

Behavior-Based Malaria Incidence Prediction Model in the Hanura Community Health Center Work Area, Pesawaran Regency, Lampung, Indonesia

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ABSTRACT: Malaria is an infectious disease caused by the Plasmodium parasite and transmitted through the bite of an infected female Anopheles mosquito. This disease remains a public health problem in the working area of the Hanura Community Health Center, Pesawaran Regency, Lampung, Indonesia. Behavioral factors and home protection conditions are thought to play a role in increasing the risk of malaria, such as the use of mosquito nets, mosquito repellent, wire mesh, and activities outside the house at night. This study aims to analyze behavioral factors that influence the incidence of malaria in the working area of the Hanura Community Health Center, Pesawaran Regency, Lampung, Indonesia. This study used an observational analytical design with a case-control approach conducted in November 2025–January 2026. The study sample consisted of 113 case groups and 113 control groups selected using proportional random sampling techniques. Data were obtained through questionnaires and analyzed using the Chi-Square test with a significance level of $\alpha = 0.05$. The results showed that the use of mosquito nets had a significant relationship with the incidence of malaria (p-value = 0.016; OR = 2.00; 95% CI = 1.17–3.42), the use of mosquito repellent (p-value = 0.002; OR = 2.95; 95% CI = 1.53–5.70), and the use of wire netting (p-value = 0.008; OR = 2.12; 95% CI = 1.25–3.61). Meanwhile, activities outside the house at night did not have a significant relationship with the incidence of malaria (p-value = 0.893). Behavioral factors and physical protection of the house play an important role in the incidence of malaria. The use of mosquito nets, mosquito repellent, and wire netting has been shown to be associated with a reduced risk of malaria, so that sustainable prevention efforts are needed through improving healthy living behaviors and protecting the home environment.

KEYWORDS: Anopheles, Case-control study, Behavior, Incidence, Malaria.

INTRODUCTION

Malaria remains a major infectious disease that poses a public health problem in various tropical and subtropical countries, including Indonesia. This disease is caused by the Plasmodium parasite, which is transmitted through the bite of an infected female Anopheles mosquito. The Plasmodium species that most commonly infect humans are Plasmodium falciparum and Plasmodium vivax. P. falciparum is known to cause severe malaria that can lead to complications and death, while P. vivax can cause relapses due to its dormant phase in the liver. Malaria is also a reemerging disease whose emergence is influenced by environmental changes and natural phenomena (Khodijah, 2024). According to the 2024 World Malaria Report, by 2023, there will be an estimated 263 million cases of malaria with 597,000 deaths worldwide. Africa remains the region with the highest malaria burden, accounting for approximately 94% of cases and 95% of global deaths from malaria (WHO, 2024). In Indonesia, malaria cases still show significant fluctuations. In 2021, 304,607 malaria cases with 48 deaths were recorded, increasing to 543,965 cases with 132 deaths in 2024. By 2025, there were 506,482 cases with 76 deaths (Ministry of Health of the Republic of Indonesia, 2025). These data indicate that malaria remains a health threat that requires serious attention and ongoing control.



Lampung Province in Indonesia is one of the regions still experiencing an increase in malaria cases. The number of malaria cases increased from 557 cases in 2021 to 2,596 cases in 2024, while by June 2025 there were 1,388 cases recorded (Lampung Provincial Health Office, 2025). In Pesawaran Regency, Lampung, Indonesia, the number of malaria cases increased from 397 cases in 2021 to 2,017 cases in 2024, and by September 2025 there were 1,123 cases of malaria recorded (Pesawaran Regency Health Office, 2025). The Hanura community health center is the area with the highest number of cases in Pesawaran Regency, with 472 cases in 2023 and a sharp increase to 1,883 cases in 2024. As of July 2025 there were still 883 cases of malaria recorded (Puskesmas Hanura, 2025). The high incidence of malaria has a broad impact on both the health and socioeconomic conditions of the community. Malaria can reduce work productivity, increase medical and healthcare costs, and degrade the quality of human resources in the long term (Steven, 2025). Malaria incidence is influenced by the interaction between the host, agent, and environment, as explained in John Gordon and La Richt's epidemiological triangle theory (Irwan, 2017). In the context of malaria, individual behavior and environmental conditions are important factors influencing the risk of transmission.

Several behavioral factors associated with malaria incidence include the use of mosquito nets, mosquito repellent, the use of wire mesh on home ventilation, and going outside at night. Going outside at night increases the risk of contact with Anopheles mosquitoes, which actively bite at night (Mayasari et al., 2016). The use of mosquito nets and mosquito repellent is an effective form of self-protection to reduce contact with malaria vectors, while the use of wire mesh on home ventilation can prevent mosquitoes from entering the house. Various previous studies have shown a significant relationship between behavioral factors and malaria incidence. Research by Wahyuni (2022) showed that individuals who did not use insecticide-treated mosquito nets had a 7.8-fold greater risk of contracting malaria compared to those who used mosquito nets. Research by Ishak (2024) found that people who did not use mosquito repellent had a 2.3-fold greater risk of contracting malaria, while Ramadhani (2024) reported a 3.36-fold higher risk in individuals who did not use mosquito repellent. In addition, houses that do not use wire mesh for ventilation have a 3.6 times higher risk of malaria transmission than houses that use wire mesh (Hidayati, 2023).

Although the government has targeted national malaria elimination by 2030 (Ministry of Health of the Republic of Indonesia, 2019), the high number of malaria cases in the Hanura Community Health Center (Puskesmas) area indicates that community behavioral factors remain a major challenge in malaria control. Therefore, research is needed on a behavior-based malaria incidence prediction model with variables such as bed net use, mosquito repellent use, wire mesh use, and nighttime activities in the Hanura Community Health Center area of Pesawaran Regency, Lampung, Indonesia. This research is expected to provide an overview of the behavioral factors that contribute to malaria incidence so that it can be used as a basis for developing more targeted, effective, and sustainable malaria prevention and control efforts. This study aims to analyze behavioral factors that influence the incidence of malaria in the working area of the Hanura Community Health Center, Pesawaran Regency, Lampung, Indonesia.

METHODS

This study was a quantitative, observational, analytical design using a case-control approach. The study was conducted from November 2025 to January 2026 in the Hanura Community Health Center working area, Pesawaran Regency, Lampung, Indonesia. The independent variables in this study included mosquito net use, mosquito repellent use, wire mesh use, and nighttime habits, while the dependent variable was malaria incidence. The case population consisted of all 158 people diagnosed with malaria in the Hanura Community Health Center working area during September–October 2025, while the control population consisted of all 30,686 people in the area. The study sample consisted of 113 respondents from the case group and 113 respondents from the control group, with a 1:1 ratio determined using the Slovin formula. The sampling technique used was proportional random sampling.

The research data consisted of primary and secondary data. Primary data were obtained through questionnaires, while secondary data were obtained from monthly reports from the Hanura Community Health Center. Data processing was carried out through the stages of editing, coding, data entry, and cleaning using the SPSS for Windows program (Notoatmodjo, 2018). Data analysis was carried out univariately to see the frequency distribution of each variable and bivariately using the Chi-Square test with a significance level of $\alpha = 0.05$ to determine the relationship between the independent variables and malaria incidence. This study has obtained ethical clearance from the Research Ethics Committee of Tanjung Karang Health Polytechnic with Number 260/KEPK-TJK/IV/2026 dated April 21, 2026.

RESULTS**Respondent characteristics**

Based on the results of data collection, the research results were obtained in the form of respondent characteristics as follows:

Table 1. Respondent characteristics (n=126)

Variable	Frequency (n)	Percentage (%)
Age (years)		
<15	70	31.0
≥15	156	69.0
Gender		
Female	86	38.1
Male	140	48.7

Based on Table 1, the majority of respondents (156 respondents) were aged ≥15 years (69.0%), indicating a predominance of the productive age group with high mobility. Based on gender, the majority of respondents were male (140 respondents) (48.7%), who are at higher risk of malaria exposure due to outdoor activities at night.

Frequency distribution of mosquito net use, mosquito repellent use, wire net use, nighttime activities and malaria incidence in the Hanura community health center work area, Pesawaran regency, Lampung, Indonesia

The frequency distribution of mosquito net use, mosquito repellent use, wire net use, nighttime activities and malaria incidents in the Hanura Community Health Center working area, Pesawaran Regency, Lampung Province is presented in Table 2.

Table 2. Distribution of frequency of mosquito net use, mosquito repellent use, wire net use, nighttime activities and malaria incidence in the Hanura community health center work area, Pesawaran regency, Lampung, Indonesia (n=126)

Variable	Frequency (n)	Percentage (%)
Mosquito net use		
No	129	57.1
Yes	97	42.9
Mosquito repellent use		
No	53	23.5
Yes	173	76.5
Wire net use		
No	115	50.9
Yes	111	49.1
Nighttime activities		
Yes	130	57.5
No	96	42.5
Malaria incidence		
Yes	113	50
No	113	50

The results in Table 2 show that the majority of respondents did not use mosquito nets (57.1%), did not optimally implement preventive measures such as wire mesh (50.9%), and had a habit of going out at night (57.5%). Meanwhile, the majority of respondents used mosquito repellent (76.5%). These findings indicate that malaria prevention practices among the community in the Hanura Community Health Center's work area are still suboptimal and have the potential to increase the risk of malaria.

Use of mosquito nets, use of mosquito repellent, use of wire netting, nighttime activities that influence malaria incidence in the work area of the Hanura community health center, Pesawaran regency, Lampung, Indonesia

The results of the analysis of the use of mosquito nets, the use of mosquito repellent, the use of wire netting, and nighttime activities that influence the incidence of malaria in the work area of the Hanura Health Center, Pesawaran Regency, Lampung Province are presented in Table 3.

Table 3. Use of mosquito nets, use of mosquito repellent, use of wire netting, nighttime activities that influence malaria incidence in the work area of the Hanura community health center, Pesawaran regency, Lampung, Indonesia (n=126)

Variable	Malaria incidence				p-value	OR (95% CI)
	Yes		No			
	n	%	n	%		
Mosquito net use						
No	74	65.5	55	48.7	0.016	2.00 (1.17-3.42)
Yes	39	34.5	58	51.3		
Mosquito repellent use						
No	16	14.2	37	32.7	0.002	2.95 (1.53-5.70)
Yes	97	85.8	76	67.3		
Wire net use						
No	47	41.6	68	60.2	0.008	2.12 (1.25-3.61)
Yes	66	58.4	45	39.8		
Nighttime activities						
Yes	66	58.4	64	56.6	0.893	-
No	47	41.6	69	43.4		

The results showed that malaria incidence was higher among respondents who did not use mosquito nets (65.5%), compared to respondents who used them (34.5%). The results showed a p-value of 0.016, indicating a significant association between mosquito net use and malaria incidence, with an OR of 2.0001 (95% CI: 1.172–3.417). For the variable of mosquito repellent use, malaria incidence was higher among respondents who used mosquito repellent (85.8%), compared to respondents who did not use mosquito repellent (14.2%). The results showed a p-value of 0.002, indicating a significant association between mosquito repellent use and malaria incidence, with an OR of 2.951 (95% CI: 1.527–5.704). For the variable of wire net use, malaria incidence was higher among respondents who used wire nets (58.4%), compared to respondents who did not use wire nets (41.6%). The results showed a p-value of 0.008, indicating a significant association between wire mesh use and malaria incidence, with an OR of 2.122 (95% CI: 1.248–3.608). Furthermore, malaria incidence was higher among respondents who went out at night (66 people (58.4%) compared to respondents who did not go out at night (47 people (41.6%)). The statistical test results showed a p-value of 0.893, indicating no significant association between going out at night and malaria incidence.

DISCUSSION

The use of mosquito nets affects malaria incidence in the Hanura community health center work area, pesawaran regency, Lampung, Indonesia

The results showed that 74 respondents (65.5%) did not use mosquito nets in the malaria-affected group, while 58 respondents (51.3%) used mosquito nets. Statistical tests showed a significant association between mosquito net use and malaria incidence (p-value = 0.016; OR = 2.00; 95% CI = 1.17–3.42). Respondents who did not use mosquito nets had a 2-fold greater risk of contracting malaria than those who did. These results align with Sembiring's (2019) study, which found a significant association between mosquito net use and malaria incidence (p-value = 0.001; OR = 7). Novianti's (2016) study also reported that



respondents who did not use mosquito nets had a 5.02-fold greater risk of contracting malaria (p-value = 0.007; OR = 5.02; 95% CI = 1.47–17.22). Furthermore, Sepriyani (2018) stated that the risk of malaria was 16.6 times greater in respondents who did not use mosquito nets (p-value = <0.001; OR = 16.6; 95% CI = 7.5–37.03).

However, these study results disagree with Mustafa's (2018) findings that there was no association between mosquito net use and malaria incidence (p-value = 0.935). Wau et al.'s (2019) study found that malaria can still occur in mosquito net users, especially if the net is damaged or torn. Similar results were also reported by Nababan et al. (2018) and Darmawansyah (2019) stated that the use of mosquito nets was not related to the incidence of malaria.

The continued presence of respondents using mosquito nets but experiencing malaria is likely due to inconsistent use, damaged nets, or the use of insecticide-free nets, which results in less-than-optimal protection. Furthermore, environmental factors and mosquito density can also influence the effectiveness of mosquito net use in preventing malaria.

The use of mosquito repellent affects malaria incidence in the Hanura community health center work area, Pesawaran regency, Lampung, Indonesia

The results showed that 97 respondents (85.8%) with malaria used mosquito repellent, while 37 respondents (32.7%) did not use mosquito repellent. Statistical tests showed that mosquito repellent use was significantly associated with malaria incidence (p-value = 0.002; OR = 2.95; 95% CI = 1.53–5.70). These results indicate that respondents who used mosquito repellent had a 2.951-fold greater risk of contracting malaria than those who did not use mosquito repellent. These results align with research by Wibowo (2017), which found that not using mosquito repellent increased the risk of malaria by 9.27 times. Research by Haqi et al. (2016) also showed that respondents who did not use mosquito repellent at night had a 6.41-fold greater risk of contracting malaria (p-value = <0.001; OR = 6.41; 95% CI = 2.81–14.64).

Furthermore, Isaeni et al. (2019) found a significant association between mosquito repellent use and malaria incidence (p-value = 0.036; OR = 2.710). However, this study's results disagree with those of Sandy et al. (2018), Nababan et al. (2018), and Novianti (2016), who stated there was no association between mosquito repellent use and malaria incidence. Panigoro et al. (2014) also showed no association between mosquito repellent lotion use and malaria incidence (p-value = 0.156; OR = 2.294), and Triwahyuni (2016) reported no significant association between mosquito coil use and malaria incidence (p-value = 0.439). Conversely, Darmawansyah et al. (2019) found a significant association between repellent use and malaria incidence.

These differing research findings indicate that the effectiveness of mosquito repellent is influenced by the type, method of use, duration of protection, and consistency of use. Although some respondents used mosquito repellent, malaria cases still occurred, likely due to irregular use or suboptimal protection, particularly when *Anopheles* mosquitoes are most active at night. Therefore, education on the proper use of mosquito repellent, combined with other prevention methods, is needed to enhance protection against malaria.

The use of wire gauze affects the incidence of malaria in the work area of the Hanura community health center, Pesawaran regency, Lampung, Indonesia

The results showed that respondents with malaria were more likely to use wire mesh (66 people) (58.4%), while respondents without malaria were more likely to not use wire mesh (68 people) (60.2%). Statistical tests showed a significant association between wire mesh use and malaria incidence (p-value = 0.008; OR = 2.122; 95% CI = 1.248–3.608). Respondents who used wire mesh had a 2.122-fold greater risk of malaria compared to respondents who did not use wire mesh. These results align with research by Oktafiani et al. (2022), which showed a significant association between wire mesh use and malaria incidence (p-value = 0.04). Hikmawati (2018) also reported that homes without wire mesh had a 10.5-fold higher risk of malaria, while Siregar et al. (2021) found a 6.872-fold greater risk of malaria in communities without wire mesh. Research by Lubis Rahaya et al. (2021) also showed a 2.5-fold higher risk of malaria in homes without wire mesh. However, this finding disagrees with research by Wibowo (2017), which found no association between the use of wire mesh and malaria incidence (p-value = 0.380).

The difference in research results may be influenced by environmental conditions, house characteristics, community behavior, and the quality of the wire mesh installation. According to Astari (2017), wire mesh can limit the entry of *Anopheles* mosquitoes into homes, especially at night. However, observations showed that some wire mesh was damaged, not properly installed, or replaced with other materials, such as woven bamboo, which has gaps that allow mosquitoes to enter the house. This

suggests that the effectiveness of wire mesh is determined not only by its presence, but also by the quality of the material, its condition, and how it is installed. Installing good wire mesh is one of the physical protection efforts to reduce contact between humans and Anopheles mosquitoes as malaria vectors (Mustafa et al., 2018; Haris Ferdinal et al., 2021).

Nighttime activities affecting malaria incidence in the Hanura community health center work Area, Pesawaran regency, Lampung, Indonesia

The analysis showed that 66 respondents (58.4%) who experienced malaria spent more time outside the home at night, while 49 respondents (43.4%) who did not experience malaria did not spend more time outside. Statistical tests showed no significant relationship between nighttime activities and malaria incidence (p-value = 0.893). This indicates that nighttime activities do not significantly influence malaria incidence among respondents. These results align with Wahyuni's (2024) study in Batu Bara Regency, which found no relationship between nighttime activities and malaria incidence (p-value = 0.755). Saputro and Siwiendrayanti's (2015) study also showed similar results (p-value = 0.244). Furthermore, Hasyim et al. (2014) found no significant relationship between nighttime activities and malaria incidence (p-value = 0.439). However, these results disagree with Isnaeni et al.'s study. (2019) showed a significant association between nighttime outdoor activities and malaria incidence (p-value = <0.001; OR = 10.513). Sembiring (2019) also stated that nighttime activities can increase the risk of malaria by increasing contact with Anopheles mosquitoes, which actively seek blood at night.

The results of this study indicate that nighttime outdoor activities were not a major factor in malaria incidence among respondents. This is likely influenced by other factors such as mosquito density, environmental conditions, preventative behaviors, and residential conditions. However, nighttime activities still have the potential to increase exposure to Anopheles mosquito bites if not accompanied by adequate personal protection such as covering clothing or mosquito repellent.

CONCLUSION

Based on the research results, it can be concluded that the use of mosquito nets, mosquito repellent, and wire netting have a significant relationship with malaria incidence in the working area of the Hanura community health center, Pesawaran Regency, Lampung, Indonesia, while the activity of going out of the house at night does not show a significant relationship. The results of the study indicate that behavioral factors and the physical protection conditions of the house play an important role in malaria incidence. Therefore, promotive and preventive efforts are needed through education on the use of mosquito nets, the use of appropriate mosquito repellent, and the installation and maintenance of wire netting optimally to support more effective and sustainable malaria control.

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