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Risk Factors Associated with The Incidence of Malaria in Mimika Baru District

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Abstract

Malaria remains a major health issue in Indonesia, particularly in the eastern regions, which contribute to about 90% of national cases. Mimika Regency, especially Mimika Baru District, is one of the high-endemic areas. This study aimed to identify human and environmental risk factors associated with malaria incidence. The research, conducted from May to June 2025 in Mimika Baru District, used a cross-sectional design with 155 respondents selected through stratified random sampling. Data were analyzed univariately and bivariately using the chi-square test. Variables included age, gender, education, occupation, healthcare access, knowledge, ventilation screen use, mosquito net use, ceiling availability, and the existence of mosquito breeding sites, resting places, and animal shelters. Results showed that 83.6% of respondents had contracted malaria in the past year. Factors significantly associated with malaria incidence were the use of ventilation screens (p=0.050), mosquito nets (p=0.025), ceilings (p=0.015), breeding sites (p=0.002), resting places (p=0.015), and animal shelters (p=0.025). Strengthening malaria prevention and control through public education, distribution of insecticide-treated nets, and improved environmental management is recommended.

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INTRODUCTION

Malaria continues to be a significant public health issue in Indonesia, especially in endemic areas like Papua where environmental conditions promote its spread. Caused by the Plasmodium parasite and transmitted through the bite of Anopheles mosquitoes, malaria remains a significant challenge in tropical countries such as Indonesia. According to the 2023 World Malaria Report, Indonesia reported over 500.000 cases, primarily concentrated in Papua. Despite the presence of healthcare facilities, high malaria rates persist in certain areas such as Mimika Baru District. Several regions report an Annual Parasite Incidence (API) above 1.500, indicating high transmission levels (1).

The epidemiological triad consists of the host, agent, and environment. The host refers to the individual or population at risk of contracting the disease, influenced by factors such as age, gender, genetic, and immunity (2). The agent is the causative factor of the disease, such as the *Plasmodium* parasite responsible for malaria incidence. The environment encompasses external factors that affect the agent and host, including climate, living conditions, and social determinants of health. These three components interact in a complex way to influence the occurrence and spread

of diseases. In the case of malaria, understanding these interactions can help in designing more effective prevention and control strategies.

Numerous studies have explored the factors influencing malaria transmission in various regions, highlighting environmental, individual, and socioeconomic factors as key contributors. risks include poorly ventilated homes and the absence of mosquito nets, with studies indicating that houses with screens can lower malaria risk by up to 5,000 times compared to houses without screens (3). In terms of individual factors, male residents, especially those of working age, are more at risk due to increased outdoor activity, which raises exposure to Anopheles mosquitoes (4). Additionally, educational factors are crucial, as individuals with lower educational levels often have less knowledge about malaria prevention, which can lead to higher infection rates. According to the Triad Epidemiological theory by Gordon and La Riche, there are three primary interactions that can lead to disease: the host, the agent, and the environment. The host refers to individuals or populations at risk of contracting a disease, such as those with certain characteristics, including age, gender, and education level. The agent is the causative factor of the disease, such as the Plasmodium parasite. (5). On the other hand, the vector is the organism that transmits the agent, in this case, the Anopheles mosquito, which carries and spreads the Plasmodium parasite to humans (6). The environment encompasses external factors that influence both the agent and the host, such as housing conditions and social environment, which refers to community habits or behaviors, including the use of bed nets, ventilation screens, and the presence of ceilings (7).

This study provides an integrated perspective by combining environmental and individual educational factors to highlight the complex nature of malaria transmission in the region. It tackles the challenge of understanding what contributes to the high malaria rates in Mimika Baru District, aiming to offer practical recommendations for more effective malaria control strategies. This study aimed to identify the risk factors for malaria incidence related to both human and environmental factors.

METHODS

This study employed a quantitative approach with a cross-sectional design to identify risk factors associated with malaria at a specific point in time in Mimika Baru District. The research was conducted from May to June 2025. The study population consisted of 171.200 residents across 16 villages. Sampling was carried out using the stratified random sampling technique, in which all villages in Mimika Baru District were included as strata. Within each village, respondents were selected randomly, ensuring that every individual had an equal chance of being chosen, and that the sample was proportionally representative of the population.

The sample size was calculated using the Lameshow formula for two-proportion hypothesis testing with a 95% confidence level. Among the variables tested, gender produced the largest required sample size (62 respondents). Therefore, the final minimum sample size was determined by taking the largest calculated sample and multiplying it by two, resulting in 124 respondents. To minimize the potential for invalid or incomplete data, an additional 10% was added to the total, bringing the final sample size to 155 respondents. The variables examined in this study include age, gender, education level, occupation, access to healthcare facilities, knowledge, use of ventilation, use of mosquito nets, presence of ceilings, presence of breeding places, presence of resting places, and presence of animal cages.

Data were collected using a closed-ended questionnaire based on the standardized Riskesdas (Basic Health Research) 2018 questionnaire. The Riskesdas (Basic Health Research) is a national survey conducted by the Health Research and Development Agency (Balitbangkes) in Indonesia, which assesses the prevalence of diseases, health risk factors, and access to healthcare services. This study also uses a previous research questionnaire, and a questionnaire that had undergone validity and reliability testing, particularly for the malaria knowledge variable.

Instrument validity and reliability testing were conducted prior to data collection in May 2025 on 30 respondents who were not part of the main sample. The validity test used Pearson's correlation, showing all items had correlation coefficients (r count) greater than the r table value of 0.361, indicating all items were valid. Reliability was assessed using Cronbach's Alpha, yielding a value of 0.809, which indicates a high level of internal consistency. These results confirmed that the instrument was both valid and reliable for use in the main study.

The data were processed and analyzed using statistical software, employing univariate analysis for descriptive statistics and bivariate analysis to examine relationships between risk factors and malaria incidence. This study has passed the ethical test stage, which is appropriate and determined by the Komite Etik Penelitian UPN "Veteran Jakarta." Ethical approval was granted under Ethical Approval Number: 55/VI/2025/KEP.

RESULTS AND DISCUSSION

Univariate analysis was conducted to determine the distribution of research by calculating the frequency and percentage of each study variable.

Table 1. Proportion of Malaria Incidence in Mimika Baru District

Variable	Frequency	Presentation (%)
Malaria Incidence		
Ever Had	123	79.4
Never Had	32	20.6
Total	155	100

Based on the data from Table 1 above, the proportion of malaria cases was found to be 123 out of 155 respondents (79.4%). The proportion of respondents who had contracted the disease in the past month was 56, while 67 respondents had malaria in the past year. This might be due to the fact that Mimika Baru is one of the malaria-endemic areas in Papua Province that contributes approximately 90% of the total malaria cases at the national level (8). This can also be caused by several factors, such as the variables examined in this study, the geographic conditions of Mimika Baru District which tend to be humid, and the unpredictable climate and daily rainfall, all of which lead to water accumulation that can become breeding grounds for mosquitoes.

Table 2. Frequency Distribution of Respondents

Variable	Frequency	Presentation (%)
Age		
Productive	126	81.3
Non Productive	29	18.3
Gender		
Male	54	34.8
Female	101	65.2
Education Level		
Low	63	40.6
High	92	59.4
Jobs		
High Risk	118	76.1
Medium Risk	35	22.6
Low Risk	2	1.3
Health Facilites		
≥5 km	40	25.8
<5km	115	74.2
Knowledge		
Low	29	18.7
Middle	68	43.9
High	58	37.4
Use of Ventilation Screen		
Improper	105	20.6
Proper	50	79.4

Based on the frequency distribution data presented in Table 2, in terms of age, most respondents (81.3%) were in the productive age group, indicating that the majority of those affected by malaria are within the economically active population. This suggests that malaria remains a significant health concern for individuals who are essential to the workforce. Only 18.3% of the respondents were non-productive, which includes the elderly and children who may have different levels of exposure and vulnerability to malaria. This trend aligns with findings from previous study which show that the proportion of malaria cases in the productive age group has been steadily increasing over the years, with a higher malaria burden observed in adults compared to other age groups (9).

The most malaria-infected patients were female, comprising 65.2% of the total 155 respondents. This gender difference may reflect varying exposure levels due to different outdoor activities or household roles. Malaria cases are more commonly found in males. This is because males tend to spend more time outdoors and have jobs that require them to be outside at night (10). In addition, there are internal factors that make males more susceptible to malaria. One of these is the hormonal difference between males and females, which affects the immune response to malaria (11). In terms of education, more than half of the respondents (59.4%) had a high level of education, with many having completed higher education. This suggests that, while education levels are relatively high, there may still be a gap in translating knowledge into effective malaria prevention practices, particularly regarding behavioral changes, such as the use of preventive tools like bed nets. This gap could be influenced by socio-cultural factors, lack of access to prevention tools, or inadequate health education programs that fail to emphasize the importance of preventive measures despite high educational attainment. Thus, improving practical knowledge and reinforcing behavior changes at the community level could significantly enhance malaria prevention efforts.

Table 3. Frequency Distribution of Respondents on Environment Vactors

Use of Mosquito Nets		
No	107	71.6
Yes	48	28.4
Presence of Ceilings		
Improper	53	19.4
Proper	102	80.6
Presence of Breeding Place		
Existing	110	78.1
Non- existing	45	21.9
Presence of Resting Place		
Existing	56	19.4
Non- existing	99	80.8
Presence of Animal Shelters		
Existing	107	71.6
Non- existing	48	28.4

However, a large portion of the population still faces exposure risks due to environmental factors. Regarding housing and environmental factors, 71.6% of respondents did not use bed nets while sleeping, indicating a major shortcoming in preventive practices. Most respondents' houses had proper ceilings (80.6%), which could help limit mosquito access. However, the presence of breeding sites (78.1%) and resting sites (19.4%) for mosquitoes in the vicinity, combined with 71.6% of respondents having animal enclosures near their homes, creates a conducive environment for mosquito transmission. These findings highlight the need to improve environmental management and increase the use of bed nets. Additionally, addressing the presence of animal enclosures near homes is critical, as they can serve as attractants for mosquitoes. By improving these factors, the risk of malaria transmission can be significantly reduced, and preventive practices can be strengthened.

Table 4. Bivariate Analysis of Risk Factors of Malaria Incidence

	Malaria Incidence				**Total**		***p value***
	Malaria		**Not Malaria**				
	n	**%**	**n**	**%**	**n**	**%**	
Gender							
Male	49	90.7	5	9.3	54	100	0.010
Female	74	73.3	27	26.7	101	100	
Education Level							
Low	45	71.4	18	28.6	63	100	0.044
High	78	84.8	14	15.2	92	100	
Use of Ventilation Screen							
Improper	93	88.6	12	11.4	105	100	<0.001
Proper	30	60.0	20	40.0	50	100	
Use of Mosquito Nets							
No	92	86.0	15	14.0	107	100	0,.002
Yes	31	64.6	17	35.4	48	100	
Presence of Ceilings							
Improper	48	90.6	5	9.4	53	100	0.013
Proper	75	73.5	27	26.5	102	100	
Presence of Breeding Place							
Existing	97	88.2	13	11.8	110	100	<0.001
Non- existing	26	57.8	19	42.2	45	100	
Presence of Resting Place							
Existing	50	89.3	6	10.7	56	100	0.022
Non- existing	73	73.7	26	26.3	99	100	
Presence of Animal Shelters							
Existing	91	85.0	16	15.0	107	100	0.009
Non- existing	32	66.7	16	33.3	48	100	

Relationship Between Human Factors and Incidence of Malaria

Based on the research, gender was a significant factor associated with malaria risk. The study found that 90.7% of males are affected by malaria (p-value = 0.010), indicating a strong association between gender and malaria incidence. This finding suggests that males are at a higher risk of contracting malaria compared to females. One of the contributing factors is that men tend to spend more time outdoors, especially from night until early morning, either for work or socializing. This increased exposure to the environment, particularly during peak mosquito activity hours, significantly raises the risk of malaria transmission. Additionally, hormonal differences also contribute to the higher susceptibility of males to malaria compared to females. Testosterone in the male's body can suppress the immune response, making men more vulnerable to infection, including malaria (12). This hormonal influence may contribute to the increased malaria incidence observed in males. Furthermore, the immune system of males may be less responsive to infections, further explaining the higher rate of malaria cases among men. These findings are consistent with studies conducted in other regions. For instance, research in North Kivu revealed a significant relationship between gender and malaria incidence, with similar results showing that males were more susceptible to malaria (p-value <0.050) (13). This supports the notion that gender, particularly male exposure and immune system differences, is a key determinant in malaria risk. Given the results, it is important to focus on gender specific interventions dan prevention, particularly in males who are more likely to be exposed to malaria mosquitoes.

In addition regarding human factors, the level of education was also found to be significantly related to malaria incidence (p value = 0.044). Individuals with higher education levels have a lower risk of contracting malaria, likely due to better knowledge, attitudes, and behaviors compared to those with lower education levels. This suggests that education plays a crucial role in malaria prevention by enhancing individuals' awareness and understanding of the disease. People with higher education levels tend to have better access to health information, which helps them make informed decisions about prevention methods, such as using bed nets, avoiding mosquito breeding areas, and seeking timely treatment. This research is consistent with a study in Southwest Nigeria, which also found a significant correlation between education level and malaria incidence (p value = 0.012) (14). The study emphasized that those with formal education generally have a better understanding of malaria prevention and treatment strategies compared to those without formal education (15). Higher levels of education are associated with greater health literacy, which can lead to improved malaria control practices. In contrast, individuals with lower education levels may lack access to critical health information, which increases their vulnerability to malaria. An individual with higher education should generally have better knowledge compared to someone with lower education. People with limited knowledge about malaria have a higher risk of contracting the disease compared to those with adequate and good knowledge (16). This highlights the importance of educational interventions in malaria prevention strategies. Public health campaigns should focus on increasing awareness and providing education to communities, especially in areas with lower education levels, to improve malaria prevention efforts.

Relationship Between Environmental Factors and Incidence of Malaria

Based on the research, a significant relationship was found between various environmental factors and malaria incidence in Mimika Baru District. The installation of a properly ventilated screen significantly reduces the risk of malaria (p value <0.001). This finding aligns with the study in Mimika Regency which also found a significant correlation between ventilation screens and malaria incidence (p-value < 0.000) (16). Additionally, a 2024 study confirmed a significant relationship between ventilation screens and malaria incidence (p value = 0.001) (17). The correlation can be explained

through their role in reducing the entry points of mosquitoes into a home. When the spaces are properly screened with fine mesh, it becomes much harder for mosquitoes to enter, thus reducing the chances of residents being bitten and infected with malaria. Therefore, the presence of better ventilation in the house can significantly reduce malaria transmission (18). In addition to the role of the ventilation screen, the use of bed nets has also been found to be a critical factor in malaria prevention. A significant correlation is also found between the use of bed nets and malaria incidence (p value = 0,002), it concluded that individuals who do not use bed nets at night are at a higher risk of being infected with malaria. Using bed nets is an effective way to reduce malaria transmission. Bed nets, particularly those treated with insecticides, provide an effective barrier between individuals and mosquitoes, especially Anopheles mosquitoes, which are responsible for spreading malaria. These nets have proven to be one of the most cost-effective measures in malaria prevention, especially in regions with high transmission rates. In Mimika Baru, most of the population still underestimating the importance of using bed nets, believing that bed nets are ineffective in preventing malaria and feeling reluctant to set them up in their sleeping areas. Studies in malaria-endemic areas have shown that the consistent use of bed nets can reduce malaria incidence by up to 62% (19). This highlights the potential impact of bed nets in reducing malaria cases, particularly when combined with other preventive measures such as insecticide treated nets. However, this finding contrasts with research conducted in 2022, which found no significant relationship between malaria and the use of bed nets (20).

Beyond the use of bed nets, other environmental factors, such as the presence of a ceiling in homes, also play an essential role in malaria incidence. Based on this study, a significant relationship was found between having a well installed ceiling and malaria incidence (p value = 0.013). This indicates that people with poor or no ceilings are at a higher risk of contracting malaria. The analysis shows that inadequate ceiling installation is a risk factor for malaria. Installing a proper ceiling can reduce gaps in the house, which serve as entry points for Anopheles mosquitoes. This suggests that proper ceiling installation can help reduce the risk of malaria in Mimika Baru. This finding aligns with the study in Kaligesing, which also found a significant relationship between the presence of a ceiling and malaria incidence (p value = 0.000) (21). It is additionally consistent with research in Jayapura, which observed a link between having a good ceiling and lower malaria incidence (3). According to the research in Purworejo, people without proper ceilings are 35 times more likely to contract malaria (21).

Another crucial environmental factor contributing to malaria transmission is the presence of mosquito breeding sites near residential areas. Based on the research conducted, a relationship was found between the presence of mosquito breeding sites (p value < 0.001). The closer the breeding habitat is to the house, the higher the risk of malaria transmission, as stagnant water serves as a place for larvae to live and develop into adult mosquitoes (22). This finding, with a Prevalence Ratio of 1.527, indicates that having a breeding site within 75 meters of a house is a significant risk factor for contracting malaria. This result highlight the importance of managing the surrounding environment to reduce the risk of mosquito breeding in residential areas. The proximity of breeding sites to homes creates a direct pathway for mosquitoes to enter, further increasing the likelihood of malaria transmission. This result aligns with the previous study, which found a relationship between breeding sites and malaria incidence (p value = 0.000) (21). Similarly, the research in Aceh also showed a correlation between malaria incidence and the presence of breeding places near residents' homes (p value = 0,034) (23). The study concluded that individuals living near mosquito breeding sites are at a significantly higher risk of contracting malaria than those who do not live near such sites (19).

In addition to breeding sites, other factors such as the presence of resting places for mosquitoes further contribute to malaria transmission. Based on the analysis, a significant relationship was found between the presence of resting places and malaria incidence (p value = 0.022). This is further supported by a Prevalence Ratio value of 1.121, indicating that

the presence of resting places is a risk factor for malaria incidence in Mimika Baru. Resting places are critical to malaria transmission because Anopheles mosquitoes, the primary vectors of malaria, often rest in these areas before returning to seek humans or animals as their food source. Mosquitoes tend to rest in shaded areas, such as bushes, trees, or other vegetation, where they are sheltered from the elements and can rejuvenate before going out to feed. This finding is consistent with the study in Arso City Health Center, which found a relationship between the presence of bushes as mosquito resting places and malaria incidence (p value = 0.000) (24). This finding is also supported by previous research which revealed a significant relationship between the presence of resting places (p value = 0.003) and malaria incidence, further highlighting that the presence of resting places around homes increases the risk of malaria exposure substantially (25).

Furthermore, animal shelters have been identified as another contributing factor in the spread of malaria in the Mimika Baru. Based on the analysis, a significant relationship was found between the presence of animal shelters and malaria incidence (p-value = 0.009). This suggests that having animal shelters is a risk factor for malaria in Mimika Baru. Animal shelters contribute to malaria transmission because Anopheles mosquitoes, the primary vectors for malaria, are attracted to animals such as goats, cats, and dogs, which they use as a source of blood. This finding aligns with the previous study, which found a significant relationship between animal shelters and malaria incidence (p-value = 0.002), indicating that the presence of animal shelters increases the risk of malaria (21). The study highlighted that animal shelters, often located near residential areas, serve as additional attractants for mosquitoes, thereby exacerbating the risk of malaria transmission. However, this finding contradicts research in Batu Bara District thet did not find a significant relationship between animal shelters and malaria incidence (p-value = 0.082). Despite this, their study showed that the presence of animal shelters around homes increased the risk of malaria by three times (20). These findings emphasize the importance of managing environmental factors, such as animal shelters, to reduce malaria risk in the region. Effective strategies could include minimizing mosquito attraction by maintaining proper hygiene around animal shelters, ensuring that animals are kept away from sleeping areas, and exploring interventions that limit mosquito access to these potential breeding and feeding sites.

CONCLUSION

This study found that 83.6% of respondents (128 of 155) had malaria. Most were female (79.4%) and had higher education (59.4%). Gender and education were significantly correlated with malaria incidence. Environmentally, 79.4% lived in houses with proper ventilation screens, 28.4% used bed nets, and 80.6% had good ceilings. Mosquito breeding sites were present in 78.1% of homes, while 80.8% had no resting places and 71.6% had no nearby animal shelters. Significant associations were found between malaria incidence and ventilation screens, bed net use, ceilings, breeding places, resting places, and animal shelters ($p < 0.05$). These findings highlight the need for comprehensive, community-based malaria control beyond health office interventions. Cross-sector collaboration involving housing, environmental, and educational authorities is essential to improve home infrastructure, promote mosquito-proof housing design, and strengthen health education. Regional governments should integrate malaria prevention into development planning and support sustainable community engagement to reduce transmission risk effectively.

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