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Environmental Determinants of Malaria Incidence

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Abstract

Malaria is a protozoan infection caused by the genus Plasmodium, with over 150 Plasmodium species infecting mammals. There are 400 Anopheles mosquitoes, but 30-40 species cause malaria. Malaria is a disease with complex transmission dynamics; malaria is also associated with geographic heterogeneity over time. The method used in this research is a literature review with systematic analysis assessed by the suitability of the topic and the desired criteria. It can be concluded that the determinants of malaria are related to the environment, knowledge, activities at night, type of work, and socioeconomics.

1. Introduction

Currently, malaria is still a global health problem, which can lead to death. The bite of a female Anopheles mosquito causes malaria. There are 400 species of Anopheles mosquitoes, but there are 30-40 species of Anopheles mosquitoes that cause malaria. Malaria is a disease caused by protozoan infection through Plasmodium infection. There are several easily recognizable symptoms of malaria, such as difficulty breathing, fatigue, fever, and headache. Symptoms of malaria will appear within 10 to 15 days after a female Anopheles mosquito bite. Malaria can also be transmitted through contaminated needles and blood transfusions.

Malaria occurs due to infection with one-celled parasites of the class Sporozoa, tribe Plasmodium, and Hemosporida. There are five types of Plasmodium that cause malaria in humans, namely; P. Knowlesi, P. malariae, P. Ovale, P. Falciparum, P.Vivax [1]. The clinical symptoms of malaria are divided into two, namely, uncomplicated malaria and severe malaria; uncomplicated malaria does not cause severe complications that only cause general symptoms; the symptoms that appear last 6-10 hours. Severe malaria usually occurs due to complications caused by Plasmodium falciparum, but severe malaria also occurs due to complications from other types of Plasmodium that are not treated. If left untreated, P. falciparum malaria can progress to severe illness and death within 24 hours [2].

Plasmodium Knowlesi was initially found in long-tailed monkeys (Macaca Fascilurasis). Plasmodium knowlesi is a disease transmitted through the bite of female Anopheles mosquitoes that previously rested on long-tailed monkeys. Plasmodium knowlesi (P.knowlesi) is now considered the fifth malaria parasite that causes widespread human malaria [3]. There are 5 of the 20 species of Plasmodium that infect macaques; in 2004, Knowlesi malaria cases were reported to spread to countries outside Malaysia, such as Thailand, the Philippines, Vietnam, Singapore, Indonesia, Brunei, and Cambodia. In Indonesia, the first case of P. Knowles was in the forests of South Kalimantan in 2010 [4].

Malaria is a disease with complex transmission dynamics associated with geographic heterogeneity over time. Malaria is often found in endemic areas, while the intensity of transmission and burden of malaria varies, usually due to climate, economy, social development, urbanization, health systems, and other factors [5].

According to experts in the field of epidemiology, India conducted a series of studies to characterize malaria; this was done to help prevent malaria. In research from epidemiological experts in India, the results obtained that children are more susceptible to malaria than women and the elderly [6].

Several previous studies have shown that most deaths from malaria occur in children under five years of age, and malaria is highly susceptible to children under five years of age, which can lead to infection and death. In 2015, malaria killed an estimated 303,000 children under the age of five worldwide, including 292,000 in the African region. Between 2010 and 2015, malaria deaths in children under five years of age decreased by about 35%. Even so, malaria remains the leading killer of children under five, causing the end of 1 child every 2 minutes). The problem is not only a health issue but a socioeconomic issue that affects the community, especially high-risk groups. Therefore, the socioeconomic context is so intertwined that they

can be differentiated but not separated [7].

Several factors contribute to the incidence of malaria, one of which is the environment that allows Anopheles mosquitoes to breed and potentially make contact with humans and transmit malaria parasites. Several previous studies have suggested that the environment plays a dominant role in malaria incidence [8].

Behavior is one of the barriers in the malaria control and prevention phase to elimination, with many endemic areas experiencing behavioral barriers. Therefore, many researchers recommend understanding the biting and resting behavior of malaria mosquitoes so that effective vector control strategies can be implemented by considering the epidemiological context of endemic areas [9].

Based on the results of epidemiological investigations (PE), 100 positive malaria cases in Sabang City identified two imported cases with P. knowlesi and 98 indigenous cases. The travel status of positive patients reported a history of traveling out of town, where two patients had visited. It stayed with families living in one of the malaria-endemic districts in Aceh Besar. Imported malaria cases in Sabang City were reported from 2011 to 2013, with an accumulation of 12 imported cases (6 cases of P. vivax, 4 cases of P. falciparum and 2 cases of mixed infection of P. falciparum and P. vivax) [10].

2. Research Methods

This research is a literature review with systematic analysis and assessed by the suitability of the topic and the desired criteria. The data source for this study came from the literature of scientific publications obtained through internet searches. The keywords used in the search for articles are environmental factors, P.knowlesi, Anopheles, and environment. There were 12 articles analyzed through analysis, objectives, methods, and results of each piece. The criteria for writing the literature review are about P.knowlesi mosquitoes, environmental factors, and articles published in 2016-2022.

3. Results and Discussion
3.1 Result

Table 1

Title/Author/Year	Sample	Results
Determinants of Malaria Incidence (Epidemiological Study in Outbreak Areas)/ Darmawansyah, Habibi J, Ramlis R, Wulandari / 2019.	175 People	The results obtained are there is a significant relationship between Breeding palce (p=0.001), Reppelant (p=0.001), PH water (p=0.001), ventilation gauze (p=0.016), the presence of livestock cages (p=1.000), the use of mosquito nets (p=0.090) with the incidence of malaria in outbreak areas. It is expected that the community will always clean stagnant water around the house, use mosquito repellent when doing activities outside the house at night and use gauze on the pentilation of the house so as to avoid the bite of anopheles mosquitoes.
Analysis of Determinants of Malaria Disease Incidence in Kutambaru District in 2017 / Rahmadani Sitepu, Alamsyah Lukito, Elaninanivi	-	The results of data analysis obtained hygiene risk factors for the incidence of malaria p=0.003, Odds Ratio = 3.852 with Confidence Interval (CI) = 1.574-9.428. Temperature p=0.025, Odds Ratio= 2.833, Stagnant water p=0.011 and Odds Ratio= 3.063, Use of mosquito nets p=0.350 (p>0.05), Use of mosquito repellent p=0.033, Habit of leaving the house at night p=0.055, Age factor p=0.392 and Odds Ratio= 1.444, Sex against Malaria p=0.831 and Odds Ratio= 1.095. In this study, the variables that became risk factors for malaria were cleanliness, temperature, stagnant water, mosquito nets, mosquito repellent, leaving the house, age and gender. To get which factor is the most dominant with the occurrence of Malaria, the variables were tested together by conducting multiple logistic regression tests using the enter method. There were two variables that had p<0.025, namely cleanliness and stagnant water, resulting in odds ratios of 4.402 and 3.562 respectively.
Determinants of Malaria Incidence in the Working Area of Puskesmas Sukajaya Sabang City / Rahmayani / 2018	33 people	The results showed that there was a relationship between the home environment and the incidence of malaria in the work area of the Sukajaya Health Center, Sabang City p value 0.024. there is a relationship between behaviour and the incidence of malaria in the work area of the Sukajaya Health Center, Sabang City p value 0.031. Additional health counselling is needed for the community, especially about malaria. This can be done through socialisation during PKK, Posyandu, or at the Puskesmas.
Analysis of Determinants of Malaria Vivax Incidence in Teluk Pandan Sub-district, Pesawaran District / Alia Karyus, Dewi Rahayu / 2022	-	The results of this study indicate that the determinants of the incidence of vivax malaria in the working area of the Hanura Health Centre are low compliance with taking medication, requiring Drug Drinking Supervisors who come from families, cadres or health workers. The low implementation of 1-2-5 surveillance by health workers because they are focused on the Covid-19 pandemic countermeasure programme, lack of motivation and community support, towards environmental hygiene around the place of residence. It is recommended to increase health promotion efforts regarding malaria prevention, monitor adherence to taking medication, and improve surveillance.
Determinants associated with malaria incidence in Indonesia in 2016/ Ummi Kalsum, Diah Restu Pertiwi, Adelina Livia Veronica, Aprina Wulandari/ 2018	34 Indonesian provinces	The results showed that there was a correlation between the proportion of people with low education (r=0.42), poor people (r=0.47), slum households (r=0.57), the proportion of villages with community-based total sanitation (r=-0.41) and the proportion of access to proper sanitation (r=-42) with the incidence of malaria. There was no correlation between the area of oil palm plantations, the number of mining companies and the number of rubber farmers with malaria incidence. Efforts are needed to improve the people's economy so that the socio-economy of the community increases and education about sanitation and environmental health

		to reduce the incidence of malaria.
Relationship between occupation and behaviour and the incidence of malaria at the Sotek health centre, Penajam sub-district, Penajam Paser Utara distric	94 sample	Most malaria sufferers are adult males, have a high school education and the main Plasmodium is Plasmodium falciparum. The most common occupation is laborer and there is a relationship between occupation and the incidence of malaria at the Sotek Health Centre, Penajam Sub-district, Penajam Paser Utara Regency. There is a relationship between patient behaviour and the incidence of malaria at the Sotek Health Centre, Penajam Sub-district, Penajam Paser Utara Regency.
Combination of Individual and Ecological Level Determinants of the Incidence of Malaria Infection in Malaria Endemic Areas/ Duarsa, Artha Budi Susila/2019.	1.206 Sample	It was found that the incidence of malaria infection [with parasite indicator (+)] in 30 villages of malaria endemic sub-districts of South Lampung and Pesawaran Districts was 11.2%, with a description of the type of malaria plasmodium mostly P. Vivax 55.8%, followed by P. Falciparum (41.5%), and the lowest was P. Malariae (2.7%). The role of individual level (level 1) was 0.17%, the role of household level (level 2) was 43.8% and the role of village level (level 3) was 55.9% in explaining the incidence of malaria infection. It was concluded that the difference in the incidence of malaria infection in individuals was more determined by contextual factors (household level (level 2) and village level (level 3)) than compositional factors (individual level (level 1)).
Contribution of Environmental Determinants to Malaria Case Prevalence in Sabang City, Aceh Province / Teuku Maulana, said devi elvin, sofyan sufri / 2022	100 House	The results showed that the physical environment (p=0.0001), biological environment (p=0.021), and chemical environment (p=0.011) were significantly associated with malaria cases. The physical environment was the most influential predictor of malaria cases (OR 11.096).
Determinants of Behaviour of Pregnant Women About Malaria in the Oelolok Health Centre Area in 2018 / Romida Simbolon / 2021	32 responden	The results of this study can be concluded that the behaviour of pregnant women about malaria is good from the level of knowledge, attitudes and actions of pregnant women towards malaria.
Relationship between Internal and External Factors of Home Environment with Malaria Incidence in Putri Hijau Sub-district, North Bengkulu Regency / Fadillah Sari / 2016.	146 responden	The results of research that have been conducted by previous researchers that there is a relationship between house conditions, the presence of gauze on ventilation, the presence of standing water, and livestock pens which are risk factors for malaria incidence. Variables that are not associated with the presence of malaria are the presence of a garden, the ceiling of the house where the most dominant factor occurs.
Determinants of Malaria Incidence at Masni Manokwari Health Centre / Kristin Yulati Sayori, Astrid Novita / 2017	112 People	The results showed that there is a relationship between residence and the incidence of malaria, and there is a relationship between the use of mosquito nets at home, so it can be concluded that there is a relationship between gestational age, family habits, the environment, and the use of mosquito nets with the incidence of malaria in pregnant women in the Masni Manokwari health centre area.
Malaria Prevalence and Relationship with Knowledge Level in the Community in South Baturinggit / Musparlin Halid / 2018	148 sample	The results of the research conducted by this researcher show that the increase in the prevalence of malaria is caused by environmental factors, namely those that occur in the management of the environment around the house and the lack of efforts made by the local government in efforts to prevent and control the incidence of malaria so that it does not become more widespread.

3.2 Discussion

A study conducted by Darmawansyah *et al*. discussed that there are several factors determining the incidence of malaria, namely, the existence of Breeding places, where there are many puddles in ponds that are not calm with the flow of water that are not smooth so that it becomes the best place to breed malaria vectors. The presence of Anopheles mosquitoes as malaria vectors is influenced by the presence of mosquito breeding sites.

The more breeding places found, the higher the malaria incidence risk in the area. There is a need for more public awareness in understanding the use of repellent when sleeping as self-protection from Anopheles mosquito bites; this effort is carried out to prevent malaria incidence. The factor that is often ignored is the level of acidity (pH), which functions to regulate respiration and enzyme systems in the body of mosquito larvae. pH is an indicator that determines the stability of Anopheles larval breeding. This study also mentioned ventilation gauze, the distance of livestock pens, and the use of mosquito nets as self-protection from Anopheles mosquitoes; in this study, researchers formulated that there is a relationship between the presence of Breeding places, water pH, and the use of ventilation gauze with the incidence of malaria [11].

Malaria is one of the problems that currently occurs in the world, malaria cases experience ups and downs, all efforts and controls continue to be made to reduce malaria morbidity. There are many factors that can cause the incidence of malaria in Indonesia, one of which is most often discussed by previous researchers, namely the existence of breeding places where Indonesia has two seasons and during the rainy season there is a lot of stagnant water so that it becomes a breeding ground for malaria mosquitoes. However, climate is not the only factor that causes mosquito breeding sites, there are some areas close to the sea that cause waterlogging. Another cause of malaria mosquito breeding is the presence of clogged drainage, resulting in health problems, one of which becomes a breeding ground for malaria mosquitoes.

The cause of malaria is not only the presence of breeding places but there are several other factors in previous studies explaining that the level of public awareness is also an essential factor in the incidence of malaria. General knowledge is still so that there are still many people who dispose of garbage carelessly, which causes many health problems [12].

In Teuku Maulana's research, *et al*. explained that the cause of malaria can also be from biological factors. Physical, natural, and chemical conditions such as water sanitation measures, turbidity, sunlight intensity, and aquatic plants

can be found in Anopheles mosquito breeding sites. Environmental conditions precisely determine the suitability of larval habitat for Anopheles vector species [13].

However, in a study conducted by Ika Sari Oktafiani *et al*. l, the research conducted to discuss the relationship between work and behavior in the incidence of malaria, the results showed that forest workers and planters are more at risk of malaria-related going in and out of the forest where the forest is one of the Anopheles mosquito breeding grounds. This is in line with research conducted by Wibowo researchers that risky work has a percentage of 98.7%. Dimi *et al*. explained that more work is seen from specific exposure. The degree of direction and the magnitude of risk according to the nature of the work also affect the environment and socio-economic characteristics [14].

However, in a study conducted by Ika Sari Oktafiani *et al*. l, the research conducted was to discuss the relationship between work and In a study conducted by Ummi Kalsum *et al*. l, it was explained that the condition of malaria in Indonesia is still endemic primarily to malaria infection such as some areas of eastern Indonesia and some areas in Sumatra. The results obtained in this study indicate that the proportion of poor people is positively correlated with the incidence of malaria. Poverty plays a role in the spread of infectious diseases of various kinds, and absolute poverty determines the inability to meet the needs of sang, food, and health. Malaria is very influential with the poor population in remote areas far from health services. Behavior in the incidence of malaria: According to the results of research that has been done, forest workers and planters are more at risk of malaria-related to going in and out of the forest, where the forest is one of the breeding grounds for Anopheles mosquitoes. This is in line with research conducted by Wibowo researchers that risky work has a percentage of 98.7%. Dimi *et al*. explained that more work is seen from specific exposure. The degree of direction and the magnitude of risk according to the nature of the work also affect the environment and socio-economic characteristics [15].

4. Conclusion
After analyzing 12 journals, it can be concluded that the determinants of malaria are related to the environment, knowledge, night activities, type of work, and socioeconomics.

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