Analysis of Distribution Patterns of Environmental Risk Factors with Malaria Incidents in the Working Area of the Tanjung Tiram Community Health Center, Batu Bara Regency

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Abstract

Environmental conditions have a big influence on the incidence of malaria because a bad environment can increase the breeding and proliferation of Anopheles mosquitoes. The aim of this research is to determine environmental risk factors and distribution patterns of malaria in the Tanjung Tiram Community Health Center working area, Batubara Regency. This research method is analytical observational with a case control research design and an ecological approach. This research was conducted in the working area of the Tanjung Tiram Health Center, Batu Bara Regency, which was carried out from April to July 2023. Population 40,604 people. The sampling technique was purposive sampling so that the research sample was 100 people. Data collection uses questionnaires and observation sheets. Data analysis using the bivariate Chi square test on SPSS version 20 software and Analysis of malaria case distribution mapping using the Geographic Information System (GIS) application to describe the distribution pattern of malaria in Batubara Regency. The results of the study show that there is a relationship between environmental risk factors such as ceilings (p-value=0.000), wall type (p-value=0.000), ventilation (p-value=0.000), wall density (p-value=0.000), partitions on windows (p-value=0.000), the presence of puddles (p-value=0.000), gutters (p-value=0.000) and swamps around the house (p-value=0.000). The distribution of Malaria cases in Tanjung Tiram District, Batubara Regency is not spread across all areas in the district, this means that the highest number of malaria cases occur in mixed plantation areas. By depicting the distribution pattern in the form of a map, it can optimize the reduction in the incidence of malaria cases.

Keywords: Environment, Geographic Information System, Malaria

INTRODUCTION

Infectious diseases are diseases that can be transmitted from sick individuals to healthy individuals through direct contact or not. Infectious diseases are very dangerous because they can cause epidemics (Lindahl et al., 2015). An epidemic is the onset of a disease in a certain population, in a certain period of time, with a high rate of spread. There are many infectious diseases that are very dangerous, including Malaria (Baker et al., 2022).

Malaria is an infectious disease caused by the bite of a female Anhopeles mosquito infected with Plasmodium-type parasites. Malaria not only causes a high mortality rate, but also results in large financial losses in the form of care and treatment costs so that a tool is needed to determine the pattern of the spread of malaria (Tavares et al., 2022).

Health is where the body is in good condition physically, physically, mentally, spiritually and also socially (Svalastog et al., 2017; Sokang et al., 2019). Health is the most

valuable thing which is an investment in the long term for the continuation of human life and is one of the assets in supporting the success of national development. So comprehensive and sustainable health development is needed (Kruk et al., 2018).

In Health Law Number 36 of 2009 concerning health, it is stated that health development aims to increase awareness, will and ability to live healthily for everyone in order to achieve the highest level of public health (Undang - Undang Republik Indonesia Nomor 36 Tahun 2009 Tentang Kesehatan, 2009).

Malaria is still a health problem that needs to be addressed in the world and Indonesia because the morbidity rate is still quite high. Malaria has affected around 209 countries in the world. Malaria prevalence in the world in 2019 amounted to 229 million cases of malaria infection occurred in 2019 with an average of 400.000 infected people died and increased in 2023 to as many as 247 million positive cases of Malaria reported in 84 Malaria endemic countries (WHO, 2022).

Indonesia is one of the Malaria endemic countries with the number of cases in 2022 as many as 443.530, as many as 89% of positive malaria cases were reported from Papua Province. In 2023 the number of malaria cases in Indonesia amounted to 418.546 with 121 deaths. North Sumatra Province with the number of malaria cases in 2022 was 5.226 cases and in 2023 to 5.010 cases. The number of malaria cases in Batubara Regency in 2022 was 730 cases and in 2023 was 699 cases (Kemenkes RI, 2022).

Poor sanitation and home environmental conditions are factors related to the breeding of mosquitoes as a cause of malaria as one of the breeding places for Anopheles mosquitoes is resting places and breeding places such as environments where there are still many swamps, ditches where the water does not flow, sky conditions and house ceiling (Agyemang-Badu et al., 2023). Poor environmental sanitation can be influenced by the lack of public knowledge about malaria in its prevention, control and eradication. So these factors influence people's life behavior (Yang et al., 2020).

Environmental factors provide habitat for mosquitoes to develop, such as puddles of clean water that do not come into direct contact with the ground and are not exposed to direct sunlight, the presence of used goods such as free tires, bottles, plastic and other items that can hold water are possible means for harboring mosquitoes. mosquito breeding, the more used items in the home environment that can hold water, the more places there will be for mosquitoes to lay eggs and breed, thereby increasing the risk of malaria (Ferdiansyah, 2016).

Distribution pattern analysis functions to determine spatial variations, both in the incidence of a disease and its risk factors. With spatial analysis, a mapping process can be

carried out to determine the geographic distribution of potential disease risks and their relationship with existing environmental risk factors (Cristaldi et al., 2022). Based on malaria elimination data, in 2014 in North Sumatra province 15 out of 33 districts/cities had received malaria elimination certificates. In 2015 there were 18 districts/cities still in the eradication stage, spread across 189 high endemic villages and 269 moderate endemic villages (Dinas Kesehatan Provinsi Sumatera Utara, 2019).

Endemic villages are certainly at risk of contracting malaria. Batubara Regency is one of the districts in North Sumatra which has a high incidence of malaria. The number of clinical malaria sufferers in Batu Bara Regency in 2015 was 5.593 and in 2016 it was 4.856. Malaria with laboratory confirmation in 2015 was 1.205 and in 2016 there were 580. This data shows that malaria cases are still high in Batubara Regency. In 2020, there were 91 cases of malaria in the Tanjung Tiram health center working area. In 2021 there will be an increase in cases of 279 cases. Malaria data in Batubara Regency is not yet in the form of a GIS. Mapping of the distribution of cases has not been carried out.

This means that the distribution of malaria cases by region in Batubara District is not known with certainty. Identification and analysis of environmental risk factors related to the incidence of malaria in Batubara District is very necessary, so that control efforts can be more optimal. It is necessary to carry out research to analyze the distribution pattern of environmental risk factors and the incidence of malaria in Batubara Regency.

METHOD

This type of research is analytical observational research with a case-control design and an ecological approach, which aims to obtain an overview of the distribution pattern of dengue hemorrhagic fever and environmental factors using geographic information system applications.

This research was conducted in the working area of the Tanjung Tiram Health Center, Batu Bara Regency, which was carried out from April to July 2023. The population in this study were all residents in the Tanjung Tiram Health Center working area, totaling 40.604 people. The sampling technique for this study was purposive sampling which is based on certain considerations such as the characteristics or properties of the population that are already known in advance. Sampling using the Slovin formula which is calculated based on the formula, so that a sample size of 100 people is obtained.

Data collection in this study used a questionnaire in the form of interviews and by making direct observations at the research location. The variable in this study is the physical

environment in the house: ventilation, screen, type of wall, wall and ceiling density. While the physical environment variables outside the house: swamps, ditches, and puddles.

Analysis of research data with bivariate using the chi-square test with a confidence level of 95%. The decision taken from this analysis test by looking at the p value <0.05 and Odds Ratio to determine the dominant risk factor for dengue hemorrhagic fever incidence in the form of crosstab with the help of computerized software Statistical Package for the Social Sciences version 20.

Analysis of the distribution pattern and risk of malaria incidence in the working area of the Tanjung Tiram Health Center of Batubara Regency with spatial analysis which serves to determine spatial variations, both the incidence of a disease and its risk factors. Analysis of malaria case distribution mapping using the Geographic Information System (GIS) application to describe the distribution pattern of malaria in Batubara Regency.

RESULTS

Table 1. Frequency Distribution of Physical Environment Subjects in Respondents' Homes

Physical Environment in the Home	n	%
Ventilation		
Qualify	78	78
Not Qualifying	22	22
Total	100	100
Gauze wire on ventilation holes		
Qualify	50	50
Not Qualifying	50	50
Total	100	100
Wall Type		
Qualify	71	71
Not Qualifying	29	29
Total	100	100
Wall Density		
Qualify	61	61
Not Qualifying	39	39
Total	100	100
House ceiling		
Qualify	52	52
Not Qualifying	48	48
Total	100	100

Based on Table 1, it can be seen that the number of research subjects according to the physical environment variables in the house: ventilation, respondents who met the requirements were 78 (78%) respondents and those who did not meet the requirements were 22 (22%) respondents, screens that met the requirements were 50 (50%) respondents and those who did not meet the requirements were 50 (50%) respondents, the type of wall that met the

requirements was 71 (71%) respondents and those that did not meet the requirements were 29 (29%) respondents, and the wall density of respondents who met the requirements as many as 61 (61%) respondents and those who did not meet the requirements, while the ceiling of respondents who met the requirements was 52 (52%) respondents and those who did not meet the requirements were 48 (48%) respondents.

Table 2. Frequency Distribution of Physical Environment Subjects Outside the Respondent's Home

Physical Environment Outside the Home	n	%
Swampy home environment		
Nothing	61	61
Yes	39	39
Total	100	100
Drainase		
Nothing	66	66
Yes	34	34
Total	100	100
Puddles of Water		
Nothing	74	74
Yes	26	26
Total	100	100

Based on Table 2, it can be seen that the research subjects according to the physical environment variable outside the house are 39 (39%) respondents who have a swamp around the house and respondents who do not have a swamp around the house are 61 (61%) respondents who have a ditch around the house. There were 34 (34%) respondents and there were 66 (66%) houses without ditches around the house, and there were 26 (26%) respondents whose houses had standing water and there were as many as 26 (26%) respondents whose houses had no standing water around the house. 74 (74%) houses.

Table 3. Frequency Distribution of Malaria Incidents in the Working Area of the Tanjung Tiram Community Health Center, Batu Bara Regency

Malaria incident	n	%
Case	50	50
Control	50	50
Total	**100**	**100%**

In Table 3, it can be seen that in the study there were 50 (50%) respondents who experienced malaria (cases) and 50 (50%) respondents who did not experience malaria (controls).

Table 4. Bivariate Analysis of Risk Factors for Malaria Incidents in the Working Area of the Tanjung Tiram Community Health Center, Batu Bara Regency

Variable	Malaria	Total	OR	CI 95%	p-value

	Case		Control						
	n	%	n	%	n	%			
Ventilation									
Qualify	28	28.0	50	50.0	78	78.0	0.359	0.267-0,483	0.000
Not Qualifying	22	22.0	0	0	22	22.0			
Gauze wire on ventilation holes									
Qualify	5	5.0	45	45.0	50	50.0	0.012	0.003-0.046	0.000
Not Qualifying	45	45.0	5	5.0	50	50.0			
Wall Type									
Qualify	21	21.0	50	50.0	71	71.0	0.296	0.207-0.432	0.000
Not Qualifying	29	29.0	0	0	29	29.0			
Wall Density									
Qualify	19	19.0	42	42.0	61	61.0	0.296	0.117-0.045	0.000
Not Qualifying	31	31.0	8	8.0	39	39.0			
House ceiling									
Qualify	11	11.0	41	41.0	52	52.0	0.062	0.023-0,166	0.000
Not Qualifying	39	39.0	9	9.0	48	48.0			
Swampy home environment									
Yes	34	34.0	5	5.0	39	39.0	0.052	0.017-0.157	0.000
No	16	16.0	45	45.0	61	61.0			
Drainase									
Yes	32	31.0	2	2.0	34	34.0	0.023	0.005-0.108	0.000
No	8	18.0	48	48.0	66	66.0			
Puddles of Water									
Yes	26	26.0	0	0	26	26.0	0.324	0.233-0.451	0.000
No	24	32.0	50	50.0	74	74.0			

From the description in Table 4, it shows that 22 (22%) of the respondents who experienced malaria had ventilation that did not meet the requirements and 28 (28%) of those who met the requirements. And of the respondents who did not experience cases of malaria or the control group who had ventilation, all of whom met the requirements were 50 (50%) respondents. Based on statistical tests, the results of the analysis show a p-value of 0.000 or p<0.005, so it can be concluded that there is a significant relationship between the presence of ventilation and the incidence of malaria..

There were 5 (5%) respondents who experienced malaria using gauze and 45 (45%) respondents who did not meet the requirements. And of the respondents who did not experience malaria or in the control group who used gauze, there were 45 (45%) respondents who met the requirements and 5 (5%) respondents who did not meet the requirements. Based on the results of statistical tests, the results of the analysis show a p-value of 0.000 where p<0.005, thus it can be concluded that there is a significant relationship between the use of gauze and the incidence of malaria.

There were 21 (21%) respondents who experienced malaria or a group of cases that had wall types that met the requirements and 29 (29%) respondents who did not meet the requirements. And of the respondents who did not experience malaria or the control group, out of 50 (50%) the number of respondents all had the type of wall that met the requirements.

Based on statistical tests, the results of the analysis show a p-value of 0.000 or p<0.005, so it can be concluded that there is a significant relationship between the type of wall and the incidence of malaria.

There were 19 (19%) respondents who experienced malaria or a group of cases that had wall density that met the requirements and 31 (31%) respondents who did not meet the requirements. And of the respondents who did not experience malaria or in the control group who had wall density that met the requirements, there were 42 (42%) respondents and those who did not meet the requirements were 8 (8%) respondents. Based on statistical tests, the results of the analysis show a p-value of 0.000 or p<0.005, thus it can be concluded that there is a significant relationship between the type of wall and the incidence of malaria.

There were 11 (11%) respondents who experienced malaria or a group of cases whose ceiling met the requirements and 39 (39%) respondents who did not meet the requirements. And of the respondents who did not experience malaria or the control group who had a ceiling that met the requirements, there were 41 (41%) respondents and those who did not meet the requirements were 9 (9%) respondents. Based on statistical tests, the results of the analysis show a p-value of 0.000 or p<0.005, thus it can be concluded that there is a significant relationship between the ceiling and the incidence of malaria.

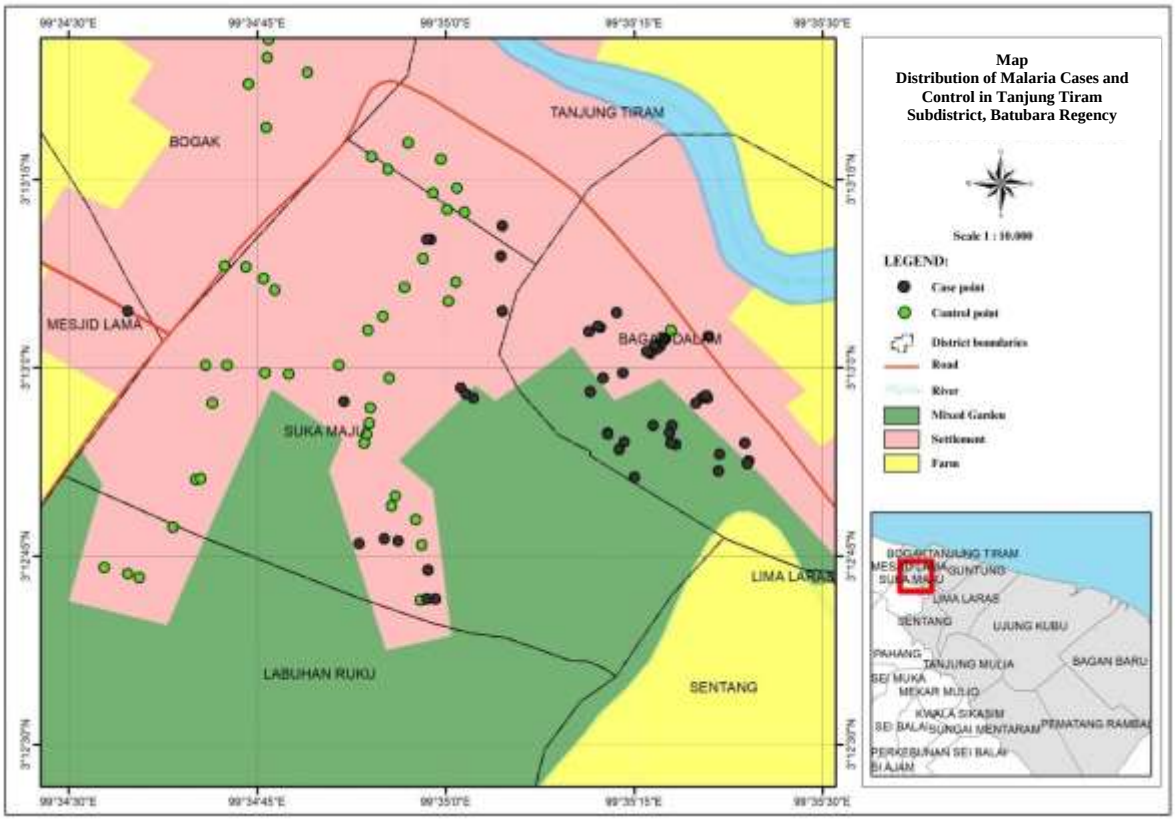
There were 34 (34%) respondents who experienced malaria or the case group who had swamps around their house and 16 (16%) respondents who did not have swamps around their house. And among respondents who did not experience malaria or the control group, there were 5 (5%) respondents who had swamps around their houses and 45 (45%) respondents who did not had swamps. Based on statistical tests, the results of the analysis show a p-value of 0.000 or p<0.005, thus it can be concluded that there is a significant relationship between the presence of swamps and the incidence of malaria.

There were 32 (31%) respondents who experienced malaria or the case group who had ditches around the house and 18 (18%) who did not have ditches around the house. And of the respondents who did not experience malaria or the control group, there were 2 (2%) respondents who had ditches around the house and 48 (48%) respondents who did not have ditches around the house. Based on the results of statistical tests, the results of the analysis show a p-value of 0.000 or p<0.005, thus it can be concluded that there is a significant relationship between the presence of ditches and the incidence of malaria.

There were 26 (26%) respondents who experienced malaria or the case group who had standing water around the house and 24 (24%) who did not have a ditch around the house. And of the respondents who did not experience malaria or the control group, all of the 50 (50%)

respondents did not have standing water around the house. Based on the results of statistical tests, the results of the analysis show a p-value of 0.000 or p<0.005, thus it can be concluded that there is a significant relationship between the presence of standing water and the incidence of malaria.

Figure 1. Map of the Distribution of Malaria Cases in Tanjung Tiram District, Batubara Regency, North Sumatra



The distribution of Malaria cases in Tanjung Tiram District, Batubara Regency is not spread throughout all areas in the district, but only in several adjacent areas. Based on research results, the largest number of cases are in mixed plantation areas. With this map, the community health center can find out which areas have high malaria cases so that the community health center can take steps to overcome malaria cases in Tanjung Tiram District.

DISCUSSION

Poor ventilation can be one of the factors causing malaria. Ventilation media where air exchange can occur. Water is one of the factors that plays a role in mosquito breeding (Rejeki et al., 2021). The findings of the study indicate a substantial correlation (p-value=0.000) between the incidence of malaria and the presence of ventilation. This is in line with research conducted by Siregar (2019), where in his research there was a significant relationship between the presence of ventilation and the incidence of malaria with p = 0.000.

Based on the research results, there is a significant relationship between the use of gauze and the incidence of malaria (p-value=0.000). This is in accordance with research Fitriani et al., (2023) which indicates that there is a substantial correlation between the installation of wire mesh in a home's ventilation system and the frequency of malaria; individuals who install wire mesh in their home's ventilation system are 15 times more likely to get malaria than those who do not.

The use of gauze plays a role in preventing malaria by preventing mosquitoes from entering the house. The physical condition of the house is closely related to the incidence of malaria, especially with regard to whether or not mosquitoes can easily enter the house. A house with ventilation that does not have wire mesh installed will make it easier for mosquitoes to enter the house to bite humans (Apriliani et al., 2021).

Based on the research results, there is a significant relationship between the type of wall and the incidence of malaria (p-value=0.000). The results of this study are in line with Siregar et al, (2021) suggests a connection between the prevalence of malaria and house walls. In communities with semi-permanent barriers as opposed to permanent walls, the risk of developing malaria is 1.157 times higher for houses walls that do not meet the standards.

The physical condition of people's houses in Pantai Cermin District with semi-permanent house walls has a 5,723 times risk of being infected with malaria compared to people who have the physical condition of houses with permanent walls. The physical condition of the house with holes in the walls of the house will create access for Anopheles Sp. mosquitoes to come in and out so that the transmission of malaria will be greater (Agustina et al., 2021).

Based on the research results, there is a significant relationship between the type of wall and the incidence of malaria (p-value=0.000). This is in accordance with research Madayanti et al., (2022) The density of a home's walls and the prevalence of malaria are correlated. The likelihood of developing malaria is 3.872 times higher in those with non-tight home walls than in those with tight house walls.

The state of the walls will facilitate mosquito entry into the house more easily than if the walls were tightly constructed. Because of this circumstance, there is an increased chance that Anopheles mosquitoes would bite household members, which raises the possibility of malaria transmission (Mmbando et al., 2022; Rusli et al., 2023).

The ceiling is a room divider on the upper walls with a roof made of wood, interior or finely woven bamboo. If there is no ceiling, it means there is a hole or gap between the wall and the roof so that mosquitoes can enter the house more freely. Thus, the risk of contact between house occupants and Anopheles mosquitoes is greater than in houses with ceilings (Kemenkes RI, 2011).

Based on the research results, there is a significant relationship between house ceilings and the incidence of malaria (p-value=0.000). The results of this study are in line with research Utami et al., (2022), which states that the physical environmental factors of the ceiling of the residence are related to the incidence of malaria.

The existence of swamps around the house which are flooded with water and overgrown with trees so that they are shady and damp, this situation is a resting place and breeding place for mosquitoes (Sembiring et al., 2023). Based on the research results, there is a significant relationship between the presence of swamps and the incidence of malaria (p-value=0.000).

The presence of large bodies of water such as swamps, fish ponds, streams and rivers as well as dense bushes close to the house result in the environment becoming a breeding ground and a preferred resting place for Anopheles mosquitoes. The number of Anopheles mosquitoes in the environment around the house is increasing so that families who live around houses with poor conditions are more at risk of malaria (Tarekegn et al., 2022; Kahamba et al., 2022).

Based on the research results, there is a significant relationship between the presence of ditches and the incidence of malaria (p-value=0.000). This is in line with the research conducted Suriyani (2023), which shows that there is a significant relationship between the presence of ditches and the incidence of malaria with OR= 0.06. The breeding places for Anopheles mosquitoes are large and medium-sized water bodies, in the form of permanent standing water, namely fresh water or brackish water, which includes swamps, river estuaries, excavated holes, abandoned ponds. Meanwhile, natural temporary puddles include puddles of rain water, river bank water and puddles. Temporary puddles are ditches, irrigation and excavated holes (Taurustya, 2020).

Environmental conditions have a big influence on the presence or absence of malaria in an area. The presence of brackish water lakes, standing water in forests, rice fields, fish

ponds, forest clearing and mining in an area will increase the possibility of malaria because these places are breeding grounds for malaria mosquitoes (Purwati, 2018).

Intermittent rain and heat are directly related to the development of mosquito larvae. Because rainwater which creates puddles is an ideal place for Anopheles mosquitoes to breed (Mattah et al., 2017). As breeding places increase, the Anopheles mosquito population will increase (Darmawansyah et al., 2019). Low humidity will shorten the life of the Anopheles mosquito, although it has no effect on the parasite. A humidity level of 60% is the lowest possible limit for mosquitoes to live. In high humidity mosquitoes become more active and bite more often, thereby increasing malaria transmission (Dompas et al., 2020).

Based on the research results, there is a significant relationship between the presence of standing water and the incidence of malaria (p-value=0.000). In line with research Manangsang et al., (2021), that the factor most related and influential to the incidence of malaria is the variable presence of bushes near the house. Houses that have a physical environment of bushes near the house have a high risk of experiencing malaria 17 times compared to respondents who have a low risk due to the presence of bushes and standing water near the house.

CONCLUSION

Based on the research results, it shows that there is a relationship between environmental risk factors such as ceilings, wall types, ventilation, wall density, partitions on windows, the presence of puddles of water, gutters and swamps around the house. The distribution of Malaria cases in Tanjung Tiram District, Batubara Regency is not spread across all areas in the district, meaning the highest number of malaria cases occurs in mixed plantation areas.

It is hoped that community health center officials can develop a more specific distribution pattern map regarding the factors that cause malaria. and it is hoped that the community will pay attention to the physical conditions inside and outside the home to reduce the risk of malaria.

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