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Association Between Vegetation Density and Standing Water Around Houses with Malaria Incidence in North Morowali Regency Indonesia

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ABSTRACT

Introduction: The increasing number of cases in the last 5 years is closely related to environmental characteristics, both physical, biological, and socio-cultural. The physical environment related to the presence of breeding places for Anopheles mosquitoes as malaria vectors has been shown to be closely related to the incidence of malaria cases in North Morowali. This study aims to Association Between Vegetation Density and Standing Water Around House with Malaria Incidence in North Morowali Regency, Indonesia.

Method: This study is a quantitative study with a cross-sectional approach. The population was all 150 individuals suspected of having malaria who underwent Rapid Diagnostic Testing, and a sample size of 60 individuals. Purposive sampling was used to determine the sample and multiple logistic regression was used to obtain a model of the independent variables.

Result: Statistically, these two groups are significant (p value < 0.05), meaning there is a significant relationship between trees/bushes around the house and (p value < 0.05), meaning there is a significant relationship between gutters/ditches/ponds around the house and the incidence of malaria cases.

Conclusion: There is a significant relationship between trees or dense bushes around the house and ditches or gutters that become places for stagnant water around the house with the incidence of malaria.

Introduction

Malaria is one of several infectious diseases that remains a global public health problem from past to present. Malaria is caused by the

Plasmodium parasite, transmitted through the bite of the Anopheles mosquito, which typically bites humans at night.^[1] Malaria is generally divided into two types: common and severe. Common malaria is a form of malaria that typically doesn't

cause serious complications and only causes primary symptoms because no vital organs are affected.^[2] Symptoms typically last 6-10 hours. Severe malaria, on the other hand, is a complication caused by common malaria if not promptly and appropriately treated. Severe malaria is generally caused by infection with the plasmodium falciparum parasite, which can lead to complications.^[3]

According to the World Malaria Report (WMR), there were 249 million cases of malaria worldwide in 2022, an increase of approximately 5 million cases compared to 2021.^[4] The majority of this increase was driven by countries in the African continent. In 2022, African countries accounted for approximately 231 million (94%) cases, while Asian countries accounted for approximately 2% of the global malaria caseload. The global malaria incidence rate increased from 57 per 1,000 people at risk in 2021 to 58 per 1,000 people at risk in 2022.^[5]

Based on the State Budget Bulletin with the theme Reviewing Malaria Elimination 2023 Edition, it states that the number of active malaria cases in Indonesia continued to increase in the 2021-2022 period, from 254,055 cases in 2021 to 443,530 cases in 2022. The highest malaria cases in Indonesia occurred in Eastern Indonesia, around 400,253 cases in 2022. The increasing trend in the number of cases is also linear with the increasing trend in deaths. The number of deaths in 2022 was 71 people. This death was the highest death incident in the 2018-2022 period.^[6]

The increase in cases over the past five years is closely related to environmental characteristics, including physical, biological, and sociocultural characteristics. The physical environment, associated with the presence of breeding sites for the Anopheles mosquito, the malaria vector, has been shown to be closely linked to the incidence of malaria cases.^[7] This is reinforced by the results of research conducted by Hernita, who stated from the results of her research that the presence of stagnant water around the house is a risk factor for malaria because it is a breeding ground for mosquitoes.^[8] The results of this study are reinforced by the research results obtained by Fitni Hidayanti which stated that those who live close to breeding places for Anopheles mosquitoes are at greater risk of contracting

malaria than those who are far from breeding places.^[9]

Naturally, malaria transmission is influenced by three main factors, the first is the host, where humans are the host and the Anopheles mosquito is the definitive host, the second is the agent, where the malaria disease agent is the Plasmodium parasite, and the third is environmental aspects that influence the incidence of malaria, including the biological, physical and socio-economic environment.^[9] Anopheles mosquitoes as malaria vectors that carry the plasmodium parasite require a suitable (receptive) environment, including a breeding place, a resting place and a feeding place.^[10]

Several studies have shown a link between home environmental conditions and malaria incidence. Furthermore, there is a link between perforated wall construction, which allows mosquitoes to enter, making occupants vulnerable to malaria transmission.^[11] Apart from functioning as a place to live and shelter, health and comfort aspects are important aspects in choosing a place to live.^[12]

Data from the results of Hatta research showed that people who have houses with ventilation that is not equipped with wire mesh have a 4 times greater risk of contracting malaria compared to people who have houses with ventilation equipped with wire mesh.^[13] Another physical condition of the house that is a risk factor for malaria is whether or not there is a ceiling that acts as a barrier between the upper walls of the house and the ceiling of the house.^[14] Houses that do not have ceilings make it easier for mosquitoes to enter the house through the ceiling, thereby increasing contact between mosquitoes and the house's occupants.^[15]

The Ministry of Health has set an ambitious target for malaria management in Indonesia, aiming to become a malaria-free country by 2030. This achievement will be preceded by malaria-free regions at both the provincial and district levels across Indonesia.^[16] In 2021, based on the latest data related to the malaria elimination program, 347 of 514 districts or cities had declared malaria elimination, or approximately 68% of the total regions in Indonesia had achieved malaria elimination.^[17]

The government has made many efforts to prevent an increase in malaria cases, and even

eliminate malaria cases in Indonesia.^[18] One of the efforts that has been made is to reduce the number of contacts between Anopheles mosquitoes and humans by using mosquito nets when sleeping.^[19] Wearing closed clothing for people living in malaria endemic areas, as well as spraying the house with mosquito repellent and sprinkling larvicidal powder around the house where mosquitoes breed.^[20]

Central Sulawesi is one of 31 provinces in Indonesia that still report confirmed cases of malaria. Malaria is one of several infectious diseases that remains a public health problem in Central Sulawesi Province, as evidenced by the prevalence of malaria cases over the past 5 years in Central Sulawesi. The number of active malaria cases was 286 in 2018 with an Annual Parasite Incidence (API) of 0.09%, dropping to 187 cases in 2019 with an API of 0.04%, then rising again to 283 cases in 2020 with an API of 0.08, dropping again to 50 cases in 2021 with an API of 0.02, then rising again in 2022 with 218 malaria cases with an Annual Parasite Incidence (API) of 0.08%. From this data, it can be concluded that malaria cases in Central Sulawesi have tended to fluctuate in the past 5 years.^[21]

North Morowali is a regency in Central Sulawesi Province. In 2022, North Morowali Regency ranked second in terms of positive malaria cases in Central Sulawesi, behind Tojo Una-Una, with an API of 0.23%. Two sub-districts are endemic for malaria in North Morowali Regency: Center Bungku and Mamosalato. Mamosalato District is home to two community health centers : Pandauke and Potowe Indo Lijo.^[21]

Potowe Indo Lijo Community Health Center has a working area of 970.22 hectares consisting of 6 villages located in inland and remote areas. The geographical condition of the Potowe Indo Lijo Community Health Center working area is in a mountainous region with an altitude of 1000 - 3000 meters above sea level. In the last three months there has been a massive increase in positive malaria cases in the Potowe Indo Lijo Community Health Center working area. Based on routine reports from Malaria program holders in December 2023 there were 22 active positive cases of malaria, increasing to 31 cases in January 2024 and increasing again to 35 cases in February 2024. In March 2024 the Central Sulawesi Provincial Health Office determined that the increase in

malaria cases that occurred in the Potowe Indo Lijo Community Health Center working area was included as an Extraordinary Event because there had been an increase in malaria cases for three consecutive periods.

Method

This study employs a quantitative, cross-sectional design aimed at analyzing the relationship between the physical home environment and the incidence of malaria within the service area of the Potowe Indo Lijo Community Health Center, North Morowali Regency. The research was conducted from May to July 2024 in remote villages classified as malaria-endemic areas.

The study population consisted of all 150 individuals who underwent Rapid Diagnostic Tests (RDT) for malaria at the Potowe Indo Lijo Community Health Center between December 2023 and March 2024. A sample of 60 respondents was selected using purposive sampling based on specific inclusion criteria: residing within the center's service area, possessing adequate communication skills, and consenting to participate.

Primary data were collected through interviews using structured questionnaires and direct observation of the respondents' physical home environments. Secondary data were obtained from the Community Health Center's malaria program reports and relevant literature. The collected data underwent processing stages comprising editing, coding, scoring, and tabulation.

Data analysis included univariate analysis to describe the frequency distribution of each variable; bivariate analysis using the Chi-square test to determine the relationship between independent variables and malaria incidence; and multivariate analysis using multiple logistic regression to identify the factors most strongly associated with malaria incidence. The study adhered to research ethics principles, including informed consent, anonymity, and confidentiality.

Result

Table 1 shows that the environmental conditions around the house that have trees/bushes in the working area of the Potowe Indo Lijo Health Center, as many as 24 (77.4%) respondents have been infected with malaria. Meanwhile, as many as 6 (20.7%) respondents who do not have trees/bushes around their house have been infected with malaria. Statistically, these two groups are significant (p value <0.05), meaning that there is a significant relationship between trees/bushes around the house and the incidence of malaria cases. From the results of the analysis, an OR value of 13 was also obtained, meaning that people who have trees/bushes around their house have a 13 times greater chance of contracting malaria compared to people who do not have trees/bushes around their house.

Table 2 shows that the environmental conditions around the house that have gutters/ditches/ponds in the working area of the Potowe Indo Lijo Health Center, as many as 22 (78.6%) respondents have been infected with malaria. Meanwhile, as many as 8 (25.0%) respondents who do not have gutters/ditches/ponds around their house have been infected with malaria. Statistically, these two groups are significant (p value <0.05), meaning that there is a significant relationship between gutters/ditches/ponds around the house and the incidence of malaria cases. From the results of the analysis, an OR value of 11 was also obtained, meaning that people who have gutters/ditches/ponds around their house have an 11 times greater chance of contracting malaria compared to people who do not have gutters/ditches/ponds around their house.

Table 1.

The Relationship between the Presence of Trees or Bushes Around the House and the Incidence of Malaria in the Potowe Indo Lijo Community Health Center Work Area North Morowali Regency

Trees or Bushes	Case				Total		Statistical Analysis
	Malaria		No Malaria		n	%	
	n	%	n	%			
There is	24	77.4	7	22.6	31	100.0	p-value = 0.000 OR = 17.00 CI 95% = 3.873- 45.023
There isn't any	6	20.7	23	79.3	29	100.0	
Total	30	50.0	30	50.0	60	100.0	

Table 2.

The Relationship between Drains/Ditches/Ponds Around Houses and Malaria Incidence in the Potowe Indo Lijo Community Health Center Work Area North Morowali Regency

Ditch or Trench	Case				Total		Statistical Analysis
	Malaria		No Malaria		n	%	
	n	%	n	%			
There is	22	78.6	6	21.4	28	100.0	p-value = 0.000 OR = 11.00 CI 95% = 3.292- 36.751
There isn't any	8	25.0	24	75.5	32	100.0	
Total	30	50.0	30	50.0	60	100.0	

Discussion

The Relationship between the Presence of Trees or Bushes Around the House and the Incidence of Malaria

The results of this study indicate that 51.7% of people suspected of having malaria who were respondents in this study had trees/bushes around their homes and 48.3% of people suspected of

having malaria who were respondents in this study had no trees/bushes around their homes. Based on bivariate analysis using the chi-square test, it shows that there is a relationship between trees or bushes and the incidence of malaria in the working area of the Potowe Indo Lijo Health Center, North Morowali Regency, with a p value = 0.000. From the results of the analysis, an OR value of 13 was also obtained, meaning that people who have

trees/bushes around their homes have a 13 times greater chance of contracting malaria compared to people who do not have trees or bushes around their homes. The results of this study are in line with research conducted, which shows that bushes have a relationship with the incidence of malaria in the work area of the Kaligensi Health Center, Purworejo Regency.^[22]

The community in the Potowe Indo Lijo Community Health Center's work area is dominated by the Wana people, who prefer to live close to forests. Most Wana still depend on forest products for their livelihood, resulting in their homes often surrounded by trees and dense bushes.

Trees or bushes that are dense and cannot be penetrated by sunlight, cause the environment to be shady and damp.^[23] This condition is a resting place, preferred by *Anopheles* mosquitoes. Trees or dense bushes if they are around the house can result in an increase in the population of *Anopheles* mosquitoes around the house, thereby increasing the risk of contact or bites by *Anopheles* mosquitoes with the residents of the house.^[24] High intensity of contact or bites by *Anopheles* mosquitoes with house occupants causes a high risk of malaria transmission.^[25]

This situation is in line with the results of research conducted²⁶ which states that the proportion of houses with dense bushes around their house has a tendency to expose the occupants of the house to malaria.

The Relationship between Drains or Ditches Around the House and Malaria Incidence

The results of this study indicate that 46.7% of people suspected of having malaria who were respondents in this study had a ditch or trench around their house and 53.3% of people suspected of having malaria who were respondents in this study did not have a ditch or trench around their house. Based on bivariate analysis using the chi square test, it shows that there is a relationship between ditches or trenches and the incidence of malaria in the working area of the Potowe Indo Lijo Health Center, North Morowali Regency, with a p value = 0.000. From the results of the analysis, an OR value of 11 was also obtained, meaning that people who have ditches or trenches around their house have an 11 times greater chance of contracting malaria compared to people who do not have ditches or trenches around their house.

The results of this study are in line with research conducted²⁷ which shows that gutters or ditches have a relationship with the incidence of malaria in Ketosari Village, Bener District, Purworejo Regency.

Based on observations made by researchers during the study, they found numerous gutters or ditches that collect rainwater or household wastewater in the surrounding areas. Stagnant water, commonly found in gutters or ditches, as well as in fish farming ponds, provides a prime breeding ground for female *Anopheles* mosquitoes.^[28] The presence of gutters or ditches around the house causes an increase in the mosquito population around the house.^[29] The high mosquito population around the house increases the risk of malaria transmission.^[30]

Conclusion

There is a significant relationship between trees or dense bushes around the house and ditches or gutters that become places for stagnant water around the house with the incidence of malaria in the working area of the Potowe Indo Lijo Health Center, North Morowali Regency.

Therefore, it is necessary to conduct outreach activities to the community, both from the Health Service and Community Health Centers, regarding efforts to prevent the transmission of malaria and to carry out regular monitoring of larvae in each house or in public places such as schools, churches and mosques.

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