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Risk Factors of the Physical Environment of the House and Larva Habitat on the Incident of Malaria in the Working Area of the Tambelang Public Health Center Southeast Minahasa Regency

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Abstract There were 65 occurrences of malaria episodes in the Tambelang Community Health Center in 2023. **Objective:** The purpose of this research was to examine the effects of the home environment and larval habitat on the occurrence of malaria in the Southeast Minahasa Regency's UPTD of the Tambelang Public Health Center. **Method:** This study uses a case control study design and is an analytical observational research project. There were 65 respondent samples of malaria cases, and 130 respondents made up the control group, which was chosen at a 1 : 2 ratio based on respondents age and sex matching the cases. **Result:** The results of the bivariate analysis indicate that the usage of wire gauze (OR=0.063), ventilation (OR=3.106), the density of larvae (OR=3.195), and the house wall (OR=3.167) are risk factors. With an OR=2.932 and CI (95%) = (1.514-5.679), multivariate analysis reveals that the state of the home's walls is the most significant risk factor for the incidence of malaria. **Conclusion:** The condition of the home's walls is the primary risk factor affecting the prevalence of malaria in Southeast Minahasa Regency. The density of larvae, the usage of wire gauze, ventilation, and an OR > 1 are additional risk factors.

Keywords Malaria, Physical Condition of the House, Larvae Habitat

1. Introduction

A female *Anopheles* mosquito carrying the parasite that causes malaria will bite you. Malaria is a potentially fatal disease. This infection is not contagious and is brought on by parasites [1]. Global malaria mortality in 2021 was expected to be 619,000, down from 625,000 in the pandemic's first year. Globally, there were 247 million cases of malaria in 2020, in contrast to 232 million in 2019 and 245 million in 2020 in 2021 [2].

Indonesia contributed the 2nd largest number of cases after India in Asia. The national target for the malaria positivity rate is less than 5%, while the national achievement in 2022 is 13% [3]. The Ministry of Health is targeting a malaria-free Indonesia by 2030. A total of 5 regions have been set as elimination targets to achieve malaria-free. Achieving malaria elimination was carried out in stages [4].

The malaria-causing *Anopheles sp*. mosquito prefers to live in tropical and subtropical regions, such as Indonesia, which is a developing country. The reason why the malaria problem in Indonesia is still becoming worse is because there are still insufficient efforts being made to lower the prevalence of malaria, including the presence of hard-to-reach spots where Anopheles mosquitoes nest and the state of the home environment. [5].

The findings of a study conducted by Siregar [6] on malaria risk factors in coastal villages in the Pantai Kunci sub-district of the Serdang Bedagai district indicate a relationship between the incidence of malaria and the variable type of house wall. According to Setyaningrum's research [7, 8], the kind of house wall and wire mesh variable determine the probability of developing malaria. The distance between the home and the breeding site as well as the walls of the house have an impact on the occurrence of malaria, according to factors that affect its incidence.

North Sulawesi Province is ranked 10th in contributing to malaria cases in Indonesia according to 2018 basic health research. This is indicated by the large number of clinical and positive cases of malaria in several districts. The total number of positive malaria cases in 2020 was 358, in 2021 there were 336 cases and in 2022 there were 318 cases based on confirmation using microscopic and RDT methods, for API (annual paracite incident) in 2020 0.38%, API in 2021, last in 2022 down from the previous year's figure of 0.44% [9].

UPTD Tambelang Community Health Center, Southeast Minahasa Regency, which has 10 community health center working areas, was an endemic area for malaria in 2020 with a total of 97 malaria cases, in 2021 143 cases, in 2022 there were 40 cases and there were as many malaria cases from January to September 2023, 65 cases with tertian malaria (Plasmodium vivax) and Tropical Malaria (Plasmodium Falciparum) [10].

The increase in malaria cases in the UPTD Working Area of the Tambelang Community Health Center is thought to be related to the fact that there are still some people who live in wooden houses with walls that are not tight, the ventilation of the house is open and they do not use properly installed wire mesh so that mosquitoes can easily enter the house. Identification of risk factors that cause malaria transmission needs to be done in order to break the chain of transmission so that preventive and control measures can be implemented appropriately. The aim of this research is to analyze the risk factors of the home environment and larval habitat on the incidence of malaria in the UPTD (elements of technical implementation of the service) of the Tambelang Community Health Center, Southeast Minahasa Regency.

2. Material and Methods

Area of Study

The study site is in the South Touluaan District, Southeast Minahasa Regency, operating area of the UPTD Tambelang Community Health Center (Figure 1). The population of 4,880, comprising 2,537 men and 2,343 women, is concentrated within the 24,416 KM2 operating area of the Tambelang Health Center UPTD (elements of technical implementation of the service). The choice of location is the distance between people's houses and the breeding place which allows malaria transmission to occur as well as the larval habitat which consists of rice fields which are partly unmanaged, fish ponds/fish ponds, irrigation canals for rice fields, rivers, plantations and like this allows the area to expand further proliferation of malaria vectors or *Anopheles Sp* mosquitoes.

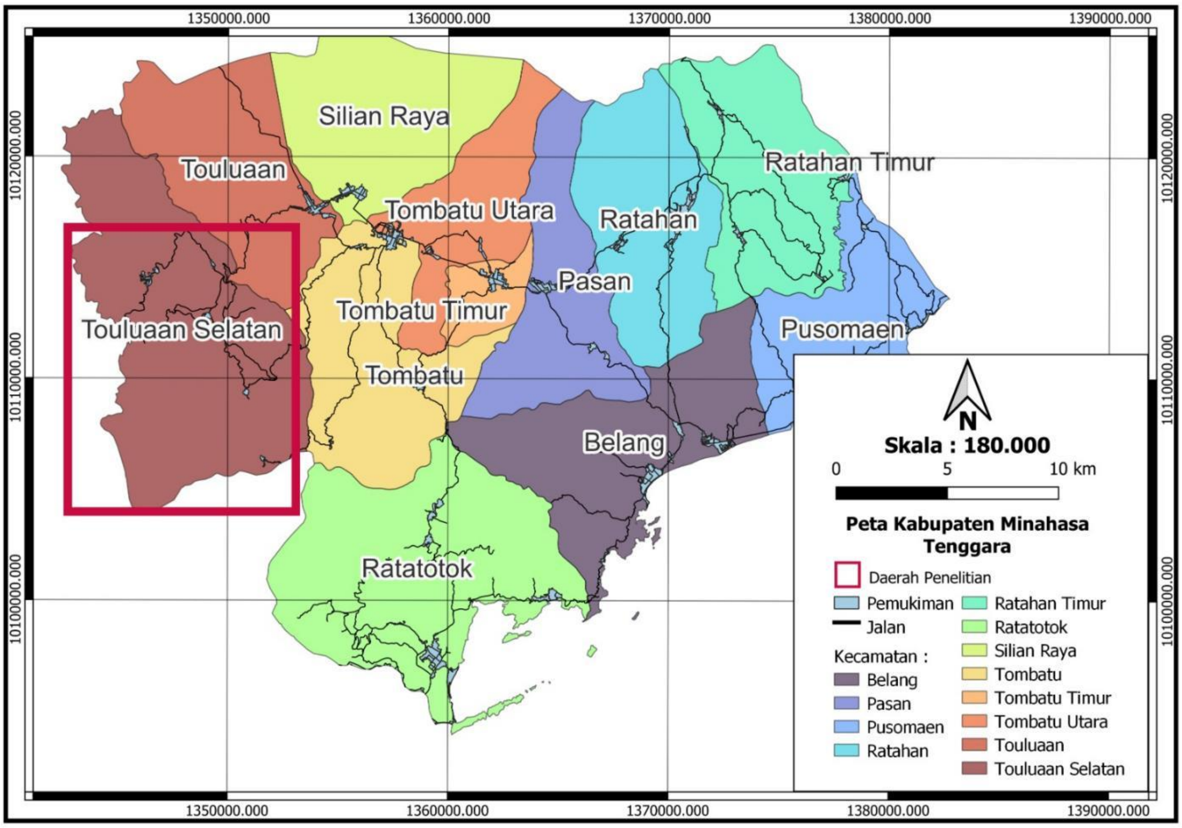

Figure 1. Research Location

Type of Research

By comparing exposure to the risk factor in the case group with the control group, this case-control study design of analytical observational research seeks to determine whether a particular risk factor actually influences the occurrence of the disease under study. The research data begins with the presence of cases, and the cause is sought retrospectively to assess the extent to which risk factors contribute to the occurrence of disease. [11].

Sample Collection

The UPTD Tambelang Community Health Center in the Southeast Minahasa region has 65 samples of malaria cases in its working area. A control group of 65 participants was chosen at a 1:2 ratio based on sharing the same gender and age as the cases. A total of 195 persons made up the sample.

Research Criteria Including

1. Willing to be a respondent in research
2. Permanently settle in Southeast Minahasa Regency's Tambelang Community Health Center's UPTD operational region.
3. The case group was recorded as positive for Malaria based on diagnosis.
4. The case group and the control group are identical in terms of age and gender.
5. Respondents who have ever suffered from malaria and are currently ill with malaria are included in the case group

Research of Instrument

The research instrument consists of; (1) Questionnaire as an interview guide to explore the information expected in accordance with the research objectives, (2) Direct observation, (3) Documentation tools: Photos and video recording of interviews (cellphone camera), (4) Writing tools to record survey results.

Research Ethics

This study was carried out with approval following ethical guidelines and a financial support number: [303/UN4.14.1/TP.01.02/2024].

Data Analysis

1. Univariate Analysis

In order to ascertain the proportion of each variable to be researched, descriptive analysis of patient characteristics is performed by presenting the frequency distribution of the variables studied and given in the form of tables and graphs.

2. Bivariate Analysis

Bivariate analysis determined the risk (Odd Ratio) of exposure to instances using a 2 x 2 table (Table 1), the independent and dependent variables were tested separately using the Chi – square statistical test.

Table 1. 2 x 2 Contingency For Odds Ratio

Risk Factors	Group Study		Amount
	Case	Control	
Positive	a	b	a + b
Negative	c	d	c + d
Amount	a + c	b + d	a + b + c + d

Information:

a = number of cases with positive risk (+)

b = number of controls with positive risk (+)

c = number of cases with negative risk (-)

d = number of controls with negative risk (-)

so,
Odds Ratio for case group = a/(a+c): c/(a+c) = a/c
Odds Ratio for control group = b/(b+d): d/(b+d) = b/d

Odds Ratio (OR) =a/c: b/d = ad/bc

Interpretation of the OR value,

a. If the OR value is > 1: The variable studied is a risk factor
b. If the OR value is < 1: The variable studied is not a risk factor
c. If the OR value = 1: The variable studied is a protective factor

3. Multivariate Analysis

To determine which variables had the greatest impact on the incidence of malaria, multivariate analysis was used. In order to perform a multivariate analysis, multiple independent variables were simultaneously connected to one dependent variable, which was then examined using a logistic regression test. The link between the independent and dependent variables can be explained using this approach. Bivariate analysis is the process used to run a logistic regression test between each independent variable. A multivariate model can be used to continue the variable if the bivariate test findings indicate a p value <0.05. [12].

3. Result

The data shown in Figure 2, indicates that 59 people (30.2%) did not go to school the remaining elementary and high school students were 47 people each (24.1%) and the rest varied to at least 1 person with a Diploma (1) (0.5%).

Figure 3 data shows that the majority of respondents did not work, namely 72 people (36.9%). The level of employment as a farmer is in second place, namely 41 (21.0%). People who work as farmers are generally heads of families who are in the plantations from morning to evening and there are at least 2 workers/coolies (1.0%).

From the data shown in Table 2, of the 195 respondents, 65 people were positive for malaria (33.3%) and 130 people were negative for malaria (66.7%). It is known that of the 195 respondents, 99 people (50.8%) had non-tight house walls and 96 people (49.2%) had tight house walls. It is known that of the 195 respondents who had open ventilation, 169 people (86.7%) had closed ventilation and 26 people (13.3%). It is known that of the 195 respondents who did not have wire mesh installed, 169 people (86.7%) had wire mesh installed, 26 people (13.3%). Out of the 195 respondents, 148 individuals (75.9%) had a distance of less than 500 meters between their house and the breeding area, and 47 individuals (24.1%) had a distance greater than 500 meters. It is known that, of 195 respondents, 178 respondents (91.3%) discovered no larvae and 17 respondents (8.7%) reported the highest density of larvae.

From the data shown in Table 3, it is known that 20 respondents (30.8%) who had tightly constructed wood home walls tested positive for malaria, compared to 45 respondents (69.2%) who had loosely constructed wood house walls. 54 respondents (45.5%) who had tightly constructed wooden walls in their homes tested negative for malaria, whereas 76 respondents (58.5%) who had tightly constructed walls in their homes tested negative for the disease. The odds ratio value OR = 3.167 and CI (95%) = (1.684-5.956) is obtained from the cross tabulation or chi square test findings for risk estimate calculations. This means that the OR value >1 suggests that the house wall variable is a risk factor for the occurrence of malaria.

From the data shown in Table 4, it is known that 4 respondents with closed ventilation tested positive for malaria (6.2%), compared to 61 respondents with open ventilation (93.8%). 108 respondents (83%) who had open ventilation tested negative for malaria, while just 22 respondents (17%) who had closed ventilation tested negative for malaria. The odds ratio value OR = 3.106 and CI (95%) = (1.023-9.432) is obtained from the cross tabulation or chi square test findings for risk estimate calculations. This means that the ventilation variable is a risk factor for malaria incidents if the OR value is greater than 1.

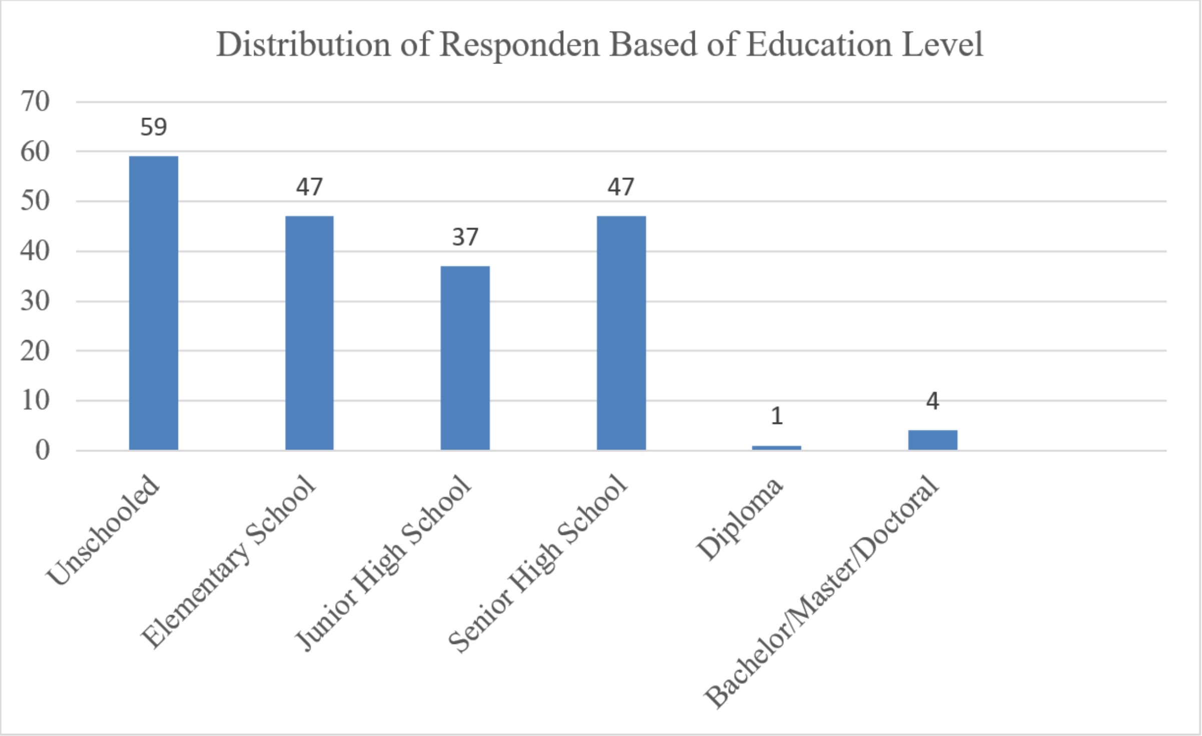

Figure 2. Distribution of Education Levels in the Tambelang Community Health Center Area

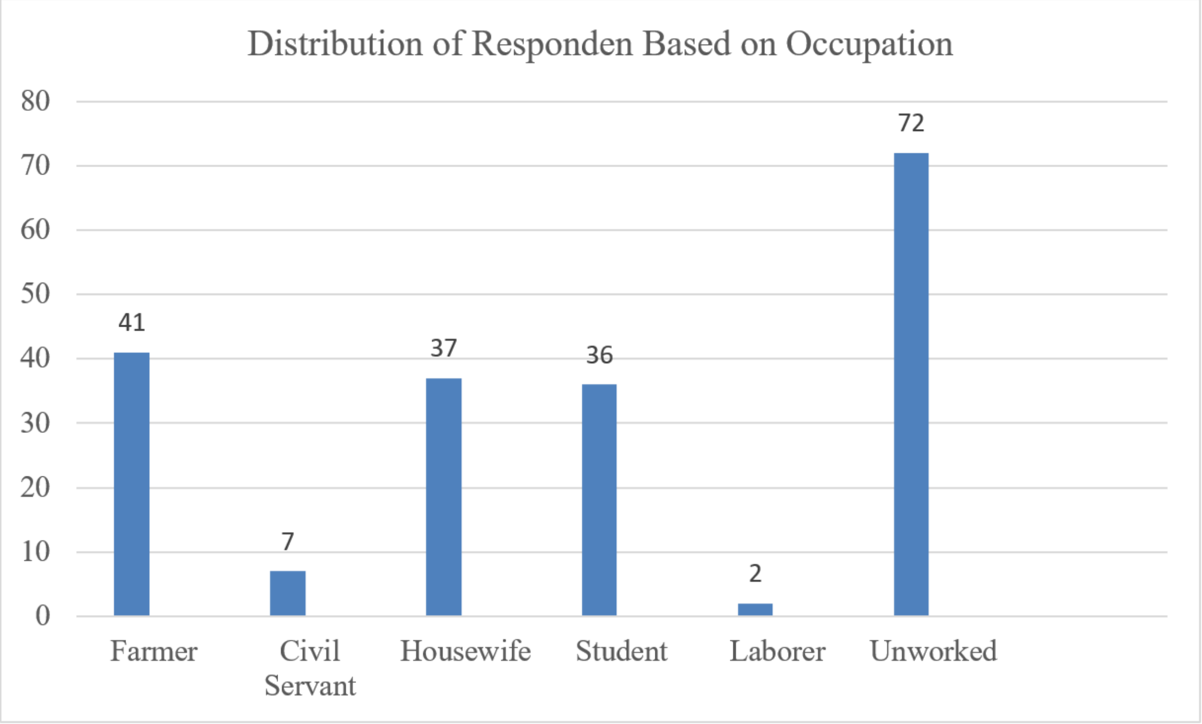

Figure 3. Distribution of Respondents Based on Occupation

Table 2. Characteristics of Respondents Based on Malaria Incidence, House Walls, Use of Wire Mesh, Ventilation, Distance from House to breeding place, Larva Density

No.	Variable Studied	Amount	
	Malaria Incidence	**N**	**%**
1.	Positive	65	33.3
	Negative	130	66.7
	Total	195	100
	House wall		
2.	Tight	96	49.2
	Non Tight	99	50.8
	Total	195	100
	Ventilation		
3.	Opened	26	13.3
	Closed	169	86.7
	Total	195	100
	Use of Gauze Wire		
4.	Installed	26	13.3
	Not Installed	169	86.7
	Total	195	100
	Distance from house to breeding place		
5.	Distance from house > 500 m	47	24.1
	Distance from house < 500 m	148	75.9
	Total	195	100
	Larvae Density		
6	Found	17	8.7
	Not Found	178	91.3
	Total	195	100

Source: Primary Data, 2024

Table 3. The Relationship Between Condition of House Walls with Malaria Incidence

House Walls	Malaria Incidence						OR (95% CI)
	Case		Control		Total		
	n	%	N	%	n	%	
Non Tight	45	69,2	54	41,5	99	50,8	3,167 (1,684-5,956)
Tight	20	30,8	76	58,5	96	49,2	
Total	65	100	130	100	195	100	

Source: Primary Data, 2024

Table 4. The Relationship Between Home Ventilation Conditions with Malaria Incidence

House Ventilation	Malaria Incidence						OR (95% CI)
	Case		Control		Total		
	n	%	n	%	n	%	
Open	61	93,8	108	83,0	169	50,8	3,106 (1,023-9,432)
Close	4	6,2	22	17,0	26	49,2	
Total	65	100	130	100	195	100	

Source: Primary Data, 2024

From the data shown in Table 5, it is known that 4 respondents (6.2%) who also had gauze wires placed tested positive for malaria, compared to 61 respondents (93.8%) who did not. 108 respondents (83%) who did not have gauze wires attached were negative for malaria, while up to 22 respondents (17%) who had gauze wires implanted were also negative for the disease. The odds ratio value OR = 3.106 and CI (95%) = (1.023-9.432) is obtained from the cross tabulation or chi square test findings for risk estimate calculations. This means that the OR value >1 shows that the wire gauze variable is a risk factor for the incidence of malaria.

From the data shown in Table 6, it is known that up to 28 respondents (43%) who lived less than 500 meters from the breeding site tested positive for malaria, but up to 37 respondents (57%) who lived more than 500 meters from the breeding site tested positive for malaria. Of the responses, 120 persons (92.3%) were negative for malaria if their distance from home to the breeding area was less than 500 m. Conversely, 10 people (7.7%) who had a distance greater than 500 m were also negative for malaria. The odds ratio values OR = 0.063 and CI (95%) = (0.028-0.142) from the cross tabulation or chi square test results for risk estimate calculations show that the distance between the house and the breeding place is not a risk factor for the incidence of malaria. This means that an OR value of less than one indicates this. One of the reasons mosquitoes are considered to be malaria carriers is the frequency of mosquito sucking, which is directly correlated with the distance between human habitation and the Anopheles mosquito breeding habitat.

The data shown in Table 7, 10 individuals (15.4%) have reported finding larval density around the home positive for malaria, whereas eighty-five individuals (84.6%) have reported finding no larval density around the house positive for malaria. There were 7 respondents (5.4%) whose density of larvae was confirmed to be negative for malaria, while 123 respondents (94.6%) did not have a density of larvae that was negative for malaria. The larval density variable is a risk factor for the incidence of malaria, as indicated by the odds ratio value OR = 3.195 and CI (95%) = (1.156-8.832), meaning the OR value >1 = 3.195, according to the results of the cross tabulation or chi square test of the risk estimate calculation.

Based on the information in Table 8, the results of logistic regression either separately or in combination revealed that the house wall variable had the greatest impact on the incidence of malaria, with an OR value = 2.932 and CI (95%) = (1.514-5.679). This means that respondents who had houses with loose walls were 2.9 times more likely to get malaria or test positive for the disease than those who had tight walls.

Table 5. The Relationship Between Use of Gauze Wire for Malaria Incidence

Use of Wire Gauze	Malaria Incidence						OR (95% CI)
	Case		Control		Total		
	n	%	n	%	n	%	
Installed	61	93,8	108	83,0	169	50,8	3.106 (1.023-9.432)
No Installed	4	6,2	22	17,0	26	49,2	
Total	65	100	130	100	195	100	

Source: Primary Data, 2024

Table 6. The Relationship Between Distance from Home to Breeding Place and Malaria Incidence

Distance from Home to Breeding Place	Malaria Incidence						OR (95% CI)
	Case		Control		Total		
	N	%	n	%	n	%	
Distance from house < 500 m	28	43,0	120	92,3	148	24,1	0,063 (0,028-0,142)
Distance from house > 500 m	37	57,0	10	7,7	47	75,9	
Total	65	100	130	100	195	100	

Source: Primary Data, 2024

Table 7. Relationship Between Larvae Density and Malaria Incidence

Larvae Density	Malaria Incidence						OR (95% CI)
	Case		Control		Total		
	n	%	n	%	n	%	
Found	10	15.4	7	5.4	17	8.7	3.195 (1.156-8.832)
Not Found	55	84.6	123	94,6	178	91.3	
Total	65	100	130	100	195	100	

Source: Primary Data, 2024

Table 8. Logistic Regression Results

Variable	B	Sig	Exp (B)	95%	
				Lower	Upper
House Wall	1,076	,001	2,932	1,514	5,679
Ventilation	1,439	,022	4,215	1,227	14,473
Use of Gauze Wire	1,313	,030	3,719	1,135	12,191
Distance from Home to Breeding Place	1,204	,038	3,332	1,069	10,382
Density of Larva	1,076	,001	2,932	1,514	5,679

Source: Primary Data, 2024

4. Discussion

The Relationship Between House Walls and Malaria Incidence

The odds ratio value OR = 3.167 and CI (95%) = (1.684-5.956) is obtained from the cross tabulation or chi square test findings for risk estimate calculations. This means that the OR value >1 suggests that the house wall variable is a risk factor for the occurrence of malaria. The density of house walls and the incidence of malaria had a relationship, where the OR value was 3.872; 95% CI = 1.183-12.676, meaning that respondents whose house walls are not tight have a 3,872 times greater risk of contracting malaria than respondents who have tight house walls. This finding was supported by prior research, which yielded a significance value of p=0.018, indicating the rejection of H0 and acceptance of the Ha value. The density of a house is influenced by the material used for its walls, with brick walls providing a tighter barrier compared to walls made of boards or plywood. The presence of gaps in such walls can serve as entry and exit points for Anopheles mosquitoes, facilitating contact between these insects and the inhabitants of the house [13]. House walls made of wood allow more holes for mosquitoes to enter [14]. Thus, if the walls of a house are made of wood, it can cause malaria. There are many houses made of wood. Thus, the incidence of malaria is influenced by house wall factors.

The Tambelang Community Health Center's (Secondary Minahasa Regency) UPTD (components of technical implementation of the service) Working Area's malaria incidence was shown to be correlated with house walls in this study. The researcher makes the assumption that most people who suffer from malaria have walls made of wood, planks, and plywood that are not tight. Because of this, it is likely that there are holes or gaps in the walls of this house, which could allow Anopheles mosquitoes to enter and bite the respondents, infecting them with malaria. This is influenced by the economic level of respondents who work as farmers, who of course cannot afford to build houses made of concrete, and also factors such as limited access and the village's distance from the city center, so it costs a lot of money to transport materials and building supplies.

This study supports that of Babba [15], who found that the incidence of malaria in the South Jayapura District Area of Jayapura City is correlated with the density of house walls (OR = 3.872). Similarly, studies conducted by Dora [16] reveal a relationship between the kind of house wall and the incidence of malaria, with a value (OR=1.157). The p value = 0.008 (p<0.005) is consistent with the findings of the chi square statistical test study. According to research by Dysoley [17], dwellings with wood walls have a 3.14 times higher chance of developing malaria than those with wood walls since wood is not a thick material.

This is also consistent with research by Dora [16], which found that the condition of respondents' homes' walls in Tenateke Village, both in the case group and the control, did not meet the requirements, and that there is a relationship between wall density and the incidence of malaria in Tenateke Village, the Tenatake Health Center's work area, where the value (P= 0.000). Anopheles mosquito reproduction may be facilitated by the materials used in the respondents' homes, which include woven bamboo, planks, reeds, and wood. Because of the walls constructed of woven bamboo, planks, thatch, and wood lack density, they have a lot of gaps, which can facilitate Anopheles mosquitoes' entry into the home. Malaria risk is increased by people's unsupportive clean living practices, such as not cleaning the home and wanting to hang dirty clothes everywhere.

The Relationship Between Home Ventilation and Malaria Incidence

The UPTD Working Area of the Tambelang Health Center, Southeast Minahasa Regency, showed a significant correlation between ventilation and the incidence of malaria, as indicated by the cross tabulation or chi square test findings, which showed a value of <0.05 (0.037). The risk estimate calculation yields the odds ratio value OR = 3.106 and CI (95%) = (1.023-9.432), indicating that a ventilation variable is a risk factor for malaria incidents if the OR value is greater than 1.

The Tambelang Community Health Center's (Secondary Minahasa Regency) UPTD (components of technical implementation of the service) Working Area's malaria incidence was shown to be correlated with home ventilation in this study. Based on field survey results, the researcher hypothesizes that the majority of malaria patients have open ventilation in their homes and do not employ wire mesh. Of course, having open ventilation within the house increases the likelihood that there will be gaps or crevices through which Anopheles mosquitoes may enter and bite, spreading malaria across the neighborhood. This is impacted by the general public's ignorance, which leads them to believe that open ventilation is normal as they are unaware of the Anopheles mosquito's entry points and the malaria transmission process. In addition, economic reasons come into play since they are unable to purchase wire mesh due to financial limitations.

This study agrees with that of Babba[15], who found a correlation between the incidence of malaria and the ventilation variable (OR= 0.087). The incidence of malaria and ventilation had a significant connection (p=0.016) [5]. As per Wahyuni's research [19], there was a significant correlation (P= 0.167) between house ventilation and the incidence of malaria in the PTFI lowland area.

A direct correlation between ventilation and malaria sickness is not usually established, despite the fact that adequate ventilation can help lower the risk of malaria transmission. As part of environmental management attempts to lower the number of Anopheles mosquitoes, the primary malaria vector, ventilation is typically taken into consideration. Temperature, air humidity, and indoor air circulation are a few environmental elements that can be influenced by good ventilation and the spread of malaria.

The Relationship Between the Use of Wire Gauze and the Incidence of Malaria

The UPTD Working Area of the Tambelang Community Health Center, Southeast Minahasa Regency, showed a strong correlation between the incidence of malaria and wire gauze, as indicated by the cross tabulation or chi square test findings, which showed a value of p < 0.05 (0.037). After performing the risk estimate calculation, the odds ratio value OR = 3.106 and CI (95%) = (1.023-9.432) are produced. This means that if the OR value is more than 1, it suggests that the wire gauze variable is associated with an increased risk of malaria incidence.

The incidence of malaria in the Tambelang Health Center's Southeast Minahasa Regency UPTD (elements of technical implementation of the service) Working Area was shown to be correlated with the use of wire mesh in this study. There will be significant gaps where the researcher believes the majority of respondents do not utilize wire mesh, which could allow Anopheles mosquitoes to enter the home and bite the respondents, giving rise to malaria. This is influenced by the general public's lack of awareness, since many believe that not utilizing wire mesh is usual and are unaware of the methods by which Anopheles mosquitoes transmit malaria. Apart from that, economic factors also play a role because of cost constraints so they cannot afford to buy wire mesh.

The use of wire mesh and the prevalence of malaria in Tenateke Village, the Community Health Center's working area (P=0.006) Tenateke, Southwest Sumba Regency, are related, according to research by Dalimunthe [18]. Because wire mesh was not used by most respondents both in the case and control groups the inside was left dark and mosquitoes were allowed to enter and reproduce. To keep mosquitoes out of the house, wire mesh is used in ventilation systems [19].

Similar findings are seen in Rahayu's research [20], which demonstrates a p-value of 0.004 <0.05 correlation between the incidence of malaria and the use of wire gauze. Similar findings were also reported in another study by Putri [21], which linked the prevalence of malaria to the use of wire gauze.

Malaria is significantly reduced by the use of wire gauze. By putting in wire mesh, you can lower the chance of malaria transmission by keeping mosquitoes out of your home. Aside from that, it is hoped that the wire mesh is intact and free of holes, reducing the amount of room mosquitoes have inside the home to bite and rest at night. On the other hand, others believe that wire mesh is difficult to install and not very useful. In addition, low socioeconomic status has an impact on the purchase of wire mesh for the home [22].

This study agrees with Babba's research [15], which found that mesh is present in home ventilation (OR = 5.182) and that variable wire mesh is useful for ventilation (OR = 0.087). The incidence of malaria and ventilation gauze had a strong correlation (p=0.016) [5]. Nadia's research [22] presents the findings from statistical analyses related to environmental quality. The results of testing for the presence of wire mesh revealed a p-value of 0.000, indicating a significant correlation between the incidence of malaria and the presence of wire mesh. The OR obtained is 15.074, indicating a 15.074-fold increase in the risk of malaria occurring in the respondent's home where wire mesh is present and meets requirements compared to respondents with the presence of wire mesh that meets the requirements.

The most significant variable, according to Ishak [23], is wire mesh. A p-value of 0.001 indicates that the risk of contracting malaria is 12.117 times higher in respondents' homes with non-compliant wire mesh conditions than in those with compliance. The findings of this investigation support those of the Afra study, which found a strong correlation (p = 0.011) between the incidence of malaria and the presence of wire mesh [24].

The Relationship Between Distance from Home to Breeding Place and Malaria Incidence

The odds ratio value OR = 0.063 and CI (95%) = (0.028-0.142) is obtained from the cross tabulation or chi square test results of the risk estimate calculation. This means that the OR value < 1 indicates that the distance between the house and the breeding place is not a risk factor for the incidence of malaria. Up to 28 individuals (43%), whose distance from home to the breeding site was less than 500 m, tested positive for malaria, whereas up to 37 individuals (57%), whose distance was greater than 500 m, tested positive for malaria. For respondents whose distance from home to the breeding place was < 500 m, 120 people were negative for malaria (92.3%) compared to respondents whose distance from home to the breeding place was > 500 m and were negative for malaria, 10 people (7.7%).

This is consistent with studies by Perdana [25], which revealed that rice fields, lakes, reservoirs, ditches, ponds, lagoons, rivers, and puddles are examples of favorable habitat types for larvae. There are areas designated as breeding grounds for Anopheles mosquitoes, where they deposit their eggs and give birth to larvae, pupae, and adult insects. Anopheles mosquitoes spawn and then fly toward human or livestock populations within a 50-meter radius in a single flight. Within a two to three km radius, mosquitoes fly the farthest [26]. The likelihood of catching malaria increases with the proximity of the residence to the Anopheles breeding region. Adult Anopheles mosquitoes, which spread the Plasmodium parasite through their saliva, are responsible for this.

In this study, malaria incidence in the Tambelang Community Health Center's UPTD Working Area, Southeast Minahasa Regency, is influenced by the distance between the residence and the breeding location. Assumedly, the majority of the malaria-affected homes in this region are situated at a distance of less than 500 meters from rice fields and marshes on the sides and rear of the homes. Of course, it's quite likely that mosquitoes will travel a distance to enter the house given the proximity to the breeding region to bite which will result in the occurrence of malaria in respondents, around the house of a malaria sufferer, such as in the front, back and side of the house, there are many puddles of water, such as swamps and pools of household waste water that are never landfilled or cleaned, so this place becomes a potential place for Anopheles mosquito larvae to breed into adults that will bite.

The distance between the breeding habitat of Anopheles mosquitoes and human habitation is closely related to the frequency of mosquito sucking, which is one of the factors that Anopheles mosquitoes are said to be malaria vectors. The intensity with which mosquitoes suck blood has a greater opportunity to transmit sporozoites in the salivary glands. This is what triggers the spread of malaria in an area due to the existence of potential habitat breeding of Anopheles mosquitoes around people's homes.

The findings of this study are consistent with those of Babba [15], who found that there are breeding sites (OR = 2.753) and that malaria is more common in the South Jayapura District Area of Jayapura City. Similarly, nesting location and malaria incidence have a substantial association (p=0.001), according to research [16]. The findings of the study on the waterlogging variable in the respondent's community using the chi square statistical test showed a p value = 0.001 (p < 0.005), indicating that the community's waterlogging factors have an impact on the incidence of malaria [27]. The study's findings indicate that there is a random pattern to the frequency of malaria in Lamboya District. The analysis of positive habitat buffering zones for larvae revealed that, although Anopheles mosquitoes can fly up to 2-3 km, the greater the risk, the closer the larvae's habitat is to the population's home. Within a radius of 500 m from the habitat, there were 25 cases, and within a radius of >500 m to 1000 m, there were 6 cases. malarial infection [28]. In addition, studies by Prawira [29] have shown that the physical attributes of a home's environment and the existence of a malaria vector's habitat close to malaria patients affect the disease's incidence.

Relationship Between Larvae Density and Malaria Incidence

The odds ratio value OR = 3.195 and CI (95%) = (1.156-8.832), which indicates that the OR value >1 = 3.195 implies that the larval density variable is a risk factor for the incidence of malaria, according to the results of the cross tabulation or chi square test for risk estimate computations. Anopheles mosquitoes breed in pools of fresh or brackish water that are constantly in contact with the ground, are not contaminated, and are not polluted. The existence of breeding places in the form of ditches that do not flow, swamps, ponds, excavated holes that collect rainwater. It will be an ideal place for mosquitoes to breed. The mosquito life cycle from egg to pupa phase requires water so that the existence of a breeding place is beneficial for Anopheles [30].

The density of Anopheles larvae found in several breeding habitats varies depending on where the eggs are placed. The selection of a place to lay eggs is carried out by adult female mosquitoes in places that have potential as breeding sites. Based on observations of the types of breeding habitat in Kemelak Village, it shows that abandoned fish ponds and swamps are the most potential types of breeding habitat for Anopheles larvae. Water spinach and grasses are examples of aquatic plants found in ponds and wetlands. Rice, water spinach, and grass are among the plants or vegetation that may be found in Kemelak Village, which serves as an Anopheles larvae breeding environment. Because vegetation offers hiding spots and food to help larvae survive, its presence can lead to an increase in the density of larvae.

In the Tambelang Community Health Center's UPTD Working Area in Southeast Minahasa Regency, the study found that larvae density affected the incidence of malaria. Researchers surmise that mosquito larvae may be found in puddles of water near the homes of malaria patients, including swamps, puddles of household water, and grassy areas. These areas are conducive to the development of Anopheles larvae because they provide mosquito larvae with grass and water spinach for hiding and shelter. Malaria could potentially be transmitted by mature mosquitoes that are present in the vicinity of the house. Additionally, a cattle pen that is quite close to people's homes is located behind and next to the house. Adult Anopheles mosquitoes may congregate in this cage because they can bite livestock like cows and buffalo.

According to Prawira's research findings [29], standing water was determined to be the most significant variable influencing the incidence of malaria. Other factors also had an impact on the incidence of malaria. According to Suriyani's research findings [28], standing water has been linked to an increased risk of malaria (OR=5.823).

Anopheles larvae had a high prevalence in aquatic areas during the rainy and dry seasons (p = 0.017), according to research by [30] Mathew. Larvae of Anopheles were discovered in 59.0% clean and 68.7% polluted water environments, respectively (p = 0.02). Positive Anopheles mosquito breeding sites were discovered in this study in rice fields, tire marks, ditches, containers, marshes, and brick holes. Remarkably, during the rainy and dry seasons, Anopheles larvae (mostly An. arabiensis) are also seen in septic tanks and pits (polluted water). This finding suggests that Anopheles mosquitoes are dispersing into contaminated areas.

The Distance Between The House And The Breeding Place Is The Variable That Has The Most Influence On The Incidence Of Malaria

The condition of the house walls is the variable that has the most influence on the incidence of malaria, according to the results of logistic regression that were obtained either simultaneously or jointly. Respondents who have house walls that are not tightly made of wood run the risk of contracting or testing positive for malaria nearly 2.9 times higher than those who do not. The house has tightly constructed walls.

The majority of the homes of malaria patients in this area are close to rice fields and swamps, which are located to the side and back of the homes at a distance of less than 50 meters. Naturally, the presence of this distance makes it very possible for mosquitoes to enter the home and bite the respondent, leading to the occurrence of malaria. Based on the researchers' assumptions, this distance is the most influential variable when compared to other variables. Around the house of a malaria sufferer, such as in the front, back and side of the house, there are lots of standing water, such as swamps and puddles, from household wastewater that is never landfilled or cleaned, so this place becomes a potential place for Anopheles mosquito larvae to breed into adults that will bite.

The wall material used in a house determines its density, if it is made of walls then the walls of the house will be tight, but walls of houses made of planks, plywood, have the possibility of gaps that can be a way for Anopheles to enter and exit the house, which allows contact to occur and to deliver mosquitoes to the residents of the house. Therefore, the physical condition of the house plays an important role in determining how often contact occurs between mosquitoes and humans. Compared to brick walls, bamboo and wood construction for home walls increases the danger of malaria transmission.

5. Conclusions

a. In Southeast Minahasa Regency, larval density is a risk factor for malaria incidence in the Tambelang Community Health Center’s UPTD.
b. In the UPTD of the Tambelang Community Health Center, Southeast Minahasa Regency, the state of the walls of the home is a risk factor for the incidence of malaria.
c. In the Southeast Minahasa Regency’s UPTD of the Tambelang Community Health Center, ventilation is a risk factor for the incidence of malaria.
d. In the Southeast Minahasa Regency's UPTD of the Tambelang Community Health Center, the use of wire gauze is a risk factor for malaria incidence.
e. In the UPTD of the Tambelang Community Health Center, Southeast Minahasa Regency, the distance between the home and the breeding site does not appear to be a risk factor for the prevalence of malaria.
f. The most important factor is the state of the house's walls. It is 2.9 times the likelihood of malaria incidence in Southeast Minahasa Regency's Tambelang Health Center's UPTD operational area.

6. Suggestions

Increasing outreach activities regarding the prevention of malaria on an ongoing basis in order to increase community participation in managing the health of themselves, their families and the environment which is carried out cross-programme, cross-sectorally and supported by sub-district and village governments, especially for people at risk of contracting malaria and who have been infected with malaria.

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Conflict of Interest

The authors affirm that there is no conflict of interest with the manuscript's publication. The writers also noted several ethical concerns, including as redundancy, double publication and/or submission, misconduct, informed consent, plagiarism, and data fabrication and/or falsification.

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