



The Dominant Factors of Physical Environmental Conditions That Affect The Incidence of Malaria (Study in The Village of Tuafanu, South-Central Timor, East Nusa Tenggara)

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ABSTRACT

Malaria is an infectious disease caused by *Plasmodium sp* parasites that grow and multiply in human erythrocytes. The incidence of malaria consists of three epidemiological components: agent, host and environmental factors. Risk factors that contribute greatly to the occurrence of malaria are the environmental conditions where humans and mosquitoes live. This research aims to analyze the dominant factors of physical environmental conditions that influence the incidence of malaria in Tuafanu Village, South Central Timor, NTT. The research was conducted with an analytic observational approach with a Case-Control Study approach. The number of samples was 60 samples with a ratio of 1:1, namely 30 cases and 30 controls taken based on purposive sampling technique. Data were collected using secondary data from BBTCLPP Surabaya in 2023. Statistical analysis used chi square test and logistic regression test. There was a significant relationship between house floor, house wall, ceiling and puddle around the house with malaria incidence in Tuafanu Village because the P-value <0.05. In all households, there was no wire mesh in the ventilation of the house. Based on the analysis of the dominant factor of physical environmental conditions that affect malaria in Tuafanu Village is puddles with a p-value of 0.012 and an OR of 0.091, which means that individuals who live in the area around their house there are puddles or stagnant water are 0.091 higher risk of malaria. The OR value < 1 indicates that puddles act as a protective factor against malaria, therefore it is necessary to clean and manage the environment to prevent the presence of water that can become a breeding place for mosquitoes and prevent malaria transmission.

Keywords: Malaria, Physical Environment, House Floor, House Wall, Ceiling, Wire Mesh, Puddles

ABSTRAK

Malaria merupakan sebuah penyakit infeksi oleh parasit *Plasmodium sp* yang tumbuh dan berkembangbiak di dalam eritrosit manusia. Faktor kejadian penyakit malaria terdiri dari tiga komponen epidemiologi yaitu agent, host dan faktor lingkungan. Faktor risiko yang berkontribusi besar pada terjadinya malaria adalah keadaan lingkungan tempat tinggal manusia dan nyamuk. Penelitian ini bertujuan untuk menganalisis faktor-faktor dominan kondisi lingkungan fisik yang mempengaruhi kejadian malaria di Desa Tuafanu, Timor Tengah Selatan, NTT. Penelitian yang dilakukan bersifat observasional analitik dengan pendekatan Studi Kasus-Kontrol (*Case Control*). Jumlah sampel sebanyak 60 sampel dengan perbandingan 1:1 yaitu 30 kasus dan 30 kontrol diambil berdasarkan teknik *purposive sampling*. Pengambilan data menggunakan data sekunder BBTCLPP Surabaya Tahun 2023. Analisis statistik menggunakan uji *chi square* dan uji *regresi logistic*. Terdapat hubungan signifikan antara lantai rumah, dinding rumah, keberadaan plafon dan genangan air di sekitar rumah dengan kejadian malaria di Desa Tuafanu karena *p-value* <0,05. Selain itu, pada seluruh KK tidak ditemukan keberadaan kawat kasa pada ventilasi rumah. Berdasarkan analisis faktor dominan kondisi lingkungan fisik yang berpengaruh pada penyakit malaria di Desa Tuafanu adalah genangan air dengan *p-value* senilai 0,012 dan OR sebesar 0,091 yang berarti individu yang tinggal di wilayah sekitaran rumahnya terdapat genangan air atau air yang menggenang 0,091 lebih besar berpeluang terkena malaria. Nilai OR < 1 menunjukkan genangan air berperan sebagai faktor protektif terhadap malaria, oleh karena itu perlu membersihkan dan mengelola lingkungan untuk mencegah adanya air yang dapat menjadi tempat perkembangbiakan nyamuk dan mencegah tertular malaria..

Kata Kunci: Malaria, Kondisi Lingkungan Fisik, Lantai Rumah, Dinding Rumah, Plafon, Kawat Kasa, Genangan Air

INTRODUCTION

Malaria is a common global health problem, especially in developing countries such as Indonesia. The number of positive cases of malaria in Indonesia in 2022 is 443,530 cases with the highest number in Papua Province, namely 393,801 cases (89%), NTT province was 15,812 cases and West Papua 13,080 cases, (Kementerian Kesehatan Republik Indonesia, 2022). The incidence of malaria can be seen by calculating the Annual Parasite Index (API) index, which is the ratio between the number of malaria positives and the number of people at risk in an area with a constant number of 1,000. The API in Indonesia is high, in 2022 was above 1, namely 1.6 per 1000 population, (Kementerian Kesehatan Republik Indonesia, 2022). The province with the highest API in Indonesia in 2022 is Papua, followed by West Papua and East Nusa Tenggara. Papua made a major contribution to the national API of 113.07 per 1000 population. The second rank is West Papua Province at 12.68 per 1000 population and the third rank is NTT with an API of 2.79 per 1000 population, the API value exceeds 1 per 1000 people (Kementerian Kesehatan Republik Indonesia, 2022).

The high API indicates that there are still many malaria endemic districts. One of them is South Central Timor District with the number of cases in 2022, namely 696 cases, and is the top 5 districts with the highest cases in NTT (Badan Pusat Statistik Provinsi NTT, 2022). One of the sub-districts with many indigenous cases in TTS Regency is Kualin Sub-district, which is 180 cases in 2022 with a population of 23,342 people, so that the API is known to have been 7.71. This shows that Kualin sub-district is a high endemic area because the API exceeds 5. The highest case in Kualin sub-district in 2022 was in Tuafanu village with 56 cases (31.1%) with a population of 3,395 people and an API of 16.49. This shows that the API in Tuafanu Village is very high, exceeding 1 per 1000 population. Malaria cases in Tuafanu Village in 2023 from January to July were 49 cases with an API of 14.43.

Malaria disease occurrence factors are composed of 3 epidemiological components, namely agent, host, and environmental factors that can affect human life and malaria vector mosquitoes (Permenkes No. 22 of 2022). A risk factor that contributes greatly to the occurrence of malaria is the state of the environment where humans and mosquitoes live. Specific environments can support mosquito breeding places more quickly (Setyaningrum, 2020). Literature Review by Lewinsca, Raharjo and Nurjazuli, (2021) in the 2016-2020 period shows that environmental conditions, habits or behavior, level of knowledge, attitudes, prevention efforts, social and economic factors, and demographics have a relation with the occurrence of malaria. This is strengthened by the Literature Review by Fitriani, Raharjo and Martini, (2022) that things related to malaria are the habits of people who live in endemic areas, the habit of people wearing mosquito nets, there are activities outdoors at night, using mosquito repellent, and wearing long and closed clothes.

The environment greatly influences the incidence of malaria in a region. Each region has different risk factors and variables that have a significant influence on the incidence of malaria. A study mentioned that in the Krueng Sabee Health Center Working Area, malaria is influenced by individual occupations, the habit of people going out at night, using insecticides, using mosquito nets, and individual knowledge. Meanwhile, a person's gender and the use of wire mesh have no effect on malaria (Setiawan, Hamisah and Fahdhienie, 2021). Research in the South Jayapura District, Jayapura City found that the determinants that have a significant relationship with the incidence of malaria are the physical environment including the density of the walls of the house, house ventilation with wire mesh, house ceiling, mosquito breeding place, mosquito resting place, and behavioral variables, namely action (Madayanti, Raharjo and Purwanto, 2022).

Research by Kemismar, (2022) in Manggarai Regency states that factors that have a relationship with the incidence of malaria are population mobility in the region, gender and the presence of mosquito breeding places such as lagoons, rice fields, and puddles contribute to transmitting malaria. Hamdani, Kartini and Mira, (2020) stated that in the Wandai Health Center Wilker, several things related to malaria are the presence of mosquito breeding places around the house, sleeping using mosquito nets and the habits of people doing activities outdoors at night, while the livestock cages are not related to the incidence of malaria. Based on these

differences, this study aims to determine the dominant factors of physical environmental conditions that affect malaria incidence in Tuafanu Village, South Central Timor, NTT.

RESEARCH METHODS

This study was an analytical observational study with a Case Control Study approach. Case control study was an epidemiological science regarding the relationship between exposure / risk factors and the disease being studied, which was carried out by comparing case groups and control groups based on their exposure status (Sugiyono in Yani, 2019). The research sample was 60 samples consisting of 30 case samples and 30 control samples which were determined using purposive sampling technique, namely the research sample was selected specifically referring to the research objectives (Hardani et al., 2020). Inclusion criteria were living at least 1 year in Tuafanu Village, family representatives who were over 18 years old or married, for the case group having a family with a history of malaria. Exclusion criteria were families who have moved or who have only lived for at less than one year. The research data used secondary data from BBTCLPP Surabaya, namely the results of the Basic Survey of Ownership and Use of Insecticide Treated Nets and Community Knowledge, Attitudes and Behavior in Malaria Prevention and Control Efforts, including all physical environmental factors and malaria disease data. The research location was Tuafanu Village, South Central Timor District, East Nusa Tenggara. The research was conducted from September 2023 to April 2024. Data were analyzed using the chi square statistical test to determine the relationship between the independent and dependent variables, and the logistic regression statistical test to determine the most dominant risk factor using the SPSS 27.01 application.

RESULTS

Table 1. The characteristics of household members in Tuafanu Village

Household members characteristics	Cases		Control		Total	
	N	%	N	%	N	%
Gender						
Male	11	36,7	9	30	20	33,3
Female	19	63,3	21	70	40	66,7
Total	30	100	30	100	60	100
Occupation						
Housewife	14	46,7	19	63,3	33	55
Farmer	10	33,3	4	13,3	14	23,3
Student	2	6,7	2	6,7	4	6,7
Retired	1	3,3	1	3,3	2	3,3
Nurse	1	3,3	1	3,3	2	3,3
Driver	1	3,3	2	6,7	3	5,0
Unrecorded	1	3,3	1	3,3	2	3,3
Total	30	100	30	100	60	100
Education						
No School	2	6,7	1	3,3	3	5,0
Elementary School	9	30,0	7	23,3	16	26,7
Junior High School	11	36,7	7	23,3	18	30,0
Senior High School	5	16,7	13	43,3	18	30,0
Diploma	1	3,3	0	0,0	1	1,7
Bachelor	2	6,7	2	6,7	4	6,7
Total	30	100	30	100	60	100

Based on the table 1, it is known that most of the household members or family member who represents the household in this study were women, 63.3% in the case group and 70% in the control group. Most of the household members were housewives, 46.7% in the case group

and 63.3% in the control group. The majority of households in the case group were junior high school graduates (36.7%), while the majority of households in the control group were senior high school graduates (43.3%).

Table 2. Household behavior in malaria prevention efforts

Behaviors	Cases		Control		Total	
	N	%	N	%	N	%
Good	6	20	12	40	18	30
Not Good	24	80	18	60	42	70
Total	30	100	30	100	60	100

Based on the table 2, it is known that households that have good behavior in conducting malaria prevention efforts are mostly in the control group, 40%, compared to the case group, 20%. Poor behavior is mostly in the case group, which is 80%, compared to the control group, which is about 60%.

Table 3. Survey Results of Environmental Sanitation Facilities in Tuafanu Village

Environmental Sanitation Facilities	Cases		Control		Total	
	N	%	N	%	N	%
Waste Disposal Facilities						
Eligible	3	10	5	16,7	8	13,3
Not eligible	27	90	25	83,3	52	86,7
Total	30	100	30	100	60	100
Liquid Waste Disposal Facilities (Household Liquid Waste)						
Eligible	2	6,7	3	10	5	8,3
Not eligible	28	93,3	27	90	55	91,7
Total	30	100	30	100	60	100

Based on the table 3, it is known that the eligible waste disposal facilities in Tuafanu Village were mostly in the control group at 16.7% compared to the case group at 10%. Then, the ineligible waste disposal facilities were mostly in the case group, which amounted to 90% compared to the control group of 83.3%. Overall, the waste disposal facilities in Tuafanu Village were mostly ineligible at 86.7%.

The eligible liquid waste disposal facilities in Tuafanu Village were mostly in the control group at 10% compared to the case group at 6.7%. The ineligible liquid waste disposal facilities were mostly in the case group at 93.3% compared to the control group at 90%. Overall, liquid waste disposal facilities in Tuafanu Village were mostly ineligible at 91.7%.

Table 4. Relationship between Physical Environmental Conditions and Malaria Incidence in Tuafanu Village

Padarand Village									
Physical Environmental Conditions	Cases		Control		Total		p-value	OR	95%CI
	N	%	N	%	N	%			
Floor type									
Soil and Sand	12	40	4	13,3	16	26,7	0,041	4,333	1,203-15,605
Cement/ceramic/other	18	60	26	86,7	44	73,3			
Total	30	100	30	100	60	100			
Wall Type									
Cement/Permanent	10	33,3	19	63,3	29	48,3	0,039	3,455	1,195-9,990
Duck/Wood/Semipermanent	20	66,7	11	36,7	31	51,7			
Total	30	100	30	100	60	100			

Physical Environmental Conditions	Cases		Control		Total		<i>p-value</i>	OR	95%CI
	N	%	N	%	N	%			
House ceiling									
Available	0	0	6	20	6	10	0,031	2,250	1,670-3,032
No	30	100	24	80	54	90			
Total	30	100	30	100	60	100			
Puddles									
Available	13	43,3	3	10	16	26,7	0,009	6,882	1,707-27,752
No	17	56,7	27	90	44	73,3			
Quantity	30	100	30	100	60	100			

Based on the table 4, the results of the analysis show that the soil and sand house floors mostly cause malaria (40%) compared to not affected by malaria (13.3%), while cement/ceramic/other floors mostly do not cause malaria (86.7%) compared to affected by malaria (60%). The analysis showed that there is a significant relationship between the house floor and malaria incidence in Tuafanu Village because the p -value < 0.05 , which was 0.041. Odds ratio (OR) is 4.333, meaning that houses with soil and sand floors have a 4.333 times higher chance of malaria incidence (95%CI: 1.054-2.719) compared to houses with cement/ceramic floors.

Cement/permanent wall types mostly did not cause malaria incidence (63.3%) compared to those affected by malaria (33.3%). While the type of wall bebek / wood / semipermanent mostly causes malaria (66.7%) compared to those not affected by malaria (36.7%). The results of the analysis showed a p -value of $0.039 < 0.05$, meaning that there is a significant relationship between the type of house wall and the incidence of malaria in Tuafanu Village. Odds ratio (OR) of 3.455 means that the type of bebek/wood/semipermanent wall has a 3.455 times higher risk of developing malaria with the results (95%CI: 1.195-9.990) compared to cement/permanent walls.

The presence of a ceiling in the house can cause less malaria (0.%) than those who do not have malaria, which is 20%. Meanwhile, the no ceiling causes malaria by 100% and not malaria by 80%. The results of the analysis showed a p -value of $0.031 < 0.05$, meaning that there is a significant relationship between the presence of a ceiling and the incidence of malaria in Tuafanu Village. Odds ratio (OR) of 2.250 means that the no ceiling in the house has a chance of 2.250 times the risk of being infected with malaria with the results (95%CI: 1.670-3.032) compared to the presence of a ceiling in the house.

The presence of puddles around the house area with the incidence of malaria shows that the presence of puddles mostly causes malaria (43.%) compared to those who are not affected by malaria (10%). Then houses that do not have puddles around them mostly do not cause malaria (90%) compared to those affected by malaria (56.7%). Statistical tests showed a p -value of $0.009 < 0.05$, which means there is a significant relationship between the presence of puddles and the incidence of malaria in Tuafanu Village. Odds ratio (OR) of 6.882 means that the presence of puddles has a 6.882 times chance of being affected by malaria (95%CI: 1.707-27.752) compared to the absence of puddles around the house.

Multivariate analysis is intended to see the relationship between several independent variables and one or more dependent variables (more generally one variable), (Fauziyah, 2020). This analysis was carried out with a logistic regression test to analyze the causal relationship between several independent variables with 1 dependent variable on a nominal scale (Aini and Inayah, 2020).

Table 5. Multivariate Analysis Modeling

Independent Variable	Sig	Exp(B)	95%(CI)	Description
House Floor	0,041	0,091	0,009-0,912	Significant
House Wall	0,022	0,191	0,046-0,788	Significant
Ceiling	0,999	0,000	0,000-0,000	Not significant
Puddles	0,012	0,091	0,014-0585	Significant
Constant	0,001	143,432		

Based on the table 5, it is obtained that the results of the logistic regression test analysis of 4 independent variables related to the incidence of malaria, the variable of the presence of puddles around the house is the most dominant variable on the incidence of malaria with a significance value of 0.012, meaning that if there are puddles around the house, it will be more at risk of being infected with malaria, on the other hand, if there are no puddles around the house, it will reduce the risk of malaria. The OR value of 0.091 means that the presence of puddles has a 0.091 times chance of causing malaria. The OR value is <1 which means that puddles act as a protective factor of malaria, therefore it is necessary to clean and manage the environment to prevent the presence of water that can become a breeding place for mosquitoes and prevent malaria.

DISCUSSION

Relationship between House Flooring and Malaria Incidence in Tuafanu Village. Based on the results of the analysis of house floors in households in Tuafanu Village, the p-value is $0.041 < 0.05$, which means that there is a significant relationship between the type of house floor and the incidence of malaria in Tuafanu Village. The OR value of 4.333 means that houses made of soil and sand have a 4.333 times higher chance of malaria incidence (95%CI: 1.054-2.719) compared to houses with cement or ceramic floors. Most of the HHs' floors were made of cement, both coarse and fine cement. This makes it easier to clean and keeps the room from humidity. There are some houses that have been ceramicized, but there are still houses with soil and sand floors, especially in the case group or households that have family members who have had malaria, at 40%.

Floors consisting of soil can cause the room to become humid and have a dark color, which is favored by mosquitoes as a resting place. A soil floor house in a part with water-using activities can cause puddles of water, potentially becoming a breeding place for mosquitoes. This statement is supported by a study which states that the condition of the soil floor can cause increased humidity in the house and is favored by mosquitoes (Matdoan, Otok and Atok, 2020). A good house floor is waterproof, flat and smooth but not slippery, no cracks, and does not absorb dust, floors in contact with water must be sloping so that they are easy to clean and there is no puddle, clean and light in color, (Kementerian Kesehatan Republik Indonesia, 2023). The condition of livable houses greatly affects the incidence of malaria, every 1% increase in the percentage of livable houses can reduce the malaria API by 0.39 per 1000 population (Matdoan, Otok and Atok, 2020). Houses that are not in good condition and do not meet the requirements such as houses on stilts have wooden or plank floors with poor moisture can serve as resting places and have gaps for mosquitoes to easily enter. This situation can risk being bitten by mosquitoes and getting Malaria compared to living in a house that meets the requirements (Fitri Lestari, Hasyim and Novrikasari, 2022).

Relationship between House Walls and Malaria Incidence in Tuafanu Village. Referring to the results of the analysis of the relationship between the type of wall and the incidence of malaria shows a p-value of $0.039 < 0.05$, which means that there is a significant relationship between the type of wall of the house and the incidence of malaria. Odds ratio (OR) of 3.455 means that semi-permanent wall types have a 3.455 times higher risk of malaria infection (95%CI: 1.195-9.990) compared to permanent walls. The majority of households with a family member who has ever had malaria in Tuafanu village have houses with semi-permanent walls such as bebak, wood, or partly wood and cement. The semi permanent walls allow holes or gaps in the walls that can cause mosquitoes to easily enter the house.

According to Billal, Sary and Perdana, (2022) semipermanent wall houses such as wooden walls can have small holes between the walls. This can allow mosquitoes to enter the house and bite humans that can cause malaria. This is supported by Masriadi, (2017) who states that houses that have wooden walls, will allow holes or gaps for mosquitoes to enter the house.

According to Utami, et al., (2022), one of the physical environmental factors that affect malaria is the density of the walls of the house. This is supported by Lewinsca, Raharjo and Nurjazuli, (2021) who state that inadequate wall conditions can affect the incidence of malaria.

Good walls are strong, waterproof, flat, not easy to absorb dust, easy to clean, light colored, bright and clean (Kementerian Kesehatan Republik Indonesia, 2023). According to Isworo, Hadi and Setiyani, (2023) in their research, the environmental risk that is closely related to the occurrence of malaria in Kulon Progo Regency is the walls of the house. The walls of the house are leaky and not waterproof, allowing places that support the breeding of mosquitoes that cause malaria, on the other hand, strong and waterproof walls can contribute well in the prevention of malaria.

Relationship between Ceiling and Malaria Incidence in Tuafanu Village. The results of the analysis of the relationship between the ceiling of the house and the incidence of malaria obtained a p-value of $0.031 < 0.05$, which means that there is a significant relationship between the ceiling and the incidence of malaria in Tuafanu Village. Odds ratio (OR) of 2.250 means that the absence of a ceiling in the house has a chance of 2.250 times more risk of being infected with malaria (95%CI: 1.670-3.032) compared to the presence of a ceiling. The analysis is in line with the statement of Madayanti, Raharjo and Purwanto, (2022) which states that in the South Jayapura District of Jayapura City there is a close relationship between the presence of a ceiling and the incidence of malaria, a house without a ceiling is 3,250 times more at risk of being infected with malaria than a house with a ceiling. The ceiling can prevent *Anopheles* mosquitoes from entering the house.

The ceiling can be a barrier that prevents mosquitoes from entering the house from the top of the house. The existence of a ceiling causes mosquitoes to be unable to enter from the gap between the roof of the house and the top wall. In accordance with Lestari's research, (2023) which states that a house without a ceiling is installed, indicating that there is a hole or gap at the border of the wall and roof of the house which makes it easier for mosquitoes to enter freely and suck human blood. Good ceiling conditions are strong, clean, easy to clean, not easy to absorb dust, flat and ideal height for air entry and exit. According to Hidayati et al. (2023) houses that do not meet the requirements such as no ceiling or only partially installed are at risk of malaria because mosquitoes can still enter and bite humans.

Relationship between Ventilation on Wire Mesh and Malaria Incidence in Tuafanu Village. According to the survey data, there were no households with wire mesh ventilation in Tuafanu village, in all households that were respondents. There are several houses that do not have windows. Ventilation is installed with wire that is not tight or with wood nailed sparsely, then covered with curtains, this condition makes it easy for mosquitoes to enter the house and transmit malaria. Puskesmas Kualin has conducted counseling related to malaria prevention in Tuafanu Village such as the use of mosquito nets, the use of anti-mosquito lotion, and at the same time delivering prevention by using wire mesh. The counseling focused on prevention by using mosquito nets and distributing insecticide-treated nets to the community.

The use of wire mesh has not yet been counseled on the importance of wire mesh use in malaria prevention and the eligible forms of wire mesh that are effective in preventing mosquitoes from entering the house and preventing malaria. Community education and behavior also have an important contribution to malaria prevention.

Education in Tuafanu Village is mostly junior and senior high school 30% and elementary school as much as 26%. Community behavior in prevention and control of malaria is mostly not good at 70%. This shows that the behavior of the community in Tuafanu Village in making malaria prevention efforts is still not well done, one of which can be seen from the absence of wire mesh in the ventilation of houses in all research households. Adding wire mesh to ventilation is a manifestation of attitude towards malaria prevention. According to Masriadi, (2017) wire mesh in ventilation such as windows or vents can reduce the risk of human contact with *Anopheles* mosquitoes with humans, thus prevent malaria transmission.

Community attitudes are very important in the prevention and control of malaria. According to Wahyuni and Wulandari, (2023) in their research argue that there is a close relationship between a person's knowledge, attitudes and actions taken in an effort to prevent malaria in pregnant women in Kurik Village, Merauke. According to Zulaikhah et al., (2020) community

attitudes and community behavior related to the occurrence of malaria are concerned and active in the prevention of malaria, especially in behavior, one of which is wearing wire mesh installed on the house ventilation in an effort to reduce the number of *Anopheles* sp mosquitoes that can enter and infect the inhabitants.

Relationship between Puddles and Malaria Incidence in Tuafanu Village. Based on the survey data obtained, the results of the analysis of the relationship between the presence of puddles around the house and the incidence of malaria showed a p-value of $0.009 < 0.05$, which means that there is a significant relationship between the presence of puddles and malaria in Tuafanu Village. The OR value of 6.882 means that the presence of puddles is 6.882 times more risk to be infected with malaria (95%CI: 1.707-27.752) than without puddles around the house. According to Kemismar, Manurung and Weraman, (2022) in their research, the breeding places that are positive for mosquito larvae are rice fields, stagnant water, puddles, springs, estuaries and rivers. Locations where *Anopheles* mosquitoes can live and develop include stagnant water, either fresh water or brackish water according to the mosquito species, not polluted by anything harmful and must be in direct contact with the ground.

According to Arief, Arif and Erlani, (2020) in their literature study, puddles have a close relationship with the occurrence of malaria. Stagnant water is a bionomic or breeding place that may be one of the risk factors contribute to malaria infection. This is because the *Anopheles* sp mosquito that causes malaria likes puddles to be a place to lay eggs and develop mosquito larvae, especially brackish water. Based on the survey results, there is a lot of stagnant water around the houses of households in Tuafanu Village. The number of puddles will increase during the rainy season and it is difficult to dry out, so it stagnates for a long time and has the potential to become a breeding place for mosquitoes. This is supported by the topography of Tuafanu Village, which is a coastal and lowland area, puddles are difficult to shrink if there is no water drainage and provision of good sanitation facilities.

Tuafanu Village has inadequate sanitation facilities such as the majority of people do not have household liquid waste disposal systems or drainage systems that can help drain water around the house, so that water becomes stagnant and has the potential to become a breeding place for mosquitoes. Research by Desimal et al., (2023) said there was a close relationship between the presence of sewage or sewers and malaria infection in malaria-prone areas in Sekotong District, West Lombok. Based on the survey data, most of the households in Tuafanu Village did not have liquid waste disposal facilities (households) or had inadequate liquid waste disposal facilities, which amounted to 91.7%. Inadequate waste disposal facilities can result in stagnant water that has the potential to become a breeding place for mosquitoes due to stagnant household liquid waste around the house.

In the absence of sewerage or trenches, when it rains, rainwater will pool around the house and in the roadside area. Large amounts of stagnant water cannot dry out quickly, forming puddles that can become breeding grounds for mosquitoes. The topography of Tuafanu Village is in a coastal area which is low-lying, so there are many puddles, swamps or lagoons. Waste disposal also contributes to stagnant water around houses in Tuafanu Village. The survey results showed that in the case group, 90% of household waste disposal did not qualify and 83.3% did not qualify in the control group, or 86.7% overall. Waste disposal in Tuafanu Village is mostly done by digging garbage pits, collecting garbage at a certain corner, or using open bins, then burning them. This shows that waste disposal does not qualify and risks the incidence of malaria because digging holes or uncovered bins can cause puddles of water and become a breeding place for mosquitoes.

Other puddles have the potential to become breeding places, namely livestock puddles, puddles formed from livestock footprints and vehicle tracks because there are many soil roads. This statement is in line with the opinion of Billal, Sary and Perdana, (2022) which states that puddles are often found around the house and are at risk of becoming mosquito breeding places, namely holes used for animal footing, excavated soil, puddles near livestock drives, and even puddles caused by passing vehicles. Literature research shows that the dominant risk factor that contributes to supporting malaria in Indonesia is the presence of breeding places such as

puddles, individuals who live around breeding places are 5.077 times more at risk of being infected with malaria than individuals who live far from breeding places. The nearer the puddle around the house, the more at risk of contracting malaria, because the puddle is one of the breeding places (Lewinsca, Raharjo and Nurjazuli, 2021). According to Manangsang et al., (2021) one of the environmental factors related to the occurrence of malaria is the presence of puddles around the house. Householders who live in the vicinity of high-risk puddles are 4 times more at risk of being infected with malaria than residents of houses that have puddles around their homes in the low-risk category.

Dominant Factors of Physical Environmental Conditions that Affect Malaria Incidence in Tuafanu Village. The results of the analysis conducted in Tuafanu Village show that the dominant factors of physical environmental conditions that influence the incidence of malaria are puddles and house walls. The results of statistical analysis showed that puddles had a p-value of $0.012 < 0.05$ and an OR of 0.091, which means that individuals who live in areas around their houses have puddles or stagnant water have a 0.091 higher risk of malaria. The type of house wall has a p-value of $0.022 < 0.05$ and an OR of 0.191, which means that people who have semi-permanent house walls have a 0.191 higher risk of malaria infection compared to permanent houses. The type of floor of the house has a p-value of 0.041 and an OR of 0.091, which means that people who have soil and sand house floors are 0.091 at higher risk of malaria infection compared to people who have ceramic or cement house floors. The presence of puddles around the house, wall type and floor type have an OR value of < 1 , which means they act as protective factors for malaria incidence in Tuafanu Village.

CONCLUSION

The dominant factor of physical environmental conditions that affect malaria in Tuafanu Village is puddles with a p-value of 0.012 and an OR of 0.091, which means that individuals who live in the area around their house there are puddles or stagnant water have a 0.091 higher risk of malaria. The OR value < 1 indicates that puddles acts as a protective factor against malaria, therefore it is necessary to clean and manage the environment to prevent the presence of water that can become a breeding place for mosquitoes and prevent malaria transmission. Future research is expected to develop research by analyzing other environmental conditions that have the potential to increase the incidence of malaria such as chemical, biological and socio-cultural factors.

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