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Vector of Malaria Receptivity Mapping at Melolo Health Center, Umalulu District, East Sumba Regency

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Abstract: Malaria is a life-threatening global infectious disease, which is spread through the bite of an infected female Anopheles mosquito. Plasmodium as the cause of malaria consists of six species, namely P. falciparum, P. vivax, P. malariae, P. ovale curtisi, P. ovale wallikeri, and P. Knowlesi. Indonesia is one of the malaria-endemic countries, with most of the districts/cities with high endemic status located in Papua and West Papua. East Nusa Tenggara Province still has three districts with high endemic status, namely East Sumba, West Sumba, and Southwest Sumba. In 2022, the number of laboratory-confirmed malaria cases in Indonesia reached 3,358,447 cases, an increase of 3.1% compared to 2021, which recorded 2,040,229 cases. This study aims to determine the pattern of malaria vector receptivity mapping in the Melolo Health Center Working Area, Umalulu District, East Sumba Regency. The type of research used is a descriptive approach. The results of the study showed that the level of malaria vector receptivity in the area was relatively high. The most common habitat found was swamps, with the most malaria sufferers being women aged between 6 and 50 years. The distribution pattern of malaria sufferers showed a cluster form, and the Malaria Habitat Index (IHM) value of 43.48% indicated the potential for significant spread of malaria.

Keywords: Malaria; Receptivity; Spread

Introduction

Malaria is a life-threatening global disease that is spread to humans through the bite of an infected female Anopheles mosquito. Plasmodium that causes malaria consists of 6 species, including *P. falciparum, P. vivax, P. malariae, P. ovale curtisi, P. ovale wallikeri and P. knowlesi* (Semakula et al., 2023). Malaria transmission occurs due to the reciprocal relationship between Plasmodium malaria (agent) humans and Anopheles mosquitoes (host) and the environment (Naserrudin et al., 2022; Rougeron et al., 2022). These three components support each other, so that malaria transmission increases and environmental factors are generally the most dominant determinants of malaria incidence (Madayanti et al., 2022). In 2021, there were an estimated 247 million new cases of malaria (up from 245 million in 2020) and 619,000 malaria-related deaths worldwide (up from 625,000 in 2020). The World Health Organization (WHO) Africa region accounted for 95% of malaria cases and deaths in 2021. Nearly half of all malaria deaths worldwide occurred in 4 countries: Nigeria (31.3%), The Democratic Republic of the Congo (12.6%), United Republic of Tanzania (4.1%) and Niger (3.9%). According to the latest world malaria report, there were 249 million cases of malaria in 2022. The estimated number of malaria deaths is 608,000 in 2022 compared to 610,000 in 2021.

Indonesia is one of the malaria endemic countries and until now most of the districts/cities with high endemic status are in Papua and West Papua (Nurwidayati et al., 2024). East Nusa Tenggara Province still has 3 high endemic districts, namely East Sumba, West Sumba and Southwest Sumba. The number of laboratory-confirmed malaria prevalence in Indonesia throughout 2022 was 3,358,447 cases. This prevalence

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increased by 3.1% compared to 2021, which was 2,040,229 cases (Kemenkes, 2023).

Several factors that influence the emergence of malaria in an area are altitude, sunlight, pH, water salinity, dissolved oxygen, genetic conditions, plants, climate, genetics, rainfall intensity, temperature, depth of water sources, water currents, and air humidity (Hong et al., 2023; Yadav & Upadhyay, 2023). Several factors come from the behavioral aspects of the community that are considered to contribute to the emergence of malaria, namely community behavior related to the use of insecticide-treated mosquito nets, the habit of not using mosquito coils, and not using repellents (Fadillah & Azizah, 2022; Trapsilowati et al., 2016). East Nusa Tenggara Province is the province with the second highest number of malaria cases after Papua Province. Based on data quoted from the Indonesian Health Profile, the prevalence of malaria in East Nusa Tenggara Province in 2021 was 502,798 confirmed cases and the incidence increased to 912,552 cases in 2022. In order to eradicate Malaria, the Indonesian government has issued Decree of the Minister of Health Number 293/2019 concerning Malaria Elimination in an effort to support the malaria elimination program. The goal of the malaria control program in Indonesia is to achieve gradual malaria elimination no later than 2030. The stages of elimination are from the Regency/City, Province, regional and national levels. The process is preceded by an elimination assessment for Java and Bali in 2023, an assessment for Sumatra, NTB and malaria elimination assessment for Java and Bali in 2023, an assessment for Sumatra, NTB and Sulawesi in 2025, an assessment for Kalimantan and North Maluku in 2027, an assessment for NTT and Maluku in 2028, an assessment for West Papua and Papua in 2029, and national elimination certification in 2030 (Afsahyana, 2021; Rahayu et al., 2023).

Malaria elimination is an effort to stop local malaria transmission in a certain geographic area (Arisanti & Nurmaliani, 2019; Tomia et al., 2024). However, the cessation does not mean that there is no possibility of imported malaria cases or when it is considered that there are no malaria vectors in the area. Therefore, the community and stakeholders remain vigilant to prevent re-transmission. Based on Governor Regulation No. 11 of 2017, the target for malaria elimination in East Nusa Tenggara Province by 2023 is that all 22 districts/cities must be malaria-free. Based on the report of the NTT Health Service, the achievement by 2022 is that only seven districts/cities have received malaria-free certificates, namely Manggarai Regency, East Manggarai, West Manggarai, Kupang City, Ngada, Ende and Nagakeo. The success of malaria elimination in a district/city, province, island can be measured by the indicator that no malaria cases have been reported for 3 consecutive years, and has good surveillance implementation capabilities.

In addition, Annual Parasite Incidence (API) <1 per 1,000 population is the basis for an area to be declared malaria-free. National data shows that malaria API reaches 1.25 per 1,000 population with 90% laboratory examination coverage. In highly malaria-endemic areas, API>5% is obtained, moderately endemic areas API 1-5% and low endemic areas API <1%. Until now, not all areas have received malaria-free certificates from the Indonesian Ministry of Health because cases of indigenous malaria are still found. Malaria certificates have not been obtained because there are areas that are classified as malaria-receptive areas. Receptive areas are areas that have a high density of malaria vectors and environmental and climate factors that have the potential for malaria transmission (Depraing, 2023; Tahulending et al., 2024). Mapping the area of malaria-receptive areas is a malaria elimination maintenance activity needed to map areas that still have an environment that supports malaria transmission as a form of early warning (Lourenco, 2019). The function of receptive mapping is that it can be used as a basis for vector control in the area3. Previous research conducted with the aim of determining the level of receptivity of malaria transmission areas in Buton Regency, Southeast Sulawesi Province, the results of the study showed that the level of malaria receptivity in Buton Regency, especially in Wajah Jaya Village, was at a moderate level of receptivity. Adult mosquitoes were found to have 3 identified Anopheles species, namely An. Minimus, An. Indifinitus and An. Kochi. Habitat Index (HI) of Anopheles vectors, sp> 1, Anopheles vector breeding places are puddles, rivers, ditches, ponds, rivers, swamps and rice fields with characteristics of temporary and clear water, moss and mud, with a water pH of 6-6.5 and zero salinity. Vector confirmation by PCR was negative for all species.

The East Sumba Regency area is one of the areas in East Nusa Tenggara Province with a high endemic level, reaching 7 cases of malaria per 1000 residents. Based on data obtained from the East Sumba District Health Office, the trend of malaria cases in the area has decreased to exceed the lowest case trend in 2018-2022 in the May-July 2023 period, but malaria cases are currently reported to have increased again compared to previous months. The purpose of conducting research on receptive maps in the East Sumba region is that there is no malaria receptive mapping as a document that is one of the assessment items in malaria elimination. Based on several phenomena, researchers are interested in conducting research on Malaria Vector Receptivity Mapping in East Sumba Regency.

Method

The type of research used in this study is quantitative research. Quantitative research is a research technique based on the philosophy of positivism, generally used in conducting research on a specific population or sample, the sampling method generally uses a random technique with the help of research tools in the form of questionnaires and the analysis used is statistical in nature with the aim of proving the hypothesis that has been decided (Afsahyana, 2021; Rahayu et al., 2023).

The approach used in this study is a descriptive approach. The descriptive method is used to create a systematic, factual and accurate picture or description of existing phenomena. Quantitative descriptive research is research that describes variables as they are supported by data in the form of numbers generated from the actual situation. This study uses data collection techniques through questionnaires, observations and interviews.

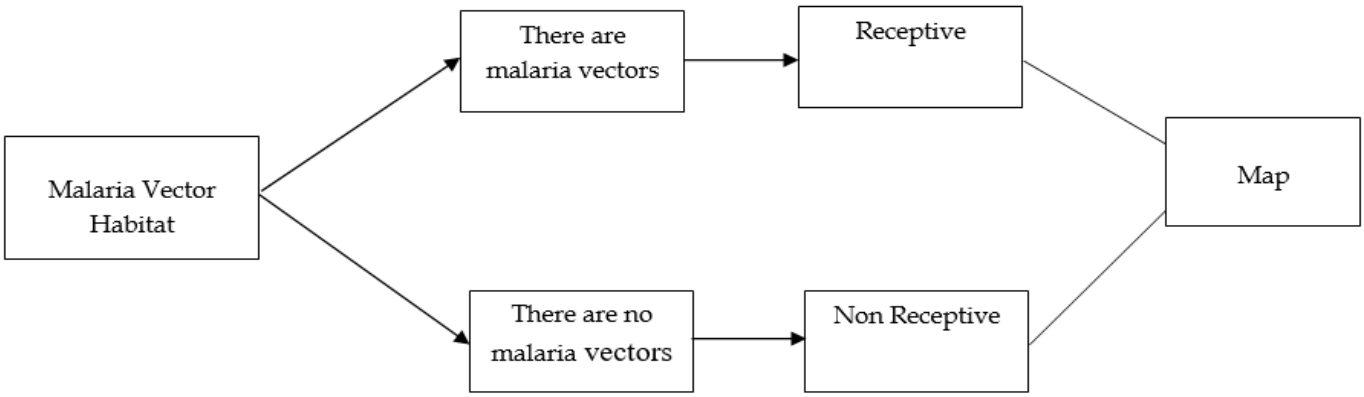

Figure 1. Research conceptual framework

Result and Discussion

Results

Overview of Research Location

Geographical Conditions

Umalulu or in full called Tana Umalulu is a sub-district in East Sumba Regency, East Nusa Tenggara, Indonesia. Umalulu is an area which is in full called Tana Umalulu (Umalulu Land). During the Dutch colonial period, Umalulu Land was known as Melolo Land, Melolo Landschaap, or Melolo Kingdom. Then during the independence period it was called the Melolo Swapraja Region (BPS Sumba Timur, 2023).

Table 1. Population by Gender

Village	Population Number of souls/km²		
	Men	Women	Total
Lairuru Village	715	715	1430
Watupuda Village	800	770	1.570
Umalulu Village	670	637	1.307
Ngaruh Kanoru Village	416	396	812
Lambu Kore Village	1.623	1.576	3.199
Watu Hadang Village	1.159	1.110	2.269
Mutunggeding Village	1.259	1.145	2.404
Matawai Atu Village	946	889	1.835
Patawang Village	1.155	1.104	2.259
Wanga Village	924	875	1.799
Total of Village Umalulu	9.667	9.217	18.884

Demographic Conditions

Umalulu District consists of 9 villages and 1 sub-district, the population reaches 18,884 people/km² with an area of 307.9 km² (bps 202). Most of the Umalulu population lives from farming in the fields (corn, rice, tubers, beans) and raising livestock (pigs, horses, buffalo, chickens). Agriculture in the form of rain-fed rice fields has now been intensively cultivated with the construction of a dam in Watuhadaangu village. Another source of income is making woven cloth which is better known as "Sumba cloth". In addition, there are also those who make handicrafts, such as woven palm leaves and making gold and silver jewelry.

Overview of Dengue Fever Cases in East Sumba

Umalulu District, located in East Sumba Regency, East Nusa Tenggara (NTT), is also an area that faces major challenges related to malaria. As an area with a tropical climate and many remote areas and limited access to health facilities, malaria is one of the public health problems that is quite a concern. The following is a general description of malaria cases in Umalulu District, East Sumba Regency (BPS Sumba Timur, 2023).

Based on data obtained from the East Sumba Health Service52, in 2023 there were 230 cases of malaria recorded, with an incidence rate of 12.1 cases per 1,000 population. Meanwhile, in 2024 until August, the number of malaria cases was recorded as 139 cases, which is equivalent to an incidence rate of 7.4 cases per

1,000 population. Based on the incidence prevalence rate (API) indicator used, the API value in both years (API> 5 per 1,000 population) indicates that Umalulu District is still in the endemic high category or at high risk of spreading malaria. Umalulu District, which has a tropical climate with relatively hot temperatures and high humidity, offers environmental conditions that support the development of malaria vectors, namely Anopheles mosquitoes. Although this area does not have many swamps like some other areas known for their malaria mosquito habitat, stagnant water caused by high rainfall can create ideal breeding grounds for Anopheles mosquitoes, potentially increasing the risk of malaria transmission in the area (Wardani & Arifah, 2016).

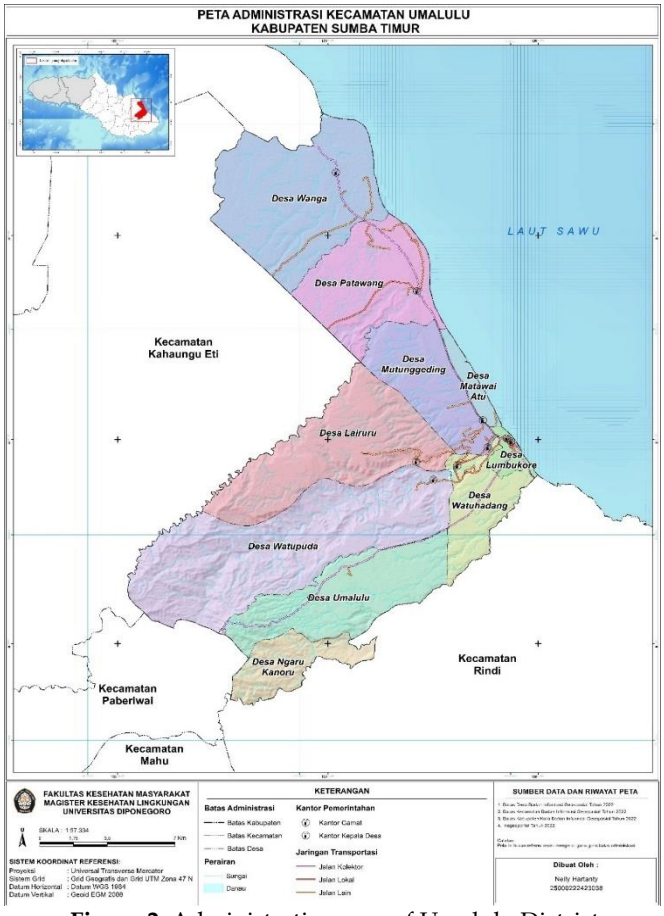

Figure 2. Administrative map of Umalulu District

In addition, the large number of houses with simple structures and limited access to adequate sanitation in several parts of Umalulu District increase the risk of exposure to malaria. The lack of use of insecticide-treated mosquito nets or other protection is also a triggering factor (Gutiérrez-Jara et al., 2022). In addition, community access to health facilities in Umalulu is limited, especially in isolated villages far from the sub-district center. This makes it difficult to detect and treat malaria early.

As in many other areas in East Nusa Tenggara, this sub-district tends to have a fairly high incidence of malaria. Although the incidence of malaria can fluctuate depending on the rainy season and control efforts made, malaria cases often occur, especially during the rainy season when stagnant water is more common.

Based on a report from the East Sumba District Health Office, this sub-district was once recorded as one of the areas with a fairly high number of malaria cases. However, control efforts carried out by the local government, with support from international health organizations, have shown a decrease in cases in recent years.

General Description of Respondent Characteristics

The following are the characteristics of respondents in the work area of the Melolo Health Center, Umalulu District, East Sumba Regency.

Table 2. Respondent Characteristics

Variable	Amount	Percentage (%)
Gender		
Men	64	46.7
Women	73	53.3
Age		
1-5 years	21	15.3
6-9 years	29	21.2
10-18 years	45	32.8
19-59 years	42	30.7
Work		
Farmers	65	47.4
Livestock Farmers	17	12.4
Fishermen	15	10.9
Traders	20	14.6
PNS/TNI Polri	8	5.8
etc	12	8.8

Based on Table 2 In the occupation variable, the majority of respondents come from farmers, which covers almost half of the population (47.4%). This shows that farmers are the most dominant occupational group in this area. Other significant occupations are traders (14.6%), livestock breeders (12.4%), and fishermen (10.9%). This shows that the agriculture, fisheries, and trade sectors have an important role in the livelihoods of the local community. Civil servants/TNI Polri are the smallest group, only 5.8%, indicating that most respondents come from the informal sector or primary sectors such as agriculture and fisheries. Others (8.8%) include other types of jobs that are not specifically mentioned in this table.

So it can be concluded that overall, this table shows that the population studied mostly consists of women (53.3%) and is in the age range of adolescence to

adulthood (10-59 years). In terms of occupation, the majority of respondents work in the agricultural sector (47.4%), with the trade, livestock, and fisheries sectors also quite significant. The formal sector such as civil servants or TNI/Polri covers a small part of the population studied.

Characteristics of Mosquito Habitat in Umalulu District, East Sumba Regency

The types of mosquitoes found in Watupuda Village, Umalulu District, include Anopheles anularis, which is identified in habitats in rice fields and buffalo footprints; Anopheles aconitus, which is found on buffalo footprints and riverbanks; Anopheles maculatus, which breeds on riverbanks and puddles; and Anopheles barbirostris, which is found in ditches, ponds, water sources, and puddles.

The main habitats for the breeding of these mosquitoes are rice fields, with an average pH of 7 and salinity between 0 and 1 ppm, as well as buffalo puddles and swamps with a pH of around 7.5 and salinity of 0. Most of these habitats consist of clear water and are exposed to direct sunlight, creating an environment that supports the development of mosquito larvae. In addition, natural predators such as fish are also found in almost all habitats, functioning as mosquito population control. Tinhead Fish, for example, is only found in permanent habitats such as springs and river flows.

In Watupuda Village, which is a hilly area, Anopheles maculatus is found on riverbanks and puddles formed around river flows. In other mountainous and hilly areas, springs and rock depressions that hold water can also be breeding grounds for Anopheles maculatus. In both areas, Anopheles maculatus mosquitoes prefer clear water, with a pH of around 7, exposed to direct sunlight, as the most supportive conditions for their breeding.

Vector Receptivity

Vector receptivity, which refers to the ability or tendency of a vector (in this case a mosquito, such as Anopheles) to carry and transmit a disease, in this case malaria (Yukich et al., 2022).

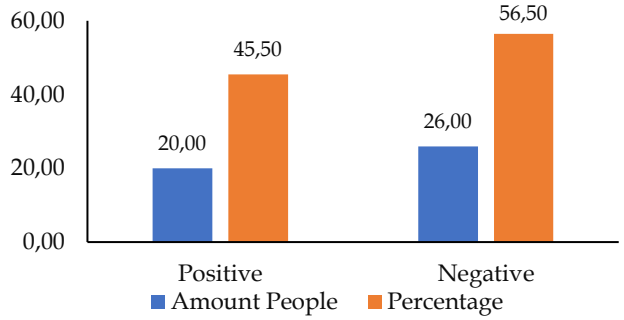

Figure 3. Vector of malaria receptivity

The data in Figure 3 illustrates the proportion of vectors that are infected and can transmit malaria (positive) compared to those that are not infected (negative). With a figure of 43.5% for positive vectors, this shows that almost half of the mosquito population tested has the potential to be a source of malaria transmission, while more than half (56.5%) are not infected and do not play a role in spreading the disease.

Spatial Analysis of Anopheles Larvae Receptivity

Most of the villages/sub-districts surveyed showed negative or non-receptive results, meaning that no Anopheles larvae were found in the location at the time of the survey. This shows that these areas are relatively safe from the potential for malaria transmission at the time of the survey. However, several villages/sub-districts showed positive or receptive results, meaning that Anopheles larvae were found. These areas have the potential to be breeding grounds for malaria mosquitoes, which can cause malaria transmission if not handled immediately (Carnevale & Manguin, 2021; Yu et al., 2022).

Although most of the survey results showed negative/non-receptive, it is important to continue monitoring areas that show positive/receptive results, because they have a high potential for malaria transmission. Malaria prevention and eradication programs in the area must be improved in order to reduce the risk of malaria transmission to the community (Liu et al., 2022).

Spatial Analysis of Malaria Distribution

The distribution of malaria in the Melolo Health Center Work Area, Umalulu District, East Sumba Regency, can be understood through an epidemiological analysis that considers various environmental, social, and health factors. Malaria in this area, as in many other endemic areas, is caused by infection with the Plasmodium parasite, which is transmitted through the bite of an infected female Anopheles mosquito. The following is data on parasites that cause malaria in the Melolo Health Center Work Area.

Based on Table 3, in 2023, P. falciparum was the most dominant malaria-causing parasite in the area, with more than 65% of the total cases. P. vivax also contributed significantly, while P. malariae was less common, but still present in a small number of cases. Meanwhile, in 2024, although the number of P. falciparum cases decreased, this parasite remained the main cause of malaria, with an increasing proportion of 74.5%. Meanwhile, P. vivax cases decreased significantly, and P. malariae remained rare, although the percentage was relatively stable.

Table 3. Number of Parasites Causing Malaria in the Melolo Health Center Work Area

Parasite Name	Year 2023		Year 2024	
	Total	Percentage%	Total	Percentage%
P. Falciparum	130	65.3	102	74,5
P. Malariae	14	7.0	10	7.3
P. Vivax	55	27.7	25	18.2

Characteristics of Malaria Sufferers Respondents in the Melolo Health Center Work Area, Umalulu District

Based on Table 1 on the occupation variable, the majority of respondents came from farmers, which covered almost half of the population (47.4%). This shows that farmers are the most dominant occupational group in this area with the largest population consisting of women (53.3%) and in the age range of adolescence to adulthood (10-59 years). This happens because farmers have an ideal work environment for the anopheles mosquito to live and breed.

This study is not in line with the 57 in Jayapura City in 2021 with the results that the most malaria sufferers were men with a percentage of 62.7% in the 16-64 years age range with a percentage reaching 72.51%. On the map of the distribution of malaria endemics per district/city, it shows the provinces of Papua, West Papua and NTT and only one province outside the eastern region, namely East Kalimantan (Panajem Paser Utara Regency) whose area is still highly endemic to malaria. Based on 2021 data, as many as 81% of malaria cases came from Papua Province, namely 9,999 out of 22 cases. If we look at the cases per district in Papua Province, we can see that 80% of cases are spread across 9 districts/cities, one of which is Jayapura City and if we sort it out again, as many as 70% of malaria cases in Papua Province come from Jayapura City, Jayapura Regency, Keerom Regency and Mimika Regency. 56

Characteristics of Mosquito Habitat in Umalulu District, East Sumba Regency

Based on Table 3, it shows that the type of breeding place is mostly found in swamps with KJ 6.5, PH 8, salinity 1.00, turbidity level is turbid, direct light shade with biota growing in it including swamp grass, water hyacinth. In addition, it is also widely found on the banks of large rivers with KJ 5.6, PH 7, salinity 0.00, clear turbidity level, direct light shade with biota growing, moss, water bushes, and fish.

This study is in line with that conducted in the Pijorkiling Health Center work area that the types of Anopheles breeding habitats in the Pijorkoling Health Center work area are rice fields, rivers, fish ponds, puddles and ditches. The water temperature in the breeding habitat ranges between 28–34 °C, the water pH in all breeding habitats ranges between 7.4–8.2 with a salinity of 0 0/00. All Anopheles breeding habitats are exposed to direct sunlight.

The main habitats for mosquito breeding are rice fields, with an average pH of 7 and salinity between 0 and 1 ppm, as well as buffalo wallows and swamps with a pH of around 7.5 and salinity of 0. Most of these habitats consist of clear water and are exposed to direct sunlight, creating an environment that supports the development of mosquito larvae. In addition, natural predators such as fish are also found in almost all habitats, functioning as mosquito population control. Tinhead fish, for example, are only found in permanent habitats such as springs and rivers.

In Watupuda Village, which is a hilly area, Anopheles maculatus is found on riverbanks and puddles that form around river flows. In other mountainous and hilly areas, springs and rock depressions that hold water can also be breeding grounds for Anopheles maculatus 61

Malaria Vector Receptivity Level at Melolo Health Center, Umalulu District

Based on Table 3, illustrates the proportion of vectors that are infected and can transmit malaria (positive) compared to those that are not infected (negative). With a figure of 43.5% for positive vectors, this shows that almost half of the mosquito population tested has the potential to be a source of malaria transmission, while more than half (56.5%) are not infected and do not play a role in the spread of the disease.

Lasalimu District, showed that this village is a receptive area for malaria vectors, because positive habitats for Anopheles larvae were found such as puddles, rivers, ditches, ponds, lakes, rivers, swamps, and rice fields. One strategy to eradicate malaria is malaria elimination, which is regulated in the Decree of the Minister of Health of the Republic of Indonesia No. 293/MENKES/SK/2009. Malaria elimination aims to stop local malaria transmission in an area, although cases of imported malaria and malaria vectors may still exist, so vigilance is still needed to prevent re-transmission.

If there is an area that is receptive to malaria, it means that the area has conditions that support disease transmission, either because of the presence of vectors (mosquitoes carrying malaria parasites) with high density, or environmental and climate factors that support the development of these vectors (Palaniyandi,

2021). The main dangers of having a malaria receptive area are:

Wider DiseaseArea

Receptive areas can be a place for the development of wider malaria transmission. Many malaria vectors and supportive environmental conditions will increase the risk of the disease spreading to a larger area, infecting more people.

Increase in Malaria Cases

If malaria continues to spread in receptive areas, the number of malaria cases can increase sharply. This will increase the burden on the health system, increase morbidity, and risk causing an epidemic in the area.

Health and Economic Burden of Malaria

Malaria is a disease that requires medical treatment, such as treatment and prevention. An increase in the number of malaria cases will increase treatment costs, damage productivity, and disrupt the economy of the area, especially in more remote areas or those with less access to health services.

Risk of Death

Especially in vulnerable groups, malaria that is not treated properly can cause serious complications, even death, especially in children, pregnant women, and people with weak immune systems. Areas that are receptive to malaria have the potential to increase this risk if prevention and treatment efforts are not carried out properly.

Disruption to the Malaria Eradication Program

Receptive areas that have not been detected or have not received sufficient attention can hinder overall malaria eradication efforts. Without proper mapping and rapid preventive action, the area could become a center for the re-infection of malaria, even if malaria elimination programs are already underway in other areas.

Therefore, detection of receptive areas is very important so that preventive measures, such as vector control (for example by administering insecticides or using insecticide-treated bed nets) and malaria treatment, can be carried out immediately to prevent further spread.

The lack of an integrated malaria management program is due to a governance system that does not allow for cross-agency programs and budgeting. Each institution has its own program and performance indicators. Financial responsibility and program success are only sectoral, making it difficult to develop an integrated program, so that malaria control cannot be carried out effectively.

The implementation of IVM to eradicate malaria has not been going well. Collaboration between sectors is not effective. Community involvement is always carried out, but it has not become a culture to free the community from mosquito bites. The community is often not vigilant so that being bitten by Anopheles mosquitoes is the main obstacle in isolating the spread of mosquitoes. Although the community has sufficient knowledge to understand the benefits of bed nets, they prefer comfort rather than using the bed nets to control the spread of malaria between humans.

Spatial Analysis of Anopheles Larvae Receptivity The majority of villages/sub-districts surveyed showed receptive properties, indicating the presence of Anopheles larvae in these locations during the survey. These villages/sub-districts gave positive or receptive results, meaning that there were Anopheles larvae in the area. These areas have the potential to be breeding grounds for Anopheles mosquitoes, which are the main vectors for the spread of malaria, and can facilitate the transmission of malaria if not handled with appropriate control measures.

The Melolo Health Center working area has several habitats or breeding grounds for Anopheles mosquitoes, including small swamps, pond edges, rice fields with slow water flow, post-harvest rice fields, buffalo footprints, buffalo drinking places, swamps, water tanks, buffalo wallows, ditches, and empty land. These places are environments that are favored by Anopheles mosquitoes as breeding grounds.

According to the Indonesian Ministry of Health, malaria receptive areas are areas with dense malaria vectors and environmental and climate conditions that support transmission. In contrast, non-receptive areas do not have malaria vectors. Determination of receptive areas can be done through the discovery of malaria vectors, both larvae and adult mosquitoes, or based on the presence of indigenous malaria cases if vector data is not yet available (Ito et al., 2024).

Spatial Analysis of Malaria Disease Distribution

P. falciparum is the most dominant malaria-causing parasite in the area, with more than 65% of the total cases. P. vivax also contributes significantly, while P. malariae is less common, but still present in a small number of cases. Meanwhile, in 2024, although the number of P. falciparum cases has decreased, this parasite remains the main cause of malaria, with a proportion that has increased by 74.5%. Meanwhile, P. vivax cases have decreased significantly, and P. malariae remains rare, although the percentage is relatively stable.

Umalulu District has an area of 307.9 Km^2 or 30,790 hectares with a location that is generally along the hilly

north coast and very low and uneven rainfall each year, where the rainy season is relatively short when compared to the dry season. Umalulu District is one of the agricultural producing districts in East Sumba Regency. The district with a population of 18,884 people consists of 9 villages and 1 sub-district. The distribution of malaria is based on swamp areas and large riverbanks. Environmental factors greatly influence the growth of malaria vectors. The spread of malaria is influenced by local characteristics of the region including differences in regional ecology. It is known that malaria is transmitted by Anopheles mosquitoes, and each species has different behavior or bionomics according to its habitat environment. The environment of rice fields, hills, and beaches which are characterized by different altitudes, types of vegetation, types of mosquito breeding sites, can determine the types of Anopheles species and different transmission patterns. 6 Breaking the chain of transmission is a disease eradication strategy that must be carried out on a regional basis.60

Malaria Habitat Index

Each mosquito species has a specific habitat preference for laying eggs, such as fresh water, clear puddles, shady ponds, or brackish water (Abdalla et al., 2022). Some species can even lay eggs in narrow habitats such as animal footprints on the ground or tree holes. Identification of breeding sites and densities of Anopheles mosquitoes is very important in areas with active malaria transmission. This provides an overview of the potential for transmission during collection and risk factors for future transmission. Collecting larvae and pupae from various habitats can help identify vector species, determine suitable habitats for each species, and design more effective and efficient vector control programs (Stanton et al., 2021).

Malaria control requires a comprehensive and integrated approach, starting from vector habitat management, use of insecticide-treated bed nets, appropriate treatment, to continuous monitoring. With accurate data on the Malaria Habitat Index (IHM) and an understanding of malaria distribution patterns, control efforts can be carried out more effectively and efficiently, reducing the risk of transmission and leading to the elimination of malaria in endemic areas. The results of the Malaria Habitat Index (IHM) calculation play an important role in identifying areas that require more attention in malaria control efforts, especially in the management and mitigation of high-risk habitats. With accurate IHM data, vector control programs can be implemented more effectively to prevent the spread of malaria. The IHM value obtained was 43.48% in the Melolo Health Center working area, Umalulu District, indicating that the area is an area at high risk of malaria transmission.

Conclusion

High receptivity levels and very active local spread. The habitat characteristics in the Melolo Health Center area, Umalulu Regency, which are most commonly found are swamps. The characteristics of malaria sufferers who are most often female, as many as 53.8%, with an age range of 6 to 50 years. The distribution pattern of malaria sufferers in the Melolo Health Center work area, Umalulu District, shows a cluster pattern. The habitat index in the Melolo Health Center work area, Umalulu District, is included in the high-risk category for the spread of malaria with a Malaria Habitat Index (IHM) value of 43.48%.

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Conflicts of Interest

The authors declare no conflict of interest.

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