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Risk Factors for Malaria in Indonesia

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ABSTRACT

Malaria, as a tropical disease, continues to be the focus of attention both globally and in Indonesia. This is reflected in point 3.3 of the Sustainable Development Goals (SDGs) as well as in the strategic plan of the Indonesian Ministry of Health, which targets malaria elimination by 2030. This article is the result of a literature review that adopts a narrative approach, by referring to various studies published in national and international journals related to malaria risk factors. The literature search process was conducted through Google Scholar and PubMed databases, using keywords such as "risk factor", "malaria", and "Indonesia". Based on the search of articles published in the last five years, it was found that the most frequently identified risk factors include environmental factors and physical conditions, residence factors and housing conditions, individual behavior and activity factors, social and economic factors, and individual behavior and activity factors. Therefore, it is recommended to improve the quality of facilities, improve environmental conditions, and strengthen education to individuals as strategic steps to reduce the prevalence of malaria in Indonesia.

***Keywords**: risk factors, malaria, Indonesia*

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INTRODUCTION

Infection of red blood cells caused by Plasmodium parasites is known as malaria. Malaria is a major driver of morbidity and mortality in both children and adults (1). Malaria remains a serious public health problem, especially in remote areas. For this reason, the Indonesian government has designated it as a priority disease that must be tackled. This is stated in Presidential Regulation (PP) No. 2 of 2015 concerning the *Rencana Pembangunan Jangka Menengah Nasional* (RPJMN) 2015-2019 and RPJMN IV 2020-2024. The high prevalence of malaria and the threat of new diseases arising from population mobility affect the degree of public health (2).

Malaria remains one of the leading causes of morbidity and mortality in children and adults (1). Although the government continues to make efforts in its control, for remote areas it becomes a threat in the field of public health. The government, through Government Regulation No. 2 of 2015 on RPJMN 2015-2019, has prioritized malaria control. In RPJMN IV 2020-2024, it is stated that the prevalence of malaria as an infectious disease is still in the high category, besides that there is a threat of new diseases due to high community movement, which will certainly affect the health status of the community. Malaria cases amounted to 227 million incidents spread across 85 countries with malaria endemic status. There was an increase in cases to 241 million in the following year after the Covid-19 pandemic, showing an increase of 14 million cases compared to 2019. Although the number of deaths caused by malaria has decreased since 2000, from 896,000 to 562,000 in 2015, and 558,000 in 2019, deaths from malaria actually increased in 2020, reaching around 627,000, an increase of about 12% compared to the previous year (3).

As a tropical disease, malaria has received special attention both in the world and in Indonesia. This is evidenced by the goals of the Sustainable Development Goals (SDGs) and also contained in the Indonesian government's plan through the Ministry of Health's

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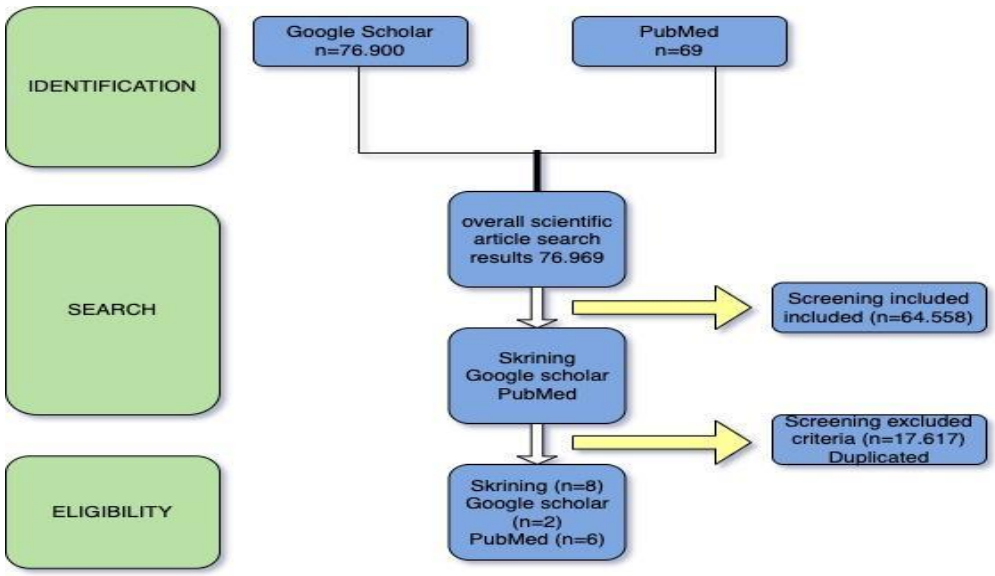
strategic plan, with the target of eliminating malaria by 2030 (2). Based on this, the author compiled this paper to discuss the risk factors that influence the incidence of malaria in Indonesia. Understanding the risk factors is expected to increase awareness of malaria prevention. In addition, the identification of these risk factors can provide recommendations to health facilities and related parties to work together in malaria prevention (4).

METHODS

Journal selection was done by considering the relevance of the topic, publication period (2018-2023), and full access in Indonesian or English. Articles selected had to address malaria risk factors in Indonesia and were from reputable databases such as Scopus, Google Scholar, and journals indexed in Sinta 1 and Sinta 2. The search was conducted using keywords such as "risk factors", "malaria", and "Indonesia", with the help of the Publish or Perish application. From this search, 8 relevant articles were found that met the criteria.

Figure 1: Prism Diagram of Malaria Risk Factor Selection in Indonesia.



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Data from the selected journals will be analyzed narratively by presenting an overview of malaria risk factors found in previous studies. This analysis includes identification, comparison and synthesis of findings on risk factors for malaria. In addition, the analysis will also evaluate the interrelationships between risk factors and the quality of the research methodology used to ensure the credibility of the research results in describing malaria risk factors in Indonesia.

RESULTS

Based on a literature review over the past 5 years, it is known that research on malaria risk factors is limited; there are only nine studies.

Table Study of Risk Factors for Malaria Occurrence in Indonesia

No	Author, Year	Location and Research Subjects	Research Type and Research Methods	Risk Factors
1	(Sulistyawati et al., 2020)	Banjarnegara Indonesia, a total of 100 people with 50 positive and 50 as controls.	*Case control study*, data taken using a questionnaire, data analysis method is chi-square.	According to these findings, unused mosquito nets, home ventilation without nets, outdoor activities that do not pay attention to prevention, are risk factors associated with malaria.
2	(Sri Rejeki et al., 2021)	Crossing the border of Menoreh Village, Java, Indonesia,	Observational study with *case control study.* This study used a questionnaire as a data collection tool, which was then analyzed	Houses located at an altitude of more than 500 meters above sea level, with wall structures made of bamboo or wood, and

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		All positive patients totaled 138 cases.	through univariate, bivariate, and multivariate approaches. Univariate analysis was conducted to describe the overall characteristics of the data, while bivariate analysis was used to explore the relationship between two variables. To identify complex influencing factors, multivariate analysis was used.	do not use insecticides. In addition, the house is less than 100 meters away from the site, increasing the mosquito breeding grounds.
3	(Sulistyawati & Fitriani, 2019)	Samigaluh District, Kulon Progo Regency, Indonesia. The number of subjects in this study was 86 people, positive controls were 43 people and negative controls were 43 people.	Quantitative case control study during spring, at Samigaluh Public Health 2. The tool used was a questionnaire to collect	This study shows that outdoor work done late at night increases a person's risk of developing malaria. This is related to the biting activity of Anopheles mosquitoes, the main vector of malaria in Samigaluh, at night.
4	(Guntur et al., 2021)	East Nusa Tenggara Province Indonesia 1503 respondents who are 18 years old and above.	Cross-sectional survey Methods interview	The study concluded that the lack of community knowledge about malaria is a risk factor contributing to the high incidence of the disease. In addition, lack of prevention, such as not using insecticide-

				treated bed nets (LLINS), also increases the risk of malaria transmission in the community.
5	(Fahmi et al., 2022)	North Sumatra, Indonesia, with a total subject of 2208 cases based on secondary data from the Ministry of Health.	Data came from the Indonesian Ministry of Health, climate variables were provided by BMKG Medan, multivariable logistic regression to analyze imported malaria data. Total malaria patients 2208 (1679 indigenous and 392 imported cases reported during the study period.	This study in North Sumatra shows that malaria risk is influenced by age (above 18 years), occupation (military personnel, forest workers, and miners), location (eastern North Sumatra), and climatic conditions (high humidity and maximum temperature increase *P. falciparum* cases).
6	(Cahyaningrum & Sulistyawati, 2018)	Kaligesing District, Purworejo Regency, Central Java. The study subjects were 96 people consisting of 48 controls and 48 people as controls.	*Case control study,* data collection using questionnaires and checklists were collected from 96 participants 48 positive and 48 acting as controls.	This study showed that low education level, cowsheds close to the house, sleeping without mosquito nets, and not closing windows and doors in the afternoon are risk factors that increase the incidence of the disease.
7	(Frans Manangsang et al., 2021)	Keerom Regency Papua. The number of subjects in this study was 200	*Observational study* with a *case-control design* approach. Inclusion and exclusion	The study concluded that shrubs play a role in increasing the risk of malaria transmission in Keerom Papua,

		respondents. Both plasmodium positive and *plasmodium* negative as control.	criteria were used to select 200 respondents.	possibly because they provide breeding grounds for Anopheles mosquitoes. In addition, standing water is also the second largest risk factor, as it provides a place for mosquitoes to lay eggs and breed.
8.	(Setiyadi et al., 2022)	Jambi, Jambi Province, Indonesia and Sumba, NTT Province, Indonesia. A total of 485 people were the subjects of this study, consisting of 157 malaria cases and 328 controls.	This study used a case-control design with a 1:2 ratio, comparing two regions with different malaria endemicity levels, namely Jambi (low endemicity) and Sumba (high endemicity).	Malaria is affected by stagnant water and agricultural and plantation activities in forest areas. Even if improvements are made to the house, this will not have an impact if environmental conditions are not controlled.

DISCUSSION

Malaria remains a significant health problem in Indonesia, despite various prevention efforts. Risk factors that influence the spread of malaria are very diverse and are influenced by various aspects, from environmental conditions, individual behavior, to socio-economic conditions. Based on existing research, these factors can be grouped into five main categories, namely: environmental factors and physical conditions, residence factors and housing conditions, individual behavior and activity factors, social and economic factors, and individual behavior and activity factors. Next, factors that have been scientifically proven to contribute to the occurrence of malaria are described.

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Environmental Factors and Physical Conditions

Physical environmental factors play a very important role in the spread of malaria, especially in high prevalence areas. One of the main factors in this category is the presence of stagnant water, which serves as a breeding ground for Anopheles mosquitoes, the main vector of malaria. Based on findings (5)(6), areas with poorly managed standing water can worsen conditions for the spread of the disease. Stagnant water caused by rain, agricultural irrigation, or even stagnant water around settlements, creates an ideal habitat for Anopheles mosquito larvae to develop. Therefore, better water management and sanitation in such areas is one of the indispensable preventive measures to reduce the presence of mosquito breeding grounds and, in turn, reduce the risk of malaria.

In addition, the altitude of residence also affects the incidence rate of malaria. Research conducted by Sri Rejeki et al. (7) showed that houses located at an altitude of more than 500 meters above sea level were at higher risk of malaria compared to areas located at lower altitudes. Although malaria is generally more common in lowlands, altitude plays an important role in the distribution of Anopheles mosquitoes. A certain altitude can affect temperature and humidity, two factors that strongly favor the life and breeding of mosquitoes. Therefore, areas with altitudes above 500 meters should be given more attention in malaria prevention efforts, even if they were not previously considered endemic areas.

Climate change is also exacerbating the situation. Longer periods of standing water due to unexpected rainfall or extreme weather provide more opportunities for mosquitoes to breed. The same goes for elevation, where changes in temperature and humidity can create more conducive conditions for Anopheles mosquitoes to survive. This underscores the importance of expanding public health policy attention to not only focus on known endemic areas, but also take into account physical environmental factors that can expand the spread of malaria to previously unaffected areas.

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Housing Factors and House Conditions

Housing factors and house conditions have a major impact on the risk of malaria transmission, especially in endemic areas. Houses made of materials that are easily penetrated by mosquitoes, such as bamboo or wooden walls, and not equipped with insecticide-treated bed nets, will increase the chances of malaria infection. Studies (8) and (9) highlighted that house structures that are not resistant to the entry of Anopheles mosquitoes are one of the main risk factors. Insecticide-treated mosquito nets are one of the important protections to prevent mosquito bites at night, and if the house is not equipped with this protection, the occupants are more vulnerable to malaria infection. Therefore, the construction of houses with sturdier materials and the use of insecticide-treated bed nets are highly recommended in malaria control efforts.

House structures that are not resistant to the entry of Anopheles mosquitoes are one of the main risk factors. Insecticide-treated bed nets are an important safeguard to prevent mosquito bites at night, and if homes are not equipped with this protection, occupants are more susceptible to malaria infection. Therefore, the construction of houses with sturdier materials and the use of insecticide-treated bed nets are highly recommended in malaria control efforts. (9,10)

Individual Behavioral Factors and Activities

Work or outdoor activities that extend into the evening significantly increase the likelihood of individuals being exposed to *Anopheles* mosquito bites. This is due to the *Anopheles* mosquito's habit of biting at night, looking for humans as hosts to draw blood. Individual behavioral factors and activities play an important role in malaria transmission, especially in relation to direct interaction with the vector, the *Anopheles* mosquito. Outdoor activities, especially those conducted at night, greatly increase the risk of being bitten by mosquitoes that are active at that time. Therefore, outdoor activities that do not consider safe times and places are strongly associated with an increased risk of malaria infection. (8)

Lack of personal prevention efforts also plays a major role in increasing their vulnerability. Individuals who do not utilize insecticide-treated bed nets or leave windows and doors open at night are at high risk of exposure to *Anopheles* mosquito bites. The habit of not wearing mosquito nets or leaving home vents open in the afternoon to evening increases the likelihood of mosquitoes entering and biting. Without protection such as mosquito nets, individuals become highly vulnerable to bites from mosquitoes, which act as the main vectors of malaria. Therefore, simple but effective preventive habits, such as closing doors and windows or using insecticide-treated bed nets, are very important to implement as preventive measures (11).

These individual behaviors are also linked to knowledge and awareness of the dangers of malaria. Although preventive measures such as the use of mosquito nets and avoidance of outdoor activities at night seem simple, not all individuals realize how important they are in protecting themselves from malaria.

Social and Economic Factors

Social and economic factors play an important role in the spread of malaria, with various aspects affecting vulnerability. People who are less educated usually do not realize the importance of preventive measures such as using insecticide-treated bed nets or maintaining a clean environment around the house. This lack of understanding about the risks and prevention of malaria makes individuals more vulnerable to infection. Therefore, increasing the level of education and providing health education is an important step in addressing the problem of malaria in the community. (11)

Lack of knowledge about malaria and non-use of insecticide-treated bed nets are significant risk factors for malaria transmission. This is related to social and economic factors, such as education level and public awareness, which influence the preventive measures taken by individuals and communities to avoid malaria. (12)

In addition, the type of work also has a major influence on the risk of developing malaria. Workers who do a lot of activities outdoors, especially in areas with stagnant water or vegetation that supports mosquito breeding, have a higher risk of being infected with malaria. Activities that take place outdoors, especially at night, increase the likelihood of exposure to mosquito bites. Therefore, while this work is important for the economy, malaria prevention efforts should still be prioritized, such as by providing protection such as mosquito nets or protective clothing. (13)

Climate and Geography

Climatic factors and geography have a significant influence on the spread of malaria, especially in tropical and sub-tropical regions. Climatic conditions, such as high temperatures and high humidity, create conditions that are highly favorable for the development of Anopheles mosquitoes, the main vector of malaria. Warm temperatures and high humidity, coupled with the rainy season which often leads to stagnant water, create an ideal habitat for Anopheles mosquitoes to breed. The stagnant water that occurs during the rainy season provides opportunities for mosquitoes to lay eggs and breed, increasing the population of mosquitoes that can infect humans. Therefore, climate fluctuations that favor such conditions need to be taken into account in malaria control strategies, such as better water management and mosquito population control. (13)

In addition, local endemicity also plays a major role in increasing malaria incidence. Areas with high malaria endemicity, such as forested or coastal areas, are more susceptible to the spread of the disease. These areas provide a suitable place for Anopheles mosquitoes to live, with geographical conditions favorable for larval development. Areas that are more remote or less accessible to health services are often breeding grounds for Anopheles mosquitoes, and populations living there are more often exposed to malaria risk. Taking this geography into account, it is important to tailor public health policies to local characteristics to reduce the potential spread of malaria in areas of high endemicity. (6)

CONCLUSIONS AND RECOMMENDATIONS

Risk factors for malaria are environmental factors and physical conditions, housing and housing conditions, individual behavior and activities, social and economic factors, and individual behavior and activities. Therefore, people need to be more aware of the importance of maintaining environmental hygiene, using insecticide-treated bed nets, and avoiding outdoor activities at night. The government should improve sanitation management, expand counseling on malaria prevention, and pay attention to socio-economic factors in disease management. Future research should focus on the effect of climate change on the spread of malaria and locally-based solutions to reduce risk in endemic areas.

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