VIVA MEDIKA
Jurnal Kesehatan, Kebidanan, dan Keperawatan

Homepage: http://ejournal.uhb.ac.id/index.php/vm
P-ISSN: 1979-2026 E-ISSN: 2656-1034
DOI: 10.35960/vm.v17i2.1499

Risk Factor Analysis of Malaria Incidence in Mimika Baru District, Mimika Regency, Central Papua Province

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ABSTRACT

Malaria remains a global issue. Indonesia ranks second in the highest number of cases in Asia. Malaria risk factors include host characteristics (age, gender, education), behavior (habit of going out at night, habit of working at night, habit of sleeping outside at night) and environmental factors (mosquito netting, bed net use, insect repellent use). This study aims to analyze the risk factors for malaria in Mimika Baru District, Mimika Regency, Central Papua. This research uses a quantitative approach with a cross-sectional study conducted on Desember 2023. The sampling technique involved 320 respondents using cluster sampling and purposive sampling. Data were collected through questionnaires and analyzed using univariate, bivariate (chi-square and T test), and multivariate (multiple logistic regression) analysis with SPSS. Out of 320 respondents, 117 (36.6%) tested positive for malaria and 203 (63.4%) tested negative. There were associations between gender (p=0.005), education (p=0.023), nighttime outdoor habits (p=0.025), nighttime work habits (p=0.000), sleeping outdoors (p=0.023), mosquito netting installation (p=0.012), bed net use (p=0.000), and insect repellent use (p=0.014) with malaria incidence. Age was not associated (p=0.302). The dominant factor was nighttime work habits (p=0.000; OR=13.898; 95% CI=6.447-29.959). Gender and education were significantly associated with malaria incidence, while age was not. Nighttime outdoor habits, nighttime work habits, and sleeping outdoors, as well as environmental factors were also significantly associated with malaria incidence in Mimika Baru.

Keywords: Malaria, Cross-Sectional Design, Host Characteristics, Environment

1. BACKGROUND

Infectious diseases like malaria remain a global issue, with nearly half of the world's population at risk. Malaria, along with HIV/AIDS and tuberculosis, is a communicable disease whose control is part of the Sustainable Development Goals (SDGs) to be achieved by the end of 2030 (United Nations: Department of Economic and Social Affairs, 2022). In 2021, there were approximately 247 million malaria cases, with 619,000 deaths globally. According to WHO data from 2022, Indonesia ranks second after India in Asia, with an estimated 811,636 positive cases in 2021. The malaria incidence rate in Indonesia remains below 1 per 1,000 population, including 0.9% in 2020. There was a 30% increase in malaria cases from 2021 to 2022. The same year, Papua had the highest incidence rate at 63.12 per 1,000 population, contributing about 90% of total

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cases in Indonesia. Eastern Indonesia, particularly West Papua and Papua, remains a focus due to the increasing number of positive malaria cases each year.

In 2022, there were 443,530 malaria cases in Indonesia, with 393,801 (89%) from Papua. Mimika Regency had the highest positive cases in Papua, totalling 77,379. The latest data also shows that Mimika Baru District had the highest number of cases within Mimika Regency, with 21,929 cases. Mimika Baru comprises three health centres: Pasar Sentral, Timika, and Timika Jaya. According to the Malaria Centre Chairman, the high number of cases in Mimika Baru is due to unhealthy lifestyles and unclean environments.

Individual and environmental factors influence the risk of malaria as both impact health status. John Gordon and La Richt's theory states that disease occurrence is influenced by the host (human), agent (cause), and environment. Malaria risk factors based on host characteristics include age, gender, education level, host behaviours like going out at night, working at night, and sleeping outside, and environmental factors like mosquito net installation, bed net use, and insect repellent use. Other risk factors, such as stagnant water and bushes, have a significant relationship with malaria incidence in Kerom Regency, Papua Province, suggesting further research on dominant risk factors.

Regarding methodology, individual characteristics like age, gender, education, and occupation were only analyzed univariately; hence, this study will proceed to bivariate and multivariate analyses. According to interviews with staff from the three health centres in Mimika Baru, there has been no research on malaria risk factors in the health centre's working area in 2023, making this the first study on malaria risk factors in Central Papua Province. Other risk factors, such as the presence of standing water and underbrush, significantly affect the incidence of malaria in Kerom Regency, Papua Province. Therefore, this study recommends further research on other dominant risk factors associated with malaria incidence (Manangsang et al., 2021). Based on a review of the methodological aspects, individual characteristics such as age, gender, education, and occupation were limited to univariate analysis. Therefore, this study will proceed to bivariate and multivariate analyses (Lewinsca et al., 2021). From the perspective of the research location, based on interviews with staff at three related institutions, namely the three public health centers (PUSKESMAS) in Mimika Baru District, research on malaria risk factors had yet to be conducted in the health centers' working areas in 2023. Therefore, this study is the first in Central Papua Province to address malaria risk factors. Based on the above data and information, the author is interested in studying the risk factors for malaria incidence in Mimika Baru District, Mimika Regency, Central Papua Province. This study analyzes the risk factors for malaria incidence in Mimika Baru District, Mimika Regency, Central Papua Province.

2. RESEARCH METHODOLOGY

This study employs a quantitative approach utilizing a cross-sectional study design. The study was carried out in December 2023 at the Timika Health Center located in the Mimika Baru District, Central Papua Province. This research used the formula from Lameshow (1990) to gather a big sample. The sampling technique involved 320 respondents using two stages: cluster sampling and purposive sampling. In the first stage, the public health center (PUSKESMAS) with the highest population, Timika Health Center, was selected. In the next stage, samples within the chosen population were determined using purposive sampling, which aligns with the sample criteria. The inclusion criteria for the sample are individuals who have fever complaints, undergo microscopic malaria examinations at Timika Health Center, and are willing to participate and agree to informed consent. The exclusion criteria are individuals who are unwilling to participate. The independent variables in this study are age, gender, education, nighttime outdoor habits, nighttime work habits, sleeping outside at night, mosquito net installation on ventilation, bed net use, and insect repellent use. In contrast, the dependent variable is the incidence of malaria. Data collection was done through

questionnaires (which has been tested for validity and reliability) filled out by the research subjects. The data analysis included univariate analysis, bivariate analysis using chi-square, and multivariate analysis using multiple logistic regression in SPSS.

3. RESULT AND DISCUSSION

Univariat Analysis

Table 1. Age Distribution in Mimika Baru

N	Mean	Median	Modus	SD	Min	Max
320	25,29	24,00	4	17,831	1	78

Table 1 shows that all respondents are aged between 1 and 78 years, with an average age of 25. The most frequent age group among respondents is four years old.

Table 2. Sex and Education Distribution in Mimika Baru

Host Characteristics	N	%
Sex		
Male	183	57,2
Female	137	42,8
Education		
No/Not yet School	87	27,2
University	33	10,3
Senior High School	96	30,0
Junior High School	77	24,1
Elementary	27	8,4

Table 2 displays the distribution by gender, indicating that 183 people (57.2%) are male, while 137 people (42.8%) are female. The distribution by the highest education level shows that 33 people (10.3%) have a college education, 96 people (30.0%) have a high school education, 77 people (24.1%) have a middle school education, 27 people (8.4%) have an elementary school education, and 87 people (27.2%) have no formal education or are not yet in school.

Table 3. *Host* Attitude Distribution in Mimika Baru

Host Attitude	N	%
Habit of leaving the house at night		
Yes	76	23,8
No	244	76,2
Habit of Working at Night		
Yes	97	30,3
No	223	69,7
Habit of sleeping outside the house at night		
Yes	22	6,9
No	298	93,1

Table 3 presents the distribution of host behavior based on nighttime outdoor habits, showing that 76 people (23.8%) have the habit of going out at night, while 244 people (76.3%) do not have this habit. The distribution of host behavior based on nighttime work habits shows that 97 people (30.3%) work at night, while 223 people (69.7%) do not. The distribution of host behavior based on sleeping outdoors at night shows that 22 people (6.9%) sleep outdoors, while 298 people (93.1%) do not.

Table 4. Environment Factor Distribution in Mimika Baru

Host Attitude	N	%
Use of Mosquito Screens in Ventilation		
Yes	275	85,9
No	45	14,1
Use of Mosquito Nets		
Yes	103	32,2
No	217	67,8
Use of Mosquito Repellent		
Yes	124	38,8
No	196	61,3

Table 4 displays the distribution of environmental factors based on the use of mosquito screens on ventilation, showing that

275 people (85.9%) have installed mosquito screens on their ventilation, while 45 people (14.1%) have not. The distribution of environmental factors based on mosquito nets shows that 103 people (32.2%) use mosquito nets, while 217 people (67.8%) do not. The distribution of environmental factors based on mosquito repellent shows that 124 people (38.8%) use mosquito repellent, while 196 people (61.3%) do not.

Bivariate Analysis

Table 5. Bivariate Analysis

No	Variable	p - value
1	Age	0,302
2	Gender	0,004
3	Education	0,023
4	Nighttime Outdoor Activity	0,027
5	Nighttime Work	0,000
6	Sleeping Outdoors	0,026
7	Mosquito Netting	0,013
8	Bed Net Use	0,000
9	Insect Repellent Use	0,013

a. Age and Malaria Incidence

The t-test analysis on the relationship between age and malaria incidence in Mimika Baru District shows that the average z-score for respondents without malaria is 26.07 with a standard deviation 19.234. Meanwhile, the average z-score for respondents with malaria is 23.93, with a standard deviation of 15.072. The statistical test results in a p-value of 0.302 ($p<0.05$). Therefore, it can be inferred that there is no substantial disparity in the mean z-scores of individuals who have malaria and those who do not.

Statistical tests show no significant relationship between age characteristics and malaria incidence. A study by (Afriani, 2016) also showed no significant relationship between age and malaria incidence. Women generally have a more robust immune response compared to men. In general, it can be said that anyone can contract malaria. The difference in prevalence by age is related to different malaria immunity levels. Immunity acquired by infants from their mothers protects against infectious diseases. It may also be due to the same level of exposure to malaria vectors in both age groups if the home conditions for both groups still allow for mosquito breeding and resting places, such as hanging used clothes inside the house, shrubs around the house, and low awareness of using mosquito nets to avoid Anopheles mosquito bites, which usually occur at night. Additionally, weaker immunity in young ages and reduced immunity in older age groups due to comorbidities can lead to more uncomplicated Plasmodium infections, causing malaria.

b. Gender and Malaria Incidence

The statistical test based on gender shows that 43.2% of male respondents had malaria, while 27.7% of female respondents had malaria. The analysis of the relationship between gender and malaria incidence indicates a significant relationship ($p<0.05$).

In this study, the relationship between gender and malaria incidence shows a significant correlation. Gender is one of the factors influencing malaria incidence due to its association with outdoor and work habits. There is an essential relationship between gender and outdoor activities after 9 PM because men are likelier to go out after 9 PM than women in North-Central Nigeria. (Njim et al., 2018) also found a notable correlation between gender and the occurrence of malaria, with men being at a one-time higher risk of contracting malaria compared to women. The theory suggests that morbidity and mortality rates are higher in men compared to women. Males exhibit a reduced humoral and cellular immune response to infections during infancy and youth, leading to a higher vulnerability and greater severity of infectious diseases. At the same time, females have a more robust immune response than males.

c. Education and Malaria Incidence

Based on the last education level, the percentage of respondents who had malaria is as follows: 23.1% for those with no formal education or not yet in school, 13.7% for elementary school education, 29.1% for middle school education, 23.9% for high school education, and 10.3% for higher education. The analysis shows a significant relationship

between education level and malaria incidence ($p<0.05$).

The study shows a relationship between education and malaria incidence. Research by (Isworo et al., 2023) showed a significant relationship between education and malaria. There is a positive correlation between the percentage of the population with low education levels and malaria incidence. According to a study in Ethiopia, people with higher education levels are less likely to contract malaria than those with lower education levels. Similarly, a study in Nigeria showed a correlation between higher education and improved health habits and knowledge about malaria prevention. Education level does not directly affect malaria incidence but influences the type of occupation and behavior of an individual. The lower the education level, the lower the mindset in dealing with the home environment and the reluctance to seek information about malaria. Community knowledge about malaria, including how it is transmitted, prevention, and treatment, is essential in preventing and controlling malaria. A study by (Lombogia et al., 2015) stated that community knowledge about malaria transmission is quite good. However, knowledge about malaria-causing species, the biting behavior of malaria-spreading mosquitoes, and malaria breeding places is still lacking.

d. Nighttime Outdoor Activity and Malaria

33.2% of those who do not engage in nocturnal activities were found to have contracted malaria, while 47.4% of those with this habit had malaria. The statistical test ($p<0.05$) indicates a significant relationship between nighttime outdoor activity and malaria incidence.

Statistical tests show a significant relationship between the habit of going outside at night and malaria incidence. The habit of going outside at night is significantly associated with malaria incidence. (Setiawan et al., 2021) also demonstrated a link between going out at night and malaria incidence at the Krueng Sabee Health Center, where respondents who went out at night were four times more likely to suffer from malaria than those who did not have this habit. Behaviors such as going outside at night are closely related to malaria incidence in Southeast Asia. Other studies have also stated that the high risk of malaria is closely associated with nighttime activities, which include watching TV, drinking, and fishing in rivers or lakes. Research conducted in North-Central Nigeria found that 34.0% of people spent their nighttime outdoors watching TV, 39.8% just sitting outside, 9.1% playing outside, and 16.7% drinking with friends. Anopheles mosquitoes are known to be more active at night from 6 PM to 4 AM compared to morning and daytime. Mosquitoes prefer shaded, low-light, and dark places, especially in areas with many bushes and large trees or rice fields, making the area humid. Research conducted in the Salaman I Health Center Working Area, Magelang Regency, showed that people who stayed outside at night were 2.3 times more likely to contract malaria compared to those who did not stay outside at night. Staying outside until late at night makes it easier to get mosquito bites, especially since malaria vectors are exophilic and exophagic.

e. Nighttime Work and Malaria

24.7% of respondents who do not work at night had malaria, while 63.9% of those who work at night had malaria. The statistical test ($p<0.05$) shows a significant relation between nighttime work and malaria incidence.

Statistical tests also show a significant relationship between nighttime work habits and malaria incidence. Research by (Setiawan et al., 2021) at the Krueng Sabee Health Center found that respondents with risky jobs (farmers, fishermen, and laborers working at night) were likelier to suffer from malaria. (Wibowo, 2017) stated that respondents with risky jobs were three times more likely to contract malaria than those with non-risky jobs. Malaria incidence is also highly related to occupation, with a higher risk for the working population compared to the non-working population. Jobs are often assessed based on the possibility and degree of exposure and the level of risk according to the nature of the job, which also affects the work environment and the socio-economic

characteristics of employees in certain occupations.

f. Sleeping Outdoors and Malaria

34.9% of respondents who do not have the habit of sleeping outdoors had malaria, while 59.1% of those who sleep outdoors had malaria. The statistical test ($p<0.05$) indicates a significant relationship between sleeping outdoors and malaria incidence.

The research shows a significant relationship between the habit of sleeping outside and malaria incidence. Research conducted in North-Central Nigeria found that 64.5% of respondents said they slept outdoors, while 35.5% said they slept indoors. In addition to nighttime activities showing human behavior that potentially affects malaria intervention outcomes, sleeping outdoors at night is also a habit that can undermine the expected outcomes of interventions. It indicates a lack of malaria prevention practices among those who sleep outdoors—research in Kec. Mimika Baru showed that respondents chose to sleep outdoors due to the climate, where people needed to cool off outside when the weather was hot, especially those with young children. This aligns with research in Tengzet, Nigeria, where weather conditions due to climate change were the main reason for choosing to sleep outdoors at night. Although it is difficult to explain the causal relationship between climate change and malaria transmission, there is no doubt that it has significantly contributed to the current spread of the disease. Observations of 182 respondents in 24 households in Ghana found that 42% of the study population slept outdoors at some time during the night. Observations related to the use of mosquito nets were also still low, both for sleeping indoors and outdoors. The study shows that sleeping outdoors can significantly increase the risk of malaria.

g. Mosquito Screens on Ventilation and Malaria

53.3% of respondents who did not install mosquito screens on ventilation had malaria, while 33.8% of those who installed them had malaria. The statistical test ($p<0.05$) shows a significant relationship between mosquito screens on ventilation and malaria incidence.

The study shows a significant relationship between the installation of mosquito screens on ventilation and malaria incidence. Research by (Lubis et al., 2021) and (Siregar, 2019) found that using wire screens affects malaria incidence. Respondents who did not use wire screens on their home ventilation were nearly three times more likely to suffer from malaria than those who used wire screens. Research conducted in Sub-Saharan Africa shows that increased ventilation in buildings significantly reduces mosquito entry in Tanzania and is supported by research in Gambia, suggesting that this can be widely applied for malaria control in the area. Although visible light outside the hut increases mosquito entry into the house, good natural ventilation reduces the indoor concentration of carbon dioxide, a significant mosquito attractant, thereby reducing mosquito entry into the house. Installing mosquito screens on ventilation is known to be one of the preventive behaviors to avoid mosquito bites. Installing mosquito screens on home ventilation affects how easily mosquitoes can enter the house, whereas ventilation without mosquito screens makes it easier for mosquitoes to enter.

h. Mosquito Nets and Malaria

46.1% of respondents who did not use mosquito nets had malaria, while 16.5% had malaria. The statistical test ($p<0.05$) indicates a significant relationship between mosquito net usage and malaria incidence.

Statistical tests indicate a significant relationship between the use of mosquito nets and the incidence of malaria. Several factors significantly influence malaria incidence, one of which is the use of mosquito nets. Respondents who did not use mosquito nets were nearly six times more likely to suffer from malaria than those who used mosquito nets. A study conducted in Tanzania revealed that a 10% rise in the ownership of mosquito nets at the village level led to an average decrease of 52% in malaria-related deaths across all age groups in Rufiji HDSS. In Ifakara HDSS, there was a 12.1% drop in malaria mortality. The

results show an average reduction in malaria mortality by 5.4% for children under five years. Regular use of mosquito nets can reduce malaria incidence, as stated in several articles, and is a significant factor in malaria prevention. Research findings suggest that those who consistently fail to utilize mosquito nets throughout nighttime have a 4.2% likelihood of contracting malaria. Most respondents cited reasons for not using mosquito nets, such as the unavailability of nets, feeling hot, and using the nets only for some family members. Utilizing mosquito nets is a highly effective measure to prevent and minimize the interaction between Anopheles mosquitoes and individuals in good health during nighttime rest. As known, Anopheles mosquitoes actively seek blood at night. Using undamaged or unholed mosquito nets at night can prevent or protect against Anopheles mosquito bites. Using mosquito nets is an effort to reduce the risk of Anopheles mosquito bites. By not biting, no contact between humans and mosquitoes is active at night. Therefore, the prevention of malaria cases, particularly in regions where the disease is prevalent, necessitates the utilization of mosquito nets.

i. Mosquito Repellent and Malaria

41.8% of respondents who did not use mosquito repellent had malaria, while 28.2% of those who used it had malaria. The statistical test ($p<0.05$) shows a significant relationship between mosquito-repellent usage and malaria incidence.

The study demonstrates a substantial correlation between the utilization of insect repellent and the occurrence of malaria. This result aligns with (Lewinsca et al., 2021), who stated that the use of mosquito repellent has a significant relationship with malaria incidence. The malaria incidence risk is also related to the use of mosquito repellent. A study conducted at the Dawai Health Center in the East Yapen District of the Yapen Islands Regency revealed that individuals who did not use mosquito repellent had a 3.2-fold increased likelihood of contracting malaria compared to those who did. Respondents who did not use mosquito repellent experienced mosquito bites at night. However, some respondents who did not use mosquito repellent cited reasons such as disliking the smoke, causing shortness of breath, and already having mosquito nets. Using mosquito repellent prevents mosquito bites and malaria transmission if not used continuously. Research in endemic areas of Lahat Regency shows a relationship between the use of mosquito repellent and malaria incidence. Vector control can generally be done by eliminating mosquito breeding sites and preventing mosquito bites. Various types of mosquito repellents include mosquito coils (fumigants), spray repellents (aerosols), and now electric mosquito repellents and topical mosquito repellents (mosquito repellents). Most respondents in this study used mosquito coils and some used spray repellents. Using mosquito repellent is a preventive behavior against mosquito bites because those who do not are more likely to be infected than those who use mosquito repellent.

Multivariate Analysis

Table 6. Multivariate Analysis

Variable	B	OR	*p value*
Gender	-0,797	0,451	0,006
Education	-0,611	0,543	0,000
Nighttime Activity	1,014	2,755	0,006
Nighttime Work	2,632	13,898	0,000
Mosquito Netting	-0,769	0,463	0,047
Bed Net Use	-1,261	0,283	0,000

The final multivariate analysis model results indicate that the variables associated with malaria incidence include gender, education, nighttime outdoor activity, nighttime work, use of mosquito screens on ventilation, and use of mosquito nets. Nevertheless, the primary factor strongly linked to the occurrence of malaria is engaging in nighttime employment, which poses a 13.898-fold greater risk for individuals who have the practice of working throughout the night. Nighttime Outdoor Activity and Nighttime Work: These variables show an OR (Odds Ratio) > 1, indicating that these factors increase the risk of malaria. Gender, Education, Use of Mosquito Screens on Ventilation, and

Use of Mosquito Nets: These variables show an OR < 1, indicating that these factors decrease the risk of malaria or have a protective effect.

Based on multivariate analysis, the most dominant factor related to malaria incidence in Mimika Baru District is the habit of working at night. The habit of working at night can play an essential role in malaria incidence due to the conditions of the job. Nighttime work poses a greater risk of mosquito bites, which increases the respondent's risk of contracting malaria.

One consequence of excessive physical activity is fatigue. Fatigue can affect the liver and spleen functions in forming β lymphocytes needed in immunological reactions. This condition can lower the body's immune system, making it easier to contract malaria. In patients who have previously suffered from malaria, it can reactivate parasites in the liver cells or as hypnozoites.

Most respondents who contracted malaria had high-risk jobs. High-risk jobs performed by respondents included fishing, farming, and private employees who alternated night shifts in open areas. These high-risk jobs are primarily carried out in mosquito resting places. Such jobs, especially in endemic areas, have a high likelihood of contact with Anopheles mosquito bites, making it easier to contract malaria. To reduce direct contact between Anopheles mosquito vectors and people, individuals should wear body protection such as long-sleeved shirts and long pants, as well as apply mosquito repellent lotion, when performing high-risk jobs.

CONCLUSION

Based on the research results, gender, education, the habit of going out of the house at night, the habit of working at night, the habit of sleeping outside the house at night, installing mosquito screens on ventilation, using mosquito nets, and using mosquito repellent are related to the incidence of malaria. However, the habit of working at night is the most dominant risk factor, 13,898 times associated with the incidence of malaria (p-value = 0.000).

SUGGESTION

The researcher's suggestion for Puskesmas is that enhancing health promotion by educating the community on malaria prevention efforts related to risk factors is crucial. It is hoped that the community can support and adopt healthy behaviors to prevent and reduce malaria incidences, such as installing mosquito nets on ventilation, using bed nets, and mosquito repellents. For the government, these research findings can serve as a basis for further policymaking, particularly in environmental control, by providing facilities like bed nets and mosquito repellents for malaria prevention and control efforts.

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