Status	Malaria				P Value
	Yes		No		
	f	%	f	%	
Underweight	32	71.1	5	6.8	0.001
Good	9	20	63	86.4	
Overweight	4	8.9	5	6.8	

Based on the results of the Pearson Chi-Square Test analysis, with a 95% confidence interval (CI), a p-value of <0.05 was obtained, indicating a significant relationship between nutritional status, based on one of the nutritional status indicators (weight-for-age, height-for-age, and weight-for-height), and the incidence of malaria.

DISCUSSION

Malaria is one of the diseases responsible for a high mortality rate among humans worldwide. This disease is transmitted by Anopheles mosquitoes that carry a protozoan called Plasmodium, which attacks red blood cells. The incubation period for this disease can range from a few days to several months (Rahayu, 2020). Malaria is an infectious disease caused by a parasite that lives and multiplies in human red blood cells and is a contagious disease due to infection by the protozoa from the Plasmodium genus, which poses a high mortality risk with a relatively fast transmission process (Rohmani et al., 2022)The nutritional status of young children is essential for their overall health, growth, and development. It serves as a primary indicator of well-being and can significantly influence long-term health outcomes. Adequate nutrition during childhood, especially in the first 1,000 days, is crucial for optimal physical and cognitive development. The following section outlines the importance of nutritional status

in young children. Proper nutritional status supports physical growth, with studies showing a direct correlation between good nutrition and developmental milestones in children aged 24 to 60 months. Malnutrition, especially stunting, can have lifelong consequences, affecting physical and cognitive abilities (Calista & Ayubi, 2022; Ulfah et al., 2018)

Good nutritional status helps prevent health problems, allowing for early detection of potential issues (Marfuah et al., 2024). Exclusive breastfeeding and normal birth weight are significant factors contributing to better nutritional outcomes in young children. Socioeconomic factors, such as family income and maternal knowledge, also play a crucial role in determining the nutritional status of young children. Addressing these factors through targeted interventions can improve the overall quality of nutrition and health in children (Rahmadani et al., 2023; Sandy & Pratama, 2024)The relationship between nutritional status and malaria incidence is complex, particularly in children. Research shows that malnutrition, especially conditions such as anemia and underweight, significantly increases the risk of multiple malaria episodes. This correlation has been demonstrated in studies conducted in various regions, highlighting the need for integrated health strategies. Children with anemia are at a higher risk of experiencing multiple malaria episodes, with odds ratios indicating a significant correlation (Keita et al., 2024). The risk of malaria episodes is much higher during low transmission periods for children with underweight and anemia. Districts with high rates of underweight children also show increased malaria endemicity, suggesting a spatial overlap between malnutrition and malaria (Oldenburg et al., 2018; Yadav et al., 2023)

Several studies indicate that integrating nutrition programs with malaria control strategies could disrupt transmission in endemic areas. While some research shows a link between malnutrition and increased malaria incidence, others present inconsistent findings, particularly regarding severe malnutrition (de Wit et al., 2021; Yadav et al., 2023)Similar research by Jugha et al., (2023) found a relationship between nutritional status and malaria incidence, showing that children with poor nutritional status have a higher risk of malaria infection. Malnutrition increases vulnerability to infections, and infections can worsen nutritional status through reduced food intake, nutrient malabsorption, increased metabolic demands, and direct nutrient loss, as seen in conditions like diarrhea (Mandala et al., 2021; Moxon et al., 2020). Nutritional status plays a vital role in modulating susceptibility and severity of malaria infection. The underlying mechanisms of this interaction are complex and involve various physiological and immunological aspects. Nutritional status affects the development and function of the immune system, which is crucial in defending against malaria infection. Protein-Energy Malnutrition (PEM) has been shown to increase vulnerability to malaria infection and worsen clinical outcomes. Children with PEM show increased parasitemia and more severe anemia during malaria infection. PEM is associated with decreased production of pro-inflammatory cytokines, which are essential for early control of parasite infections (Mbugi et al., 2022; Xiong, 2021)

In addition to protein and energy deficiency, the relationship between iron status and malaria is complex. Iron deficiency may offer partial protection against malaria infection, possibly because parasites require host iron for their growth(Abuga et al., 2020; Muriuki et al., 2021). However, iron deficiency anemia is also associated with poorer outcomes in infected patients (Mayo-Wilson et al., 2014). Iron supplementation should be carefully administered in malaria-endemic areas, taking individual malaria status into account. Vitamin A deficiency has been linked to increased susceptibility to malaria and poorer clinical outcomes (WHO, 2016). Vitamin A supplementation has been shown to reduce malaria incidence in children in several studies (Nweze et al., 2020; Tchoumi et al., 2023). Zinc deficiency is associated with

increased susceptibility to malaria infection, and zinc supplementation has shown potential in reducing malaria incidence in children, although results vary between studies shanka(Rouhani et al., 2022; Sandalinas et al., 2023; Shankar et al., 2000)Excessive nutritional intake, manifesting in obesity, is also associated with malaria incidence. Although most research focuses on malnutrition, obesity can also influence susceptibility to malaria (Kotepui et al., 2023). Some studies indicate that obesity can increase vulnerability to malaria infection and worsen clinical outcomes (Wyss et al., 2017). This may be related to changes in immune response and low-grade chronic inflammation associated with obesity (Kalra et al., 2019)

CONCLUSION

This study shows a significant relationship between nutritional status and malaria incidence in children under five. Children with poor or inadequate nutritional status are at a higher risk of malaria infection compared to those with good nutritional status. These findings align with previous research indicating that malnutrition increases vulnerability to malaria infection, as nutrient deficiencies can weaken the immune system and worsen the prognosis of infectious diseases. Good nutritional status plays an essential role in supporting the immune system's optimal functioning. Adequate nutrient intake helps the body maintain an effective immune response. Deficiencies in nutrients such as protein and energy can disrupt cytokine production, which is critical for fighting infections. Protein-Energy Malnutrition (PEM) has been linked to increased parasitemia and severe anemia during malaria infection, making nutritional improvement particularly important in malaria-endemic regions. In addition to protein and energy, certain micronutrients also play a role in interactions with malaria. Iron deficiency, for instance, has a complex relationship with malaria infection; while it may offer partial protection, iron deficiency can also exacerbate the severity of infection. Therefore, micronutrient supplementation, including iron, vitamin A, and zinc, in malaria-endemic regions must be approached carefully, as deficiencies or excesses of these nutrients can affect malaria vulnerability or clinical outcomes.

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