

ORIGINAL RESEARCH

The Role of Parents and Environmental Conditions in the Incidence of Malaria in School-Aged Children in East Sumba Regency, Indonesia



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Abstract

Background: Malaria remains a major public health concern in eastern Indonesia, with East Nusa Tenggara Province ranking second in national malaria endemicity. In this region, East Sumba Regency is among the highest-burden districts, where school-aged children (5–14 years) account for 42.9% of reported cases and 2–3 new infections are recorded daily. Despite this high burden, limited research has examined how parental roles and environmental conditions contribute to malaria incidence in this vulnerable age group. Understanding these factors is critical for informing targeted prevention strategies.

Purpose: This study aimed to examine the relationship between parental roles and environmental conditions with the incidence of malaria among school-aged children in East Sumba Regency, Indonesia.

Methods: A cross-sectional quantitative study was conducted in January 2022 involving 120 school-aged children (grades 5 and 6) from an area in East Sumba Regency, selected through total sampling. Data were collected using validated, modified questionnaires measuring parental involvement and environmental conditions related to malaria risks. Descriptive statistics were used for univariate analysis, and Pearson's Chi-square test was applied for bivariate analysis.

Results: Among the respondents, 43 children (35.8%) had a history of malaria, while 77 (64.2%) had never experienced it. Poor parental roles were reported by 42.5% of participants, and 57.5% lived in substandard environmental conditions. Significant associations were found between parental roles ($p=0.020$) and environmental conditions ($p=0.018$) with the incidence of malaria.

Conclusion: Parental roles and environmental conditions are significantly associated with the incidence of malaria among school-aged children in East Sumba. Strengthening parental involvement and improving environmental health can be effective strategies for reducing malaria transmission in endemic settings.

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1. Introduction

Malaria is a life-threatening infectious disease caused by Plasmodium parasites, transmitted to humans through the bite of infected Anopheles mosquitos. It remains a major global health concern, particularly in tropical and subtropical regions, where children, pregnant women, and individuals with weakened immunity are especially vulnerable. In 2020, the World Health Organization reported 241 million malaria cases and approximately 627,000 related deaths across 85 endemic countries, with an increase to 247 million cases across 84 countries by 2021 (World Health Organization [WHO], 2022). In response, malaria elimination has been identified as a key target within the Sustainable Development Goals (SDGs), with global eradication aimed for by 2030 (WHO, 2022).

Indonesia has aligned its national strategy with SDGs by establishing a malaria elimination target for 2030, as outlined in Ministry of Health Regulation Number 293/Menkes/SK/IV/2009 (Ministry of Health Republic of Indonesia [MoHRI], 2019; 2022). Despite national progress, several regions remain highly endemic. In 2022, school-aged children (5–14 years) accounted for 24.8% of malaria cases in Indonesia, and East Nusa Tenggara (ENT) Province ranks third

nationally in malaria endemicity, with an Annual Parasite Incidence (API) of 1.69 per 1,000 population (MoHRI, 2022; Rozi et al., 2022). According to the United Nations Children's Fund (UNICEF, 2022), data on malaria cases in 2021 in East Nusa Tenggara (ENT) Province indicate that 94% of cases originated from Sumba Island. Among the four districts on the island, three are classified as highly endemic, while only one is considered to have low endemicity. The districts, ranked by API, are as follows: West Sumba (API 17%), Southwest Sumba (API 11.26%), East Sumba (API 6.56%), and Central Sumba (API 0.53%).

According to a recent report by the UNICEF Field Office in Kupang (Tino, 2022), East Sumba Regency, with an API of 6.56%, is the third most malaria-endemic district in ENT Province. The Annual Blood Examination Rate (ABER) in 2021 reached 15.7%, an increase from the previous year; however, coverage remains uneven across Public Health Centers (PHCs). In 2021, there were six PHCs with a lower ABER than in 2020, while the API increased compared to the previous year. Meanwhile, seven PHCs reported a higher API than the previous year, namely Nggoa (2.28), Ngadu Ngala (2.88), Baing (36.98), Tanaraing (13.9), Melolo (20.74), Kambaniru (0.37), and Pambotandjara (7.85). The incidence of malaria at the Waingapu PHC in 2021 was relatively low, with 21 reported cases. However, in 2022, an increase was observed following screening in Mbatakapi Village (Hamlet 1, 2, and 4 in Kota District), which revealed 49 malaria cases in Hamlet 1, 2 cases in Hamlet 2, and 10 cases in Hamlet 4 (Tino, 2023). Based on these findings, the incidence of malaria remains high, especially during the first two months of case tracking, highlighting the need for greater attention to reduce malaria transmission.

Children, infants, pregnant women, individuals with HIV/AIDS or low immunity, and those entering high-transmission areas without prior exposure are among the most vulnerable to malaria. In endemic regions, some people develop partial immunity, which, while never offering complete protection, reduces the risk of severe illness. Malaria remains a serious public health problem, with the potential to cause death among the aforementioned vulnerable groups, particularly children (Coldiron et al., 2021; MoHRI, 2020). Research reported that the vast majority of malaria deaths in Africa occur in young children, while in regions with low transmission and limited immunity, all age groups are at risk (WHO, 2022). Children are particularly vulnerable and represent an age group crucial to maintaining good health, as they are in a critical stage of physical and psychological growth and development (Burkot et al., 2019; Geng et al., 2019). If a child becomes ill, their growth and development may be hindered, especially in the case of malaria, as Plasmodium parasites destroy red blood cells, leading to anemia (Elmardi et al., 2021). This condition can cause stunted growth and development and, in severe cases, even death (Omonijo et al., 2021).

The high incidence of malaria is influenced by several factors, such as poor practice in malaria prevention (e.g., non-use of mosquito nets) (Ipa et al., 2020), unfavorable physical environments that promote mosquito breeding, inadequate sanitation and hygiene, and environmental influences on children's play behavior shaped by moral and cultural values (Lawpoolsri et al., 2019; Rehan et al., 2023; Tarekegn et al., 2021). Other risk factors contributing to malaria incidence among school-aged children include the education level of mothers or caregivers. Thus, special attention is required for children whose mothers have no formal education or have experienced recent intimate partner violence. Maternal education and experiences can enhance malaria prevention, while environmental conditions, such as children living in houses with unimproved wall materials, also contribute to increased risk (Bah, 2020; Chilanga et al., 2020). Parents play an essential role in malaria prevention among school-aged children by implementing vector control measures, promoting healthy sleeping behavior (e.g., bed net use), and providing health education to children (Rehan et al., 2023; Zerdo et al., 2020). Environmental conditions, such as poor housing infrastructure and proximity to mosquito breeding sites like forests or swamps, further increase malaria risks in children (Bah, 2020; Ippolito, 2017). In East Sumba, 210 toddlers were diagnosed with malaria, and 5.2% of those were babies. Additionally, 42.9% of malaria cases occur among school-aged children (5–14 years), with 2–3 new cases reported daily. The total number of malaria cases in this group reached 754, confirming East Sumba as a malaria-endemic area (Sacko et al., 2021; Selasa et al., 2022).

Although previous studies have discussed factors influencing malaria incidence, most have focused on medical and clinical aspects, such as drug resistance, treatment adherence, or the effectiveness of health facility-based interventions. For instance, Sugiarto et al. (2022) explored the history of malaria and its epidemiology, including control and eradication efforts over the past

two centuries, vector prevalence, anti-malarial usage, parasite resistance, and available data from case reports of knowlesi malaria and the conditions that support the transmission of this zoonotic infection. However, few studies have examined in depth how household environmental factors and family behavior, particularly the role of parents, contribute to malaria incidence among school-aged children. While several studies have linked environmental factors such as stagnant water and poor sanitation with malaria incidence (Dao et al, 2021; Demsash, 2024; Sembiring & Sisina, 2023), research specifically connecting parental roles (e.g., ensuring bed net use, educating children about malaria, and making health decisions) with malaria incidence among school-aged children (5–14 years) in endemic areas like East Sumba Regency remains limited. Meanwhile, local data reveal that school-aged children account for the highest proportion of malaria cases (42.9%) in East Sumba (Selasa et al., 2022), suggesting they are a vulnerable group that receives less attention in family-based interventions. No comprehensive study has yet assessed how parental support and environmental conditions surrounding the home contribute to malaria infection in school children. This study aimed to examine the relationship between parental roles and environmental conditions with the incidence of malaria among school-aged children in East Sumba Regency. The findings are expected to support further collaboration between the government, healthcare workers, communities, and parents in implementing malaria elimination programs targeting school-aged children.

2. Methods

2.1. Research design

This study employed a quantitative correlational design with a cross-sectional approach to analyze the relationship between parental roles, environmental conditions, and the incidence of malaria in school-aged children. Using this design, measurements and observations of variables were conducted once at a single point in time, without any follow-up.

2.2. Setting and samples

This study was conducted in a village located in East Sumba Regency, which has a regency-wide API of 6.56%, making it the third most malaria-endemic district in East Nusa Tenggara (ENT) Province. The population consisted of elementary school-aged children in grades 5 and 6 residing in the area. A total sampling technique was used, resulting in 120 respondents. The inclusion criteria were school-aged children in grades 5 and 6 who were willing to participate with parental consent and support in completing the questionnaire. Meanwhile, the exclusion criteria included children or parents who were unwilling or unable to complete the questionnaire, those experiencing serious health conditions or comorbidities, and respondents who did not receive direct parental assistance during questionnaire completion.

2.3. Measurement and data collection

This study examined two independent variables: the roles of parents and environmental conditions, in relation to the dependent variable, the incidence of malaria in school-aged children. The instruments used were modified questionnaires adapted from prior research in Indonesia, covering the role of parents (Sitepu, 2020) and environmental conditions contributing to malaria incidence (Atikoh, 2015). The modifications were made to tailor the instrument to this study's objectives, with a focus on questions directed at school-aged children. These included items assessing parental roles and environmental conditions relevant to malaria risk. Before use, the modified instruments were tested for validity and reliability on 30 participants outside the main study samples with similar characteristics. Validity was assessed using Pearson's correlation, and reliability was tested using Cronbach's alpha.

The questionnaire on the role of parents on malaria incidence in school-aged children contains 10 items using a Guttman scale (Yes = 1, No = 0). All items were positive, with a total score range of 0-10. This instrument showed valid item correlations ($r = 0.407$ to 0.669) and acceptable reliability (Cronbach's $\alpha = 0.730$). Meanwhile, the instrument on environmental conditions related to malaria incidents contains 10 items using a Guttman scale with a yes answer (1 point) and a no answer (0 point). All question items were positive, with a total score range of 0-10. The validity test showed item correlations ranging from 0.419 to 0.588 (valid), and the reliability test yielded a Cronbach's α of 0.727 (reliable).

Data collection took place in January 2022. The procedure began after obtaining written informed consent. Respondents were provided with paper-based questionnaires, which they completed in approximately 30–60 minutes. After completion, responses were reviewed for completeness; any incomplete answers were clarified and returned to the respondents for completion. Data were then coded (converting textual data into numeric values), entered into SPSS version 21, and checked for possible errors.

2.4. Data analysis

Univariate analysis was conducted using descriptive statistics to describe the characteristics of each variable and respondents' experience with malaria. The results were presented in frequency tables. Bivariate analysis was used to determine the correlation between the independent variables and the dependent variable using Pearson's Chi-square test. The data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 21.

2.5. Ethical considerations

This study obtained ethical clearance from the Health Research Ethics Committee of Poltekkes Kemenkes Kupang with reference number LB.02.03/1/0187/2022. Respondents were informed of the study's purpose and procedures and were given full autonomy over whether to participate. Informed consent was obtained from both the children and their parents before data collection. Confidentiality was ensured by not recording participants' names (anonymity), and all completed questionnaires were destroyed after data analysis. The study upheld ethical principles by ensuring the welfare, safety, and equal treatment of all respondents, regardless of ethnicity, race, religion, and social status.

3. Results

3.1. Distribution of malaria incidence, parental roles, and home environmental conditions

This study included a total of 120 respondents. As shown in Table 1, the majority of school-aged children (77 respondents or 64.2%) had never experienced malaria. Regarding the role of parents, the highest proportion fell into the "poor" category (51 respondents or 42.5%). Similarly, the home environment was rated as "poor" for the majority of respondents (69 respondents or 57.5%).

Table 1. Distribution of malaria incidence, parental roles, and home environmental conditions among school-aged children (n=120)

Category	Frequency (f)	Percentage (%)
Malaria experience		
Once	43	35.8
Never	77	64.2
Total	120	100.0
The roles of parents		
Good	28	23.3
Sufficient	41	34.2
Poor	51	42.5
Total	120	100.0
Home environmental conditions		
Good	19	15.8
Sufficient	32	26.7
Poor	69	57.5
Total	120	100.0

3.2. The relationship between parental roles, environmental conditions, and malaria incidence

Table 2 shows a statistically significant correlation between parental roles and malaria incidence among school-aged children ($\chi^2(2) = 7.849, p = 0.020$). These results imply that, in this context, the risk of contracting malaria among school-aged children is significantly predicted by both parental participation and environmental factors in the home. Children were more likely to have had malaria if their parents were not actively involved in preventing the disease, such as by

not making sure mosquito nets were used regularly, teaching their kids about malaria, or ignoring other preventive measures.

Table 2. Relationship between parental roles and the incidence of malaria among school-aged children (n=120)

Category	Parental roles in relation to malaria incidence			Total
	Good	Sufficient	Poor	
Malaria experiencing				
Once	13	19	11	43
Never	15	22	40	77
Total	28	41	51	120
Test statistics	Value	df	Asymp. Sig. (2-sided)	
Pearson Chi-Square	7.849*	2	0.020	
Likelihood Ratio	8.115	2	0.017	
Linear-by-Linear Association	6.065	1	0.014	
N of Valid Cases	120			

Likewise, Table 3 also shows a significant correlation between the incidence of malaria and the home environmental conditions ($\chi^2(2) = 8.090$, $p = 0.018$). Children who lived in unfavorable environmental circumstances, such as homes with poor sanitation, stagnant water around the house, or poor housing materials, were also more likely to contract the disease.

Table 3. Relationship between home environmental conditions and the incidence of malaria among school-aged children (n=120)

Category	Environmental conditions in relation to malaria incidence			Total
	Good	Sufficient	Poor	
Malaria experiencing				
Once	2	16	25	43
Never	17	16	44	77
Total	19	32	69	120
Test statistics	Value	df	Asymp. Sig. (2-sided)	
Pearson Chi-Square	8.090*	2	0.018	
Likelihood Ratio	9.086	2	0.011	
Linear-by-Linear Association	1.659	1	0.198	
N of Valid Cases	120			

4. Discussion

This study aimed to examine the relationship between parental roles and environmental conditions with the incidence of malaria among school-aged children in the East Sumba Regency, Indonesia. The findings revealed a significant association between both variables (parental roles and environmental conditions) and the incidence of malaria. Several risk factors, including the level of parental involvement and the quality of home environmental conditions, influence the likelihood of malaria incidence in this population.

This study indicated that the majority of respondents had poor parental involvement and lived in poor environmental conditions. This supports previous research highlighting the crucial role that parents play in shaping children's characters, habits, behaviors, and motivation to learn (Hosany, 2022). Parental roles include instilling preventive behaviors to prevent malaria risk, such as maintaining cleanliness in the home environment (Fajrin & Purwastuti, 2022), using mosquito nets while sleeping, applying mosquito repellent, and wearing long protective clothing during outdoor activities (Bassett-Gunter et al., 2020). Parents significantly influence children's informal education and development stages. They are expected to act as role models by guiding, educating, protecting, motivating, meeting their children's needs, and promoting clean and healthy living behaviors in school-aged children. In addition, they must help create a supportive environment and establish effective communication with their children (Hosany et al., 2022).

Parents also play a significant role in shaping their children's personalities and morals (Fajrin & Purwastuti, 2022), ethics, and behaviors (Bassett-Gunter et al., 2020; Hosany et al., 2022). Inadequate parental supervision, especially at home, in the community, and school environments, can lead to risky behavior in children. Their involvement in informal learning helps school-aged children develop healthy interaction behaviors with their environment (Hosany et al., 2022), which can influence the adoption of a clean and healthy lifestyle to prevent infections such as malaria. The home environment becomes a crucial aspect of malaria prevention in rural areas like East Sumba, where access to healthcare and sanitary facilities may be restricted. As a result, parental capacity is influenced by socioeconomic status, community norms, and access to health information in addition to reflecting individual behavior (David et al., 2018). Therefore, it is crucial to address parental roles as a vector for behavioral transmission.

Healthy habits promoted by parents, including physical activity, hygiene, and disease prevention, contribute to improved children's health outcomes (Makenga et al., 2023). Children under 15 are considered a vulnerable group to malaria (Geng et al., 2019; Zeleke, 2023), and unsupervised outdoor activities without proper protective clothing or repellent increase their exposure to mosquito bites (Zerdo et al., 2020). The roles of parents as caregivers, therefore, should be optimized to ensure that children adopt habits conducive to disease prevention (Nieminen et al., 2021). Health education that increases knowledge, motivation, and parental involvement in child care is essential for maintaining and improving children's health (Gupta & Bhat, 2019; Tandilagan et al., 2022).

The finding that parental role significantly correlates with malaria incidence among school-aged children is consistent with previous research that highlights how parenting influences children's adoption of clean and healthy living behaviors (CHLB) (Nakamura et al., 2022). Children who practice CHLB are more likely to avoid infectious diseases such as malaria (Wang et al., 2023). Parental role modeling and motivation are essential in helping children implement CHLB standards, as recommended by healthcare professionals. These include personal hygiene, appropriate hand washing, household cleanliness, proper waste disposal, and protection from mosquito bites using repellents or suitable protective clothing during outdoor activities (Diabaté et al., 2015; Musoke et al., 2013).

Environmental factors also significantly influence the transmission of malaria. These include physical (e.g., seasonal weather, rainfall, climate change, temperature, humidity, and geography) (Mau et al., 2020; Rahmani et al., 2022; Ramdzan et al., 2020; Xiang et al., 2018), biological (e.g., presence of mosquito predators such as larvivorous fish), and chemical (e.g., use of insecticides, repellents, fogging) factors (Fauziah et al., 2022; Paschalia et al., 2021; Valbon et al., 2019). Socioeconomic factors such as poverty, population density, education level, occupation, and social norms (Al-Awadhi et al., 2021; Danjin et al., 2020; Muhammad et al., 2022), and access to clean water, significantly affect malaria incidence among children aged 0–14 years. Additionally, individuals' socio-cultural behaviors, like frequently going outside at night, increase exposure to mosquito bites (Yos et al., 2018).

This study confirmed that poor environmental conditions are significantly associated with malaria incidence in school-aged children. Supporting studies indicate that housing materials (e.g., woven bamboo or wood) (Carter & Karunaweera, 2020), inadequate gauze-covered ventilation, poor lighting (Mmbando et al., 2022), and proximity to cattle breeding areas (e.g., gutters, ditches, puddles, and garbage containers) (Sharma et al., 2021) contribute to increased risk of malaria. Living in areas with inadequate infrastructure and housing near cattle pens and mosquito breeding grounds further elevates risks (Inthavong et al., 2017). Notably, the way parenting and environmental quality affect each other may make the risk of malaria even higher. For example, even if there are environmental risks, parents who are involved and well-informed may be able to reduce these by changing their behavior. On the other hand, good parenting may not work as well if there are still environmental dangers. More research should look into these interaction effects in more detail in the future.

However, previous research has reported different findings (Mwalugelo et al., 2024), indicating that cattle pens as mosquito breeding sites were not significantly associated with malaria incidence. This contradicts the present study and others suggesting that both indoor (e.g., wall and roof structures, ventilation system) and outdoor (e.g., stagnant water, uncovered garbage containers, nearby cattle pens) environmental conditions increase mosquito-human contact and malaria risk (Ippolito et al., 2017; Mburu et al., 2021). Therefore, maintaining cleanliness and

relocating cattle pens away from residential areas are vital preventive strategies. As indicated in previous studies, other environmental factors contributing to malaria risk also include unmanaged vegetation and livestock conditions (Ferraguti et al., 2021). Preventive measures such as using natural repellents (e.g., lemongrass, orange, lavender) and chemical repellents (e.g., mosquito sprays), mosquito nets, and environmental management are essential to reduce risks (Omonijo et al., 2021; Youmsi, 2017). Efforts should not only focus on changing behavior at the individual or family level but also on systemic interventions, such as making it easier for people to get to mosquito control programs, clean water, and rural health outreach. Nurse-led community health programs are important in connecting education and prevention, especially in areas where malaria is common. Moreover, empowering school-aged children to practice CHLB, such as washing hands at appropriate times, proper waste disposal, and maintaining a clean home, school, and community environment, can reduce malaria transmission. This underscores the need for holistic interventions that simultaneously target parental roles, environmental improvements, and child empowerment.

5. Implication and limitation

The findings of this study highlight a significant relationship between the role of parents and environmental conditions with the incidence of malaria among school-aged children. These results carry important implications for nursing practice, education, and policy. The findings are important for nursing practice, especially in enhancing the role of nurses in empowering parents through education on malaria prevention, conducting home environmental assessments, and implementing family-based care models for malaria control. In nursing education, these results support the integration of curricula that focus on public health and family-centered care, as well as training programs that prepare nurses to educate and engage families in disease prevention efforts. From a health policy perspective, family- and community-based interventions are needed that emphasize parental empowerment, raise awareness about environmental sanitation, and promote malaria prevention practices. The government, in collaboration with health agencies, should formulate more comprehensive prevention strategies by positioning the family as the main pillar in malaria control efforts. In addition, strengthening the role of health cadres is essential to improve environmental monitoring and provide continuous education for parents.

The limitation of this study lies in the limited scope of data collection, which was conducted solely through questionnaires and focused only on school-aged children in a single location where the highest number of malaria cases among school-aged children was reported. Additionally, this study also did not examine other community groups outside the school-aged population. Future studies should take these limitations into account.

6. Conclusion

This study revealed a significant relationship between the role of parents and environmental conditions in the incidence of malaria among school-aged children. Both parental roles and environmental conditions were predominantly categorized as poor. These findings underscore the need for integrated efforts involving families, communities, and healthcare providers to reduce malaria incidence in this vulnerable population. Further studies are recommended to analyze additional contextual factors influencing the incidence of malaria among school-aged children and to consider broader geographical coverage for a more comprehensive understanding of malaria risk factors.

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Author contribution

M.K.H. was responsible for designing the study, submitting the study for ethical approval, leading the data collection process, and drafting the initial manuscript. L.L. and S.T.J.M. assisted in data collection, participated in data analysis, and contributed to manuscript development. All authors reviewed and approved the final manuscript.

Conflict of interest

There is no conflict of interest in this research.

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