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CORRELATION OF MALNUTRITION STATUS WITH MALARIA INCIDENTS IN CHILDREN UNDER 5 YEARS OLD

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Abstract

Malaria is a prevalent disease that continues to affect infants and results in the death of over 435,000 individuals worldwide, with children under the age of five accounting for 11-30% of these fatalities. Malnutrition afflicts millions of children worldwide, especially in Indonesia, and is the leading cause of mortality among toddlers. Investigate the correlation between malnutrition and the occurrence of malaria in children under the age of five. Additionally, explore the prevalence, factors that contribute to the risk, and underlying processes of both malaria and malnutrition. This study utilized 15 internationally recognized scholarly articles to investigate the correlation between malnutrition and the prevalence of malaria in children below the age of five. According to the analysis of 10 scholarly studies, the occurrence of malaria and malnutrition among children under the age of five remains significantly elevated, particularly in African nations, various countries in South Asia, Southeast Asia, the Middle East, Central America, and South America. The analysis of 3 journal papers examined the risk factors associated with malaria and malnutrition, specifically focusing on age, environment, sanitation, economy, education, food availability, and residing in refugee camps. After reviewing 9 journal publications, it has been shown that malnutrition is a risk factor for malaria. Additionally, one of the articles suggests that children who are malnourished have a reduced likelihood of contracting malaria. The findings of this scoping review indicate a bidirectional correlation between malnutrition and the occurrence of malaria in young children.

Keyword: *Malaria, Malnutrition, Toddlers*

Abstrak

Malaria adalah penyakit umum yang terus menyerang bayi dan mengakibatkan kematian lebih dari 435.000 orang di seluruh dunia, dengan anak-anak di bawah usia lima tahun menyumbang 11-30% dari kematian tersebut. Malnutrisi menimpa jutaan anak di seluruh dunia, khususnya di Indonesia, dan merupakan penyebab utama kematian pada balita. Untuk mengetahui hubungan gizi buruk dengan terjadinya penyakit malaria pada anak dibawah usia lima tahun. Selain itu, telusuri prevalensi, faktor-faktor yang berkontribusi terhadap risiko, dan proses yang mendasari malaria dan malnutrisi. Penelitian ini menggunakan 15 artikel ilmiah yang diakui secara internasional untuk menyelidiki hubungan antara malnutrisi dan prevalensi malaria pada anak di bawah usia lima tahun. Berdasarkan analisis 10 penelitian ilmiah, kejadian malaria dan malnutrisi pada anak di bawah usia lima tahun masih meningkat secara signifikan, khususnya di negara-negara Afrika, berbagai negara di Asia Selatan, Asia Tenggara, Timur Tengah, Amerika Tengah, dan Amerika Selatan. . Analisis terhadap 3 makalah jurnal mengkaji faktor risiko yang terkait dengan malaria dan malnutrisi, khususnya berfokus pada usia, lingkungan, sanitasi, ekonomi, pendidikan, ketersediaan pangan, dan tinggal di kamp pengungsi. Setelah meninjau 9 publikasi jurnal, diketahui bahwa malnutrisi merupakan faktor risiko penyakit malaria. Selain itu, salah satu artikel menyatakan bahwa anak-anak yang kekurangan gizi memiliki kemungkinan lebih kecil tertular

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malaria. Temuan dari kajian penjajakan ini menunjukkan adanya korelasi dua arah antara malnutrisi dan kejadian malaria pada anak kecil.

Keyword: *Malaria, Malnutrition, Toddlers*

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INTRODUCTION

Malaria is an acute infectious disease caused by parasitic protozoan agents belonging to the genus *Plasmodium* , of which several subspecies of *Plasmodium* can cause disease in humans [1] . Plasmodium transmission to humans is mediated by the *Anopheles* mosquito . *Anopheles* mosquitoes depend heavily on environmental temperature to survive. This is why Anopheles mosquitoes are very common in tropical climates [2] .

Malaria is a parasitic infectious disease that has significant morbidity and mortality rates in the world. Around 219 million cases of malaria were recorded which caused the deaths of more than 435,000 people globally in 2017. The percentage of malaria mortality rates throughout the world reaches 0.3-2.2%, and this figure increases in tropical climates by 11-30% with Two-thirds of the total death cases were found in children under five years of age (toddlers). Africa and parts of Asia are areas with the highest prevalence of malaria infection among indigenous populations in the world [1.3] . This was shown in 2018, the number of cases of malaria infection in 15 sub-Saharan countries and India contributed up to 80% of total cases in the world [4] .

Indonesia is one of the countries with a high prevalence of malaria largest in Southeast Asia. Indonesia has recorded more than a quarter of a million clinical cases with 230 million people at risk of infection in 2013 [5] . A significant reduction in malaria occurred after Indonesia established a national commitment to eradicate malaria. Malaria elimination has reached 285 out of 514 districts/cities in 2018 thanks to this commitment. Indonesia is committed to becoming a malaria-free zone by 2030 [6] .

Malnutrition or malnutrition can be defined as an imbalance between nutritional needs and food intake, resulting in deficiencies of energy, protein and micronutrients which can have negative effects on growth and development. Children aged 1000 days to 24 months have the highest risk of experiencing malnutrition. Malnutrition itself can be classified based on anthropometric measurements as *stunting* (short toddlers), *wasting* (thin toddlers), *underweight* (underweight), and micronutrient deficiencies [6] .

Research by Boah *et al* . stated that there are 13.6 million children worldwide who are estimated to die every year due to malnutrition. This causes malnutrition to become the main

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contributor to the number of deaths among children under five in this world. There are an estimated 151 million (22.2%) children experiencing *stunting* . and 51 million (7.5%) children under five were at risk of *wasting* in 2016. Child deaths due to malnutrition are highest in developing countries, with most cases occurring in Sub-Saharan Africa and parts of South and Central Asia [8,9] .

Malnutrition is one of the main causes of increasing under-five mortality rates in Indonesia. Reports from Basic Health Research (Riskesdas) data show there is enhancement prevalence *underweight* as big as 19.6 % in 2013, compared to 18.4% in 2007 and 17.9% in 2010 [10] . A non-significant decrease in prevalence occurred in *wasting cases* from 13.6% in 2007 to 13.3% in 2010 [11] . Riskesdas results on *stunting* show a growth in the number of incidents from 35.6% in 2010 to 37.2% in 2013, which places Indonesia in 5th place in the country. with *stunting* rate the highest number of children under five in the world after India, China, Nigeria and Pakistan [12] .

Understanding the intricate relationship between malaria and malnutrition in toddlers is imperative for addressing the dual burden of these health challenges. This study seeks to contribute valuable insights into the interplay between malaria infection and malnutrition among toddlers in Indonesia, aiming to inform targeted interventions and contribute to the broader efforts of enhancing child health outcomes. The importance of this study lies in its potential to guide policies and strategies, ultimately supporting Indonesia's commitment to reducing malaria and malnutrition-related morbidity and mortality.

METHOD

This scoping review utilizes a thorough strategy to examine and combine studies related to the overlap of malaria and malnutrition in young children. The scoping review method is used due to its appropriateness in examining and charting the current body of literature on this complex issue.

A comprehensive search of internationally recognized journals indexed by Scimago, Scopus, and DOAJ is performed in order to systematically collect relevant studies. In addition, databases such as Google Scholar, PubMed, and ResearchGate are used to ensure a thorough retrieval of relevant articles. The search approach incorporates the utilization of Medical Subject Headings (MeSH) phrases to improve the accuracy and comprehensiveness of the search. The search queries include MeSH terms such as "Malaria," "Malnutrition," "Toddler," and their pertinent synonyms.

The inclusion criteria pertain to studies published from 2017 to 2023, enabling the integration of up-to-date breakthroughs and discoveries in the field. The selected databases and indexing services are widely recognized for their comprehensive coverage of academic articles, guaranteeing the incorporation of a wide variety of studies.

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The initial search is enhanced by a manual examination of references from the indicated articles to guarantee a thorough identification of pertinent literature. By employing a dual strategy, the scoping review is able to improve the thoroughness and inclusiveness of the investigation. This allows for a detailed examination of the existing knowledge on the relationship between malaria and malnutrition in young children.

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RESULTS

Table 1 Journal research result

No	Authors	Article Title	Article Source	Journal Index	Research methods	Research result	Conclusion
1.	Gari, T., Loha, E., Deressa, W., Solomon, T. *and* Lindtjørn, B., 2018.	*Malaria increased the risk of stunting and wasting among young children in Ethiopia: Results of a cohort study*	*PLOS One*	Scimago, Scopus, DOAJ	Analytic Observational (Historical cohort).	This research states that the risk factor *for stunting* and *wasting* is having suffered from malaria in the six months before the anthropometric assessment. *Stunting* or *wasting* also does not increase the chance of contracting malaria. Data from the results of this research showed 103 new cases of malaria, 684 new cases *of stunting* , and 239 new cases *of wasting* . Regions with limited food supplies can increase risk factors for malnutrition, children with malaria infection need more protein and calories for faster recovery than children whom not suffering from Malaria.	Malaria infection is a risk factor for *stunting* and *wasting* , but is not associated with the disease. Malaria is a risk factor *stunting* And *wasting* , so it may be necessary to monitor the status nutrition children with malaria carefully.
2.	Kojom Foko et al., 2021	*Prevalence, Patterns, and Determinants of Malaria and Malnutrition in Douala, Cameroon: A Cross-Sectional Community-Based Study*	*BioMed Research International*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	The study found 18.9% of persons had malaria, 84.9% of which were unreported. Stunting is the most prevalent malnutrition in children under five (23.6%), with a total frequency of 43.1%. Participants with malaria infection exhibited a fivefold increase in stunting risk. Malaria-positive individuals aged 5-19 had a significantly higher rate of underweight compared to malaria-negative individuals.Malnutrition and malaria presence varied by age, sex, and study area, with an 8.5% prevalence.	The results of the current investigation show how common malaria and malnutrition are in Douala. This study highlights how malaria negatively impacts nutritional status and vice versa, as well as how patient characteristics such as age and gender impact the relationship between the two diseases and how patient characteristics such as age and gender impact the relationship between the two diseases.

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3.	Das et al., 2018	*Complex interactions Between malaria and malnutrition: a systematic literature review.*	*BMC Medicine*	Scimago, Scopus, DOAJ	Systematic *Literature Reviews*	This study obtained 2945 publications obtained from the database. Out of these, 33 articles were discovered that investigated the correlation between malnutrition and the risk of malaria, as well as the impact of malnutrition on the efficacy of antimalarial treatment. Malnutrition was consistently linked to the severity of malaria, including increased parasitemia density and anemia. This study additionally discovered the impact of malnutrition on the therapeutic response of children to artemisinin combination treatment.	There is a lacking of comprehensive study on the direct impact of starvation on the likelihood of contracting malaria. The provision of supplementary data on the correlation between malaria and malnutrition has the potential to inform the development of study protocols for future research and enhance the efficacy of antimalarial therapies for significant populations that are both vast in size and particularly susceptible, and are currently lacking adequate access to healthcare services.
4.	Fevang, B. ,Havemann, K., *and* Høstmark, A.T., 2018.	*Malaria and Malnutrition: Kwashiorkor associated with Low Levels of Parasitemia*	*Malaria Research and Treatment*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	This study discovered that children diagnosed with kwashiorkor exhibited significantly reduced levels of P. falciparum parasitemia.This indicates a correlation between different groups of PEM (Protein Energy Malnutrition) and the extent of parasitemia.Kwashiorkor patients experience an overabundance of free radicals due to an excess of prooxidants. Additionally, this study revealed that individuals with kwashiorkor exhibited elevated levels of unbound fatty acids and unbound fatty acids that were more susceptible to peroxides in the red blood cell membrane. Fatty acids have been discovered to considerably impede the progression of P. falciparum in a controlled environment.	This study showed that kwashiorkor has a protective effect protective effect against malaria. Research that on this theme are still few and less specific, more research is needed further research is needed to explain this hypothesis.

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5.	de Wit et al., 2021	*Nutritional status in young children prior to the malaria transmission season in Burkina Faso and Mali, and its impact on the incidence of clinical malaria*	*Malaria Journal*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	According to this study, the nutritional condition in Burkina Faso and Mali was inadequate in 2015 and 2016, before to the malaria season. In Burkina Faso, underweight was the prevailing kind of malnutrition, but in Mali, stunting was the predominant form. In 2016, Burkina Faso and Mali had clinical malaria incidence rates of 675 and 1245 per 1000 person-years, respectively. This study discovered a correlation suggesting that severe stunting was linked to a decrease in malaria cases in Mali, whereas Burkina Faso did not exhibit this correlation. In Burkina Faso, there was a correlation between wasting and a greater incidence of clinical malaria. However, this association was not observed in Mali for mild wasting. This correlation was not consistent across nations or observed in seriously impacted children. The study also demonstrated that there was no correlation between the circumference of the upper arm and the likelihood of malaria occurrence.	Family support and a good level of paternal education are essential for working women to be able to exclusively breastfeed. Efforts to encourage exclusive breastfeeding should prioritise the inclusion of husbands and other family members in breastfeeding-related health care programmes.
6.	Ajakaye and Ibukuno Iuwa, 2020	*Prevalence and risk of malaria, anemia and malnutrition among children in IDPs camp in Edo State, Nigeria*	*Parasite Epidemiology and Control*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	Results of the investigation The study found 41.2% malnutrition in Nigeria, with 0.04% wasting, 11.2% underweight, and 39.2% stunting. Children contracted malaria 55.2% of the time. Malaria is more likely to occur in children aged 6–10, showing that age is a major risk factor. Children aged 6–10 with malaria are more prone to develop anemia. Only children aged 0–5 are at high risk for malnutrition.Children in refugee camps need specialized care. Refugee camps frequently have disease epidemics. Bad sanitation, cleanliness, overcrowding, lack of clean water, poor diet, and poor health services may contribute to high malaria and malnutrition	This study is the first to document the existing health issues among refugees in Nigeria, specifically focusing on the prevalence of malaria, anemia, and malnutrition in children under the age of 10. The salient discovery is that a limited-scale investigation has been carried out on the health challenges encountered in Nigeria. This study provides a foundation for future

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						rates in refugee camps.	research and demonstrates a substantial improvement in the well-being of refugee communities.
7.	Benedict et.al., 2018	*Geostatitical modelling of the association between malaria and child grwoth in Africa*	International Journal of Health Geographics	Scimago, Scopus, DOAJ	Retrospective studies.	This project aims to forecast and quantify the correlation between malaria and HAZs (height-for-age Z-scores) in children aged under five years. The research investigation This study conducted a total of 20 surveys, out of which 18 surveys displayed results indicating a negative connection between non-spatial univariate analysis of HAZ and malaria incidence. This study also demonstrated a limited correlation between HAZ (height-for-age z-score) and malaria, even after accounting for confounding factors and spatial risk factors such as socioeconomics, education, and breastfeeding status. A meta-analysis also found a significant association between the quantity of arable land and the prediction of the impact of malaria incidence in HAZ.	The presence of confounding factors that influence the relationship between malaria and stunting differs among different nations and changes over time. Duration. The research use geostatistical analysis to address the presence of unmeasured spatial confounding.
8.	Mensah et.al., 2021	*Prevalence and risk factors associated with asymptomatic malaria among school children: repeated cross-sectional surveys of school children in two ecological zones in Ghana*	*BMC Public Health*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	This study reveals that the Begoro area has a greater prevalence of asymptomatic malaria compared to Cape Coast, the capital of Ghana. Infection Plasmodium falciparum infection was the primary cause, responsible for 85% of all cases.Non-symptomatic school pupils have an increased probability of experiencing anemia and stunting at a higher rate.This study additionally demonstrated that males exhibited a higher likelihood of having an infection in the absence of symptoms compared to females. Furthermore, it revealed that school-aged children between 12 and 14 years old had a greater prevalence of asymptomatic illnesses compared to those between 6 and 8 years old.	Both regions in Ghana exhibit a substantial prevalence of malaria, particularly asymptomatic malaria. This burden is notably higher among males and older children, and is linked to anemia and impaired growth in children.This could potentially affect the implementation of control strategies and the eradication of malaria in Ghana.

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9.	Mburu et. al., 2021	*The Impact of Undernutrition on Cognition in Children with Severe Malaria and Community Children: A Prospective 2-Year Cohort Study*	*Journal of Tropical Pediatrics*	Scimago, Scopus, DOAJ	Analytic Observational (Historical Cohort)	The research was carried out in Kampala, Uganda, focusing on children between the ages of 18 months and 5 years who had cerebral malaria (CM), severe malarial anemia (SMA), or were community children (CC). The objective was to assess their nutritional and cognitive inadequacies. Stunting was equally widespread in all three groups, although wasting was more prevalent in CM (16.7%) or SMA (15.9%) compared to CC (4.7%), and underweight was more common in SMA (27.0%) than CC (12.8%). A 6-month follow-up was undertaken, revealing no substantial disparity in the occurrence of wasting or underweight among children with severe malaria compared to those without. Children who had a lower weight or height for their age had lower cognitive z-scores compared to children who did not have a lower height for their age.	The prevalence of wasting and underweight in children with severe malaria recovered to population levels following therapy. To address the danger of cognitive impairment, it is crucial to provide children with proper nutritional support, cognitive rehabilitation, and malaria prevention, as severe malaria and malnutrition are known risk factors for this condition.
10.	Sakwe et.al., 2019	*Relationship between malaria, anaemia, nutritional and socio-economic status amongst under-ten children, in the North Region of Cameroon: A cross-sectional assessment*	*PLoS One*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	The prevalence rates of malnutrition, anemia, and malaria in two health services in the northern region of Cameroon were 32.9%, 54.1%, and 20.6%, respectively. 56.9% of youngsters were experiencing stunted growth, 63.5% were suffering from wasting, and 34.8% had a lower weight than expected for their age. The prevalence rates for mild, moderate, and severe anemia were 8.1%, 9.2%, and 3.3%, respectively. This study demonstrates a notable correlation between hunger and malaria. The association between nutritional status and malaria infection is reciprocal. Children suffering from malnutrition are 2.07 times more likely to become infected with malaria parasites. Children with malaria had a 1.89-fold increased risk of malnutrition compared to healthy children. Stunted and underweight children exhibited a higher prevalence of malaria	The findings of this study indicated that there is a clear connection between malnutrition and the fact that malaria is present. For the purpose of ensuring optimal case management, it is of the utmost importance to establish effective collaboration between programs that aim to reduce malaria and those that implement nutrition intervention, as well as to improve socioeconomic status.

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						parasites, whereas wasted children displayed a lower prevalence.	
11.	Bendabenda et.al.,2018	*The association of malaria morbidity with linear growth, hemoglobin, iron status, and development in young Malawian children: a prospective cohort study*	*BMC Pediatrics*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	The study was done in 2016 in the city of Mngochi, Malawi, with a sample size of 2723 children. Out of all the subjects, 74.0% were recruited and had accurate measurements. The average (with a measure of variability) number of "suspected" malaria incidents per year in each child was 1.4%. The frequency of stunting among children aged 6 to 18 months rose from 27.4% to 41.5%. The study found no correlation between the occurrence of 'suspected' malaria and changes in LAZ (length-for-age z-scores), hemoglobin levels, iron status, or other developmental outcomes. Malaria was additionally linked to an elevated likelihood of stunted growth and heightened socio-emotional scores.	There is no belief that malaria is linked to alterations in LAZ, hemoglobin, or iron levels in young children residing in regions where malaria is prevalent, provided that there is rigorous surveillance and treatment. Malaria is potentially linked to the development of stunted growth and the presence of anemia. Malaria is not frequently linked to growth rates.
12.	Kurahashi et.al., 2022	*Association of undernutrition with dengue, malaria and acute diarrhea among children in a Thai-Myanmar border*	*Journal of Public Health Oxford*	Scimago, Scopus, DOAJ	Retrospective study	The research was carried out on pediatric patients, specifically those under the age of 14, who were diagnosed with both malaria and severe diarrhea. The study took place at Tha Song Yang hospital, which is located near the Thailand-Myanmar border. The data indicated that the majority of patients exhibited a minor form of the condition, and similarly, the majority of cases of malnutrition were also classified as mild. The prevalence rates of stunting were 24%, 34%, and 38.7% in cases of dengue, malaria, and severe diarrhea, respectively. Being underweight was linked to acute diarrhea and malaria, but not to stunting.	Malnutrition continues to be a prevalent issue in rural regions, often linked to diseases like malaria and acute diarrhea. Regular monitoring of nutritional status is crucial, especially in children who have malaria and acute diarrhea. It is also important to provide additional meals in these cases.

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13.	Asoba et.al, 2019.	*Influence of infant feeding practices on the occurrence of malnutrition, malaria and anaemia in children ≤5 years in the Mount Cameroon area: A cross sectional study*	*PLoS One*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	This study administered a survey to a cohort of 1227 children who were under the age of 5. The data collected from the survey revealed that 22.6% of the infants were exclusively breastfed, 60.1% were nursed with a combination of breast milk and other sources, and 17.3% were never breastfed. The prevalence rates of malnutrition, parasitemia of P. falciparum, and anemia were 32.6%, 30.4%, and 77.3%, respectively. The incidence of malaria parasitemia was significantly reduced (16.2%) in children who were exclusively breastfed compared to those who were never nursed (61.3%). Feeding patterns, including how infants are fed and their age, were important factors in predicting the presence of malaria parasites and malnutrition.	It is imperative to advocate for exclusive breastfeeding in regions where malaria is prevalent. Malaria is more prevalent in locations where the disease is common. Feeding practices have a significant impact on the occurrence of parasite infection, including malaria, as well as malnutrition and anemia.
14.	Zeng et.al., 2020	*Associations among Soil-Transmitted Helminths, G6PD Deficiency and Asymptomatic Malaria Parasitemia, and Anemia in Schoolchildren from a Conflict Zone of Northeast Myanmar*	*American Journal of Tropical Medicine and Hygiene*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	Infection with Plasmodium vivax, Plasmodium falciparum, helminths (specifically hookworm, Ascaris lumbricoides, and Trichuris trichiura) were detected in 3.3%, 0.8%, 31.5%, 1.2%, and 0.3% of the 988 children who were enrolled in the study, respectively.Analysis of anthropometric measurements indicated that 25% of the individuals exhibited stunted growth, while 50% displayed wasting. Stunting and wasting were linked to the presence of anaemia, particularly moderate to severe anaemia, as well as STH infection and malaria.	This study discovered that schools located in conflict zones exhibited a greater occurrence of G6PD deficiency, soil-transmitted helminth infections, malaria, and anemia, all of which were more prevalent. These conditions are linked to inadequate nutritional status.
15.	Alwajeeh et.al.,2020.	*Uncomplicated falciparum malaria among schoolchildren in Bajil district of Hodeidah governorate, west of*	*Malaria Journal*	Scimago, Scopus, DOAJ	Analytic Observational (cross sectional)	The prevalence of *Plasmodium falciparum* was highest at 8.0%, with most cases exhibiting low-level parasitemia and no symptoms. In contrast, *Plasmodium vivax* was only discovered in 0.25% of children. Over 50% of the children infected with *P. falciparum* were diagnosed	Children frequently experience asymptomatic falciparum malaria, which is characterized by a low occurrence of parasitic infection and a significant

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	Yemen: association with anaemia and underweight	with mild anemia, which was strongly linked to falciparum malaria. Stunting was the cause of malnourishment in the majority of children (39.3%), followed by wasting (36%). The presence of Falciparum malaria showed a strong correlation with being underweight, but not with being stunted or wasted.	association with moderate anemia and underweight.

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DISCUSSION

This study sourced journals from regions endemic to malaria, encompassing countries across Africa and several in Asia. The prevalence of both malaria and malnutrition among children under five exhibited diverse outcomes, with distinct variations observed in each country. Mann *et al* . 's research states that the prevalence of malaria in children in Nigeria is 22.6% with the most common age being 48-59 months. The prevalence of malnutrition is 37.0% in *stunting* , 22.0% in *underweight* , and 6.9% in *wasting* with the most common age being 24-35 months affected by *stunting* and 12-23 months affected by *underweight* and *wasting* [13] . Research by Wegmüller *et al.* states that the prevalence in Ghana for malaria, *stunting* and *wasting* among children under five respectively is 20.3%, 21.4%, and 7.0%. Prevalence rate malnutrition, anemia, and malaria for children under five in the northern region of Cameroon are 32.9%, 54.1%, and 20.6% respectively [14] . On the border of Thailand and Myanmar, the prevalence rates for dengue fever, malaria and acute diarrhea in children aged <14 years are 24%, 34% and 38.7% [23] .

Mann *et al. 's research* shows that men, people who live in rural areas, people in the lowest income quintile, and children whose mothers do not have formal education have a higher risk of experiencing malnutrition and malaria than other groups. Food supplies are limited too may increase risk factors for malnutrition and malaria in children who require more protein and calories for rapid recovery than unaffected children [13] . Exclusive breastfeeding in the first 6 months of age is also a protective factor for malaria. Malaria parasites were found to be much lower (16.2%) in exclusively breastfed children than those in those who have never breastfed (61.3%).[25]

Children in refugee camps are a high risk factor for malnutrition and malaria among toddlers. The number of infectious disease epidemics, availability Minimal food, poor environmental sanitation and hygiene, overcrowding, inadequate access to clean water supplies, and substandard health services are the causes of high cases of malaria and malnutrition in refugee camps [19] .

Age is also a risk factor for malnutrition and malaria. Children aged 6 to 10 years have a higher chance of contracting malaria than younger children. Children aged between 6 and 10 years who suffer from malaria is a significant factor risk for anemia, however, children aged between 0 and 5 years were the only significant risk factor associated with malnutrition[19] . Research conducted by Mensah *et al.* showed that children between the ages of 12 and 14 years had more asymptomatic malaria infections than those between the ages of 6 and 8 years [21] .

Data from the literature taken in this study shows that malnutrition can influence malaria prevalence and vice versa. In the study by Kojom Foko et al., it is highlighted that children with malaria infections have an approximately fivefold higher

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likelihood of experiencing stunting. The frequency *of underweight* is also substantially greater in malaria positive compared with malaria negative individuals among those aged 5 to 19 years [15]. Research from Das *et al.* also explained that chronic malnutrition such as *stunting* is related to the severity of malaria, including high-density parasitemia, and anemia. Even malnutrition also affects the therapeutic response of children to artemisinin combination treatments (ACTs).

Malnutrition and malaria have a significant relationship [16]. There is a bidirectional relationship between nutritional status and malaria infection. Children who are malnourished have a 2.07 times higher risk of contracting malaria parasites. The risk of malnutrition is 1.89 times higher in children with malaria compared with those without the disease [23].

Research from Fevang *et al* . explained that the level of *P. falciparum parasitemia* was much lower in malnourished children who had been diagnosed with kwashiorkor compared to children with kwashiorkor/marasmus and marasmus. This is because children with kwashiorkor have higher levels of free radicals which result in a decrease in levels of reduced glutathione, its substrates, and the antioxidant enzyme glutathione peroxidase. Children with kwashiorkor also have higher amounts of free fatty acids and free fatty acids that are more likely to peroxidize in the erythrocyte membrane. Fatty acids have been found to significantly slow the development of *P. falciparum* in culture. Study This show that kwashiorkor has a protective effect against malaria [17].

Overall this study explores the intricate relationship between malaria and malnutrition in children under five across diverse regions, including Africa and various Asian countries. The prevalence of both conditions varies significantly among nations, with distinct patterns observed. Findings from different studies provide nuanced insights into specific age groups, prevalence rates, and risk factors, emphasizing the vulnerability of certain populations.

Key risk factors such as socio-economic status, education, and exclusive breastfeeding are highlighted, along with the heightened risk observed in refugee camps due to various contributing factors. Age-related risks underscore the vulnerability of specific age groups to malaria and malnutrition.

Notably, the bidirectional impact of malnutrition on malaria prevalence and vice versa is emphasized. This study underscores the urgency of targeted interventions and collaborative efforts to address the complex nexus of malaria and malnutrition, particularly in vulnerable populations. Nevertheless, it is important to recognize this study limitations. The prevalence rates and risk variables can differ as a result of variations in study design, methodology, and geographical location. Disparities in healthcare facilities and diagnostic criteria among regions may impact the capacity to make accurate comparisons.

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The generalizability of the findings may be compromised due to publication bias, inadequate representation of specific areas, and the absence of a standardized definition and criteria for malnutrition. Notwithstanding these limitations, this review provides a comprehensive analysis of the intricate correlation between malaria and malnutrition in children under the age of five, highlighting the necessity for uniform techniques and cooperative investigation.

Despite these limitations, this assessment deepens our understanding of the subject and emphasizes the need for more unified and standardized research methods to improve reliability and applicability across diverse situations.

CONCLUSION

There is a two-way (bidirectional) relationship between malnutrition and the incidence of malaria in toddlers. Consequently, malnutrition poses a danger for malaria, and conversely, malaria poses a risk for malnutrition. Additional studies indicate that individuals afflicted with malnutrition, including kwashiorkor, exhibit a reduced susceptibility to malaria.

SUGGESTION

Future research endeavors should prioritize achieving higher levels of precision in comprehending the complex correlation between malaria and malnutrition, with the objective of making a significant contribution to the worldwide mitigation of both conditions. Moreover, it is expected that this study would function as a significant asset for healthcare practitioners, enhancing their comprehension of the interaction between malaria and malnutrition. The results should be taken into account when developing and executing extensive malaria and malnutrition prevention programs in Indonesia. This would empower healthcare professionals to make well-informed judgments by comprehensively comprehending the interplay between these two health issues, hence promoting the implementation of more efficient preventative measures.

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