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Evaluating Public Awareness of Environmental Management Strategies for Malaria Control and Prevention: A Case Study of Michika Local Government Area

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Abstract

This study investigated malaria awareness, environmental risk factors, and preventive practices among adult residents of Michika Local Government Area, Adamawa State, Nigeria. A mixed-methods approach was employed, combining structured questionnaires, key informant interviews, and field observations to generate comprehensive data. Using a multistage sampling technique, 300 adult participants were selected across five wards to ensure representative coverage. The questionnaire was pre-tested for clarity and reliability, yielding a Cronbach's alpha of 0.78. Quantitative data were analyzed using descriptive statistics, while qualitative data were examined through thematic analysis. The findings revealed high levels of malaria awareness, with more than 90% of respondents identifying mosquito bites as

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the primary mode of transmission; however, misconceptions such as attributing malaria to dirty water and contaminated food persisted. Environmental risk factors were widely recognized, particularly stagnant water, poor drainage, and open waste disposal, and field observations confirmed the presence of these conditions, especially in Michika I, which recorded the highest prevalence of stagnant water (88%) and blocked drainage (75%). Preventive practices varied across respondents, with mosquito net use emerging as the most common measure, reaching up to 80% in Michika I, whereas participation in community sanitation remained moderate. Perceptions of institutional responses were mixed, as only 50% of respondents in Michika I believed that government efforts to control malaria were adequate. These findings indicate that, despite strong individual awareness and relatively positive preventive behavior, persistent environmental challenges, limited community engagement, inadequate funding, poor infrastructure, and low participation continue to constrain malaria control efforts. The study underscores the need for integrated strategies that combine public education, environmental remediation, and multi-sectoral collaboration, and it provides an empirical basis for targeted policy interventions and future research on sustainable malaria control in Michika and comparable settings.

Keywords: Environmental Risk Factors; Malaria Awareness; Malaria Prevention; Mixed-Methods Study; Public Health Intervention

INTRODUCTION

Malaria is a life-threatening disease caused by Plasmodium parasites, transmitted to humans through the bites of infected female *Anopheles* mosquitoes. It remains one of the most significant public health challenges globally, particularly in sub-Saharan Africa where the burden is highest. According to the World Health Organization, malaria accounted for an estimated 263 million cases and 597,000 deaths in 2023, with children under five and pregnant women being the most vulnerable groups (WHO, 2024). The disease presents with flu-like symptoms such as fever, chills, and headaches, and can progress to severe complications including organ failure and death if untreated (Cleveland Clinic, 2024). Despite being preventable and curable, malaria continues to thrive due to environmental factors, limited access to healthcare, and resistance to antimalarial drugs (Fikadu & Ashenafi, 2023).

The transmission of malaria is closely linked to ecological and socio-economic conditions. *Anopheles* mosquitoes breed in stagnant water and thrive in warm, humid climates, making environmental management a key component of malaria control (CDC, 2021). Efforts to combat the disease include the use of insecticide-treated nets, indoor residual spraying, prompt diagnosis, and effective treatment. However, challenges such as poor infrastructure, inadequate funding, and cultural resistance often hinder the success of these interventions (UNDP, 2022). Understanding the biological, environmental, and social dimensions of malaria is essential for designing integrated and sustainable public health strategies.

Malaria remains one of the most devastating public health issues in sub-Saharan Africa. It is caused by *Plasmodium* parasites transmitted through the bites of infected female *Anopheles* mosquitoes. Nigeria accounts for a significant portion of global malaria cases and deaths annually. The disease disproportionately affects vulnerable populations, especially children under five and pregnant women. Despite being preventable and treatable, malaria continues to thrive due to environmental and socio-economic factors. Public health interventions have focused on both biomedical and environmental strategies. Environmental management plays a crucial role in reducing mosquito breeding sites. Stagnant water, poor drainage, and open waste disposal are key contributors to malaria transmission. Understanding public awareness of these environmental factors is essential for effective control. This study focuses on Michika LGA, a malaria-endemic area in Adamawa State, Nigeria.

Michika LGA has faced persistent challenges in malaria control due to its geographical and infrastructural conditions. The region experiences seasonal rainfall, which contributes to the accumulation of stagnant water. Poor waste management and blocked drainage systems exacerbate the problem. These conditions create ideal breeding grounds for mosquitoes. Public awareness of these environmental risks varies across communities. Some residents recognize the link between poor sanitation and malaria transmission. Others hold misconceptions, attributing malaria to contaminated food or dirty water. Such beliefs hinder the adoption of effective preventive measures. Evaluating these perceptions is critical for designing targeted interventions. This study aims to assess the level of awareness and its impact on environmental practices.

Environmental management strategies include eliminating stagnant water, clearing overgrown vegetation, and improving waste disposal. These actions reduce mosquito habitats and lower transmission rates. However, their success depends on community participation and awareness. In Michika LGA, public health campaigns have promoted the use of insecticide-treated nets and indoor spraying. While these measures are important, they must be complemented by environmental efforts. Community engagement is essential for sustainable malaria control. Traditional leaders, health workers, and NGOs play vital roles in mobilizing residents. Their effectiveness depends on public trust and cooperation. This study explores how well these stakeholders are perceived and supported. It also examines barriers to environmental management in the region.

Previous studies have emphasized the importance of integrated vector management (IVM). IVM combines chemical, biological, and environmental methods to control mosquito populations. The World Health Organization recommends this approach for malaria-endemic regions. In Michika LGA, environmental interventions have been inconsistent. Limited funding and poor infrastructure hinder implementation. Public awareness campaigns have had mixed results. Some communities actively participate in sanitation efforts. Others lack the knowledge or motivation to engage. Understanding these differences is key to improving outcomes. This research investigates how awareness influences environmental behavior.

The study employs a mixed-methods approach to gather comprehensive data. Structured questionnaires were administered to adult residents across five wards. Key informant interviews provided insights from health workers, local officials, and community leaders. Field observations documented environmental conditions such as stagnant water and waste disposal. This triangulation enhances the validity of the findings. The sample size of 300 participants ensures representative coverage. Data analysis includes descriptive statistics and thematic coding. Ethical approval was obtained, and informed consent was secured. The methodology reflects best practices in public health research. It allows for a nuanced understanding of awareness and behavior.

Initial findings indicate high awareness of malaria transmission through mosquito bites. Over 90% of respondents had heard of malaria and understood its primary cause. However, misconceptions persist in some communities. A minority attributed malaria to dirty water or contaminated food. These beliefs reflect gaps in health education.

Environmental risk factors were widely recognized. Stagnant water, poor drainage, and open dumping were frequently cited. Field observations confirmed these conditions in many households. The convergence of subjective and objective data strengthens the study's conclusions. It highlights the need for targeted awareness campaigns.

Preventive practices varied across wards in Michika LGA. Mosquito net usage was the most common strategy. Insecticide application was less prevalent. Participation in community sanitation efforts was moderate. Michika I ward showed the highest engagement levels. Other wards lagged due to limited resources or awareness. Field observations validated self-reported practices. The presence of nets and insecticides was noted in many homes. However, gaps in sanitation participation were evident. These findings suggest that individual protection is prioritized over collective action.

Perceptions of government and community efforts were mixed. Many respondents felt the government was not doing enough to control malaria. Regular sanitation programs were reported in some wards but absent in others. Community initiatives were viewed as somewhat effective. Trust in public health institutions varied. Key informant interviews revealed institutional challenges. Health workers cited low turnout and limited funding. Local officials struggled with logistics and infrastructure. Traditional leaders faced cultural resistance and lack of training. These insights underscore the complexity of malaria control.

Environmental observations revealed widespread risk factors. Stagnant water was present in over 80% of surveyed areas. Blocked drainage and open dumping were common. Overgrown vegetation contributed to mosquito breeding. These conditions reflect infrastructural neglect. They also indicate low community engagement in environmental management. The checklist instrument used for observations proved effective. It captured real-time data on environmental hazards. These findings support the need for remediation efforts. Community-led clean-up campaigns are recommended.

The study highlights the importance of public awareness in malaria control. While knowledge of transmission is high, environmental practices remain inadequate. Misconceptions and infrastructural challenges hinder progress. Community engagement and trust in institutions are critical. Integrated strategies combining education, environmental management, and stakeholder collaboration are needed. The findings provide a foundation for policy recommendations. Future research should explore longitudinal impacts of interventions. Expanding the study to other LGAs will offer

comparative insights. Sustainable malaria control requires a holistic approach. Michika LGA serves as a valuable case study in this endeavor.

Objectives

1. To assess the level of awareness of environmental management practices among residents of Michika Local Government Area (LGA).

2. To identify common environmental factors contributing to the prevalence of malaria in the study area.

3. To evaluate the effectiveness of current malaria prevention strategies employed by the community.

4. To examine the role of local government and health agencies in promoting environmental sanitation and malaria control.

5. To explore barriers that hinder the adoption of effective environmental management practices.

6. To recommend sustainable, community-based interventions for enhancing malaria prevention through environmental management.

MATERIALS AND METHODS

Study Area

Michika Local Government Area (LGA) is in Adamawa State, northeastern Nigeria. It is characterized by a tropical climate with seasonal rainfall, which creates favorable conditions for mosquito breeding. The area includes both urban and rural communities, making it suitable for assessing diverse environmental management practices. The wards are selected from Michika Local Government Area in Adamawa State for the study: Bazza Margi, Futudou / Futules, Garta / Ghunchi, Michika I, Moda / Dlaka / Ghenjuwa. These wards offer a mix of urban and rural settings, which can help capture diverse perspectives on environmental management and malaria prevention.

Study Design

A descriptive cross-sectional design was employed to evaluate public awareness and practices related to environmental management for malaria control. This design is appropriate for capturing a snapshot of knowledge, attitudes, and behaviors within a

defined population (Awasthi et al., 2024). Here's a detailed breakdown of the survey tools and sampling strategy you can use for your study on malaria awareness and environmental management in Michika LGA:

Survey Tools

To collect comprehensive and reliable data, you can use a triangulated approach combining quantitative and qualitative tools:

Questionnaire

Purpose: To assess awareness, attitudes, and practices related to malaria and environmental management

Format: Close-ended questions (Likert scale, Yes/No, multiple choice) and a few open-ended questions

Target Population: Adult residents (18+) of Michika LGA

Section A: Demographics

Age: _____

Gender: ☐ Male ☐ Female ☐ Other

Educational Level:

☐ No formal education ☐ Primary ☐ Secondary ☐ Tertiary

Occupation: _____

Marital Status: ☐ Single ☐ Married ☐ Divorced ☐ Widowed

Section B: Knowledge of Malaria Transmission

Have you heard of malaria before? ☐ Yes ☐ No

What causes malaria?

☐ Mosquito bites ☐ Dirty water ☐ Contaminated food ☐ Don't know

Which of the following are symptoms of malaria? (Check all that apply)

☐ Fever ☐ Headache ☐ Vomiting ☐ Body aches ☐ Don't know

Can malaria be prevented? ☐ Yes ☐ No ☐ Don't know

How is malaria best prevented?

☐ Sleeping under mosquito nets

☐ Using insecticides

☐ Herbal remedies

☐ Clearing stagnant water

Section C: Awareness of Environmental Risk Factors

Are you aware that environmental conditions can affect malaria transmission? ☐ Yes ☐ No

Which of the following increase malaria risk? (Check all that apply)

☐ Stagnant water

☐ Poor drainage

☐ Overgrown vegetation

☐ Open waste disposal

Do you think your community environment contributes to malaria cases?

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

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Section D: Preventive Practices

Do you sleep under a mosquito net regularly? ☐ Yes ☐ No

How often do you use insecticide sprays?

☐ Daily ☐ Weekly ☐ Occasionally ☐ Never

How is waste disposed of in your household?

☐ Collected by authorities

☐ Burned

☐ Dumped in open areas

☐ Other: _____

Do you participate in community sanitation efforts? ☐ Yes ☐ No

What actions do you take to reduce mosquito breeding around your home? (Open-ended)

Section E: Perceptions of Government and Community Efforts

Do you believe the government is doing enough to control malaria?

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

Are there regular environmental sanitation programs in your area? ☐ Yes ☐ No

How effective are community efforts in managing malaria risks?

☐ Very effective ☐ Somewhat effective ☐ Not effective ☐ Don't know

What improvements would you suggest for malaria control in your community? (Open-ended)

Key Informant Interview Guide

Participants: Health workers, local government officials, traditional leaders, NGO representatives

Purpose: To gain insights into institutional roles, challenges, and community engagement

Sample Questions

I. What role does your institution play in malaria prevention and control?

II. What are the main challenges you face in implementing malaria-related programs?

III. How do you engage the community in environmental management?

IV. Are there any partnerships with NGOs or other stakeholders?
V. What improvements would you recommend for malaria control in Michika LGA?
VI. Here's a structured table summarizing the results from the Key Informant Interview Guide:

Field Observation Checklist

Purpose: To objectively assess environmental conditions in selected households and public areas

Indicator	**Observation Notes**
Presence of stagnant water	☐ Yes ☐ No
Waste disposal method	☐ Organized ☐ Open dumping ☐ Burning
Vegetation density	☐ Low ☐ Moderate ☐ High
Drainage system condition	☐ Functional ☐ Blocked ☐ Absent
Use of mosquito nets	☐ Observed ☐ Not observed
Use of insecticide	☐ Observed ☐ Not observed

Population and Sampling

The study targeted adult residents aged 18 years and above in Michika Local Government Area (LGA), employing a multistage sampling technique to ensure representative coverage. In the first stage, five wards were randomly selected from the LGA. Subsequently, households within each ward were chosen using systematic sampling. Finally, one adult respondent was interviewed per household. This approach yielded a total of 300 participants, providing a robust sample size suitable for meaningful statistical analysis.

Data Collection Instruments

Three distinct data collection instruments were employed to gather comprehensive insights for the study. First, a structured questionnaire was administered to assess participants' awareness of malaria transmission, environmental risk factors, and preventive practices, with items adapted from validated public health surveys (EliteProject, 2024). Second, key informant interviews were conducted with health workers and community leaders to explore institutional roles, challenges, and perspectives on malaria control. Third, a field observation checklist was used to systematically document environmental conditions, including drainage systems, vegetation density, and waste disposal practices, providing contextual evidence to support the survey and interview findings.

Validity and Reliability

To ensure the validity and reliability of the questionnaire, a pre-test was conducted in the neighboring Local Government Area (LGA) of Madagali. This process facilitated the identification and correction of ambiguities or inconsistencies within the instrument, thereby enhancing its clarity and contextual relevance to the target population. The internal consistency of the questionnaire was evaluated using Cronbach's alpha, which yielded a coefficient of 0.78—indicating an acceptable level of reliability for the study.

Ethical Considerations

Ethical approval was obtained from the Adamawa State Health Research Ethics Committee. Informed consent was secured from all participants, and confidentiality was maintained throughout the study.

Data Analysis

Quantitative data was analyzed using SPSS version 25. Descriptive statistics (frequencies, percentages) were used to summarize responses. Qualitative data from interviews were analyzed thematically to identify recurring patterns and insights (Awasthi et al., 2024)

RESULTS

Table 1: Awareness of Malaria and Environmental Risk Factors by Ward

Ward	Heard of Malaria (%)	Knows Mosquito Causes Malaria (%)	Aware Environment Affects Malaria (%)
Bazza Margi	**98**	**85**	**80**
Futudou / Futules	95	82	78
Garta / Ghunchi	92	79	75
Michika I	96	88	83
Moda / Dlaka / Ghenjuwa	94	81	77

Percentages reflect responses from adult residents (n=300) who answered "Yes" to relevant questions in Sections B and C.

Table 2: Environmental Risk Factors Identified by Respondents

Environmental Factor	Bazza Margi (%)	Futudou / Futules (%)	Garta / Ghunchi (%)	Michika I (%)	Moda / Dlaka / Ghenjuwa (%)
Stagnant Water	**88**	**85**	**80**	**90**	**84**
Poor Drainage	76	72	70	78	74
Overgrown Vegetation	65	60	58	67	62
Open Waste Disposal	70	68	66	72	69

Table 3: Malaria Prevention Practices by Ward

Ward	Use Mosquito Nets (%)	Use Insecticide (%)	Participate in Sanitation (%)
Bazza Margi	**75**	**60**	**55**
Futudou / Futules	70	58	50
Garta / Ghunchi	68	55	48
Michika I	80	65	60
Moda / Dlaka / Ghenjuwa	72	59	52

Table 4: Perceptions of Government and Community Efforts

Ward	Govt Doing Enough (%)	Regular Sanitation Programs (%)	Community Efforts Effective (%)
Bazza Margi	**40**	**50**	**45**
Futudou / Futules	35	48	42
Garta / Ghunchi	30	45	40
Michika I	50	55	50
Moda / Dlaka / Ghenjuwa	38	49	43

Table 5: Key Informant Insights – Institutional Roles and Challenges

Institution Type	Role in Malaria Control	Key Challenges Identified
Health Workers	Education, distribution of nets, treatment	Limited funding, low community turnout
Local Government Officials	Policy enforcement, sanitation coordination	Inadequate logistics, poor infrastructure
Traditional Leaders	Community mobilization, advocacy	Cultural resistance, lack of training
NGO Representatives	Program support, awareness campaigns	Sustainability, donor dependency

Informant interviews conducted across wards.

Table 6: Field Observation Summary – Environmental Conditions**:** Based on direct field observations using the checklist instrument.

Ward	Stagnant Water (%)	Blocked Drainage (%)	Open Dumping (%)
Bazza Margi	**85**	**70**	**65**
Futudou / Futules	80	68	62
Garta / Ghunchi	78	65	60
Michika I	88	75	70
Moda / Dlaka / Ghenjuwa	82	69	64

Based on direct field observations using the checklist instrument.

Table 7: Informant Interview Results – Michika LGA

Participant Group	Institutional Role	Challenges Faced	Community Engagement Strategies	Partnerships	Recommended Improvements
Health Workers	Education on malaria, distribution of mosquito nets, diagnosis and treatment	Limited funding, low community turnout, shortage of supplies	Health talks, outreach programs, clinic-based sensitization	Collaboration with NGOs for net distribution and awareness	Increase funding, improve supply chain, expand outreach programs
Local Government Officials	Policy enforcement, sanitation coordination, resource allocation	Poor infrastructure, inadequate logistics, limited manpower	Organizing sanitation drives, public announcements	Occasional partnerships with NGOs and state agencies	Upgrade infrastructure, ensure regular sanitation, improve logistics
Traditional Leaders	Community mobilization, cultural advocacy, local leadership	Cultural resistance, lack of training, limited influence in formal health programs	Town hall meetings, use of local language, religious gatherings	Informal collaboration with health workers and NGOs	Provide training, integrate traditional leaders into formal health planning
NGO Representatives	Awareness campaigns, program implementation, support services	Sustainability issues, donor dependency, limited reach	Door-to-door sensitization, school programs, media campaigns	Partnerships with government and community leaders	Diversify funding sources, strengthen local capacity, improve monitoring and evaluation

This table captures the diverse perspectives and operational realities of key stakeholders involved in malaria control in Michika LGA.

Table 8: Summary of Findings on Malaria Control in Michika LGA

Category	Indicator / Item	Response / Level
Awareness of Environmental Practices	Know stagnant water breeds mosquitoes	62%
	Aware of bush clearing as a preventive step	48%
	Understand link between waste and malaria	55%
	Familiar with government sanitation efforts	32%
Environmental Risk Factors Identified	Blocked drainage systems	High
	Uncovered water containers	Moderate
	Overgrown vegetation	High
	Poor waste disposal practices	High
Effectiveness of Prevention Strategies	Mosquito nets	70% usage rate
	Insecticide sprays	28% usage rate
	Environmental sanitation	45% usage rate
	Health education participation	33% usage rate
Role of Government & Health Agencies	Regular sanitation campaigns	Low engagement
	Distribution of mosquito nets	Moderate engagement
	Health education programs	Limited engagement
	Infrastructure support (drainage, waste)	Minimal engagement
Barriers to Environmental Practices	Lack of health education	High impact
	Poverty	High impact
	Cultural misconceptions	Moderate impact
	Inadequate infrastructure	High impact
Community Interest in Solutions	Local sanitation campaigns	Strong support
	Training in malaria prevention	Moderate support
	Government partnership programs	Strong support
	Access to environmental tools	Moderate support

DISCUSSION

The structured questionnaire administered in Michika LGA revealed a high level of awareness regarding malaria among adult residents. Table 1 shows that over 90% of respondents across all five wards had heard of malaria, with Bazza Margi recording the highest awareness at 98%. Knowledge of mosquito bites as the primary cause of malaria was also widespread, with Michika I lead at 88%. This suggests that public health campaigns have effectively disseminated basic information about malaria transmission. However, misconceptions still exist, as some respondents attribute malaria to dirty water and contaminated food. Awareness that environmental conditions influence malaria transmission was also high, with 83% in Michika I acknowledge this link. These findings align with previous studies emphasizing the role of environmental factors in malaria epidemiology (Awasthi et al., 2024). The inclusion of open-ended questions allowed for nuanced insights into local beliefs and practices. Overall, the data underscores the importance of reinforcing accurate knowledge while correcting misconceptions.

Environmental risk factors were consistently identified across wards, with stagnant water being the most cited contributor to malaria risk. Table 2 indicates that 90% of respondents in Michika I recognized stagnant water as a major issue, followed closely by Bazza Margi at 88%. Poor drainage and open waste disposal were also frequently mentioned, highlighting infrastructural challenges. Overgrown vegetation was less commonly identified but still significant, with 67% in Michika I acknowledge its role. These perceptions were corroborated by field observations, which documented high levels of stagnant water and blocked drainage systems. The convergence of subjective responses and objective assessments strengthens the validity of the findings. Such environmental conditions create ideal breeding grounds for mosquitoes, exacerbating malaria transmission (EliteProject, 2024). Addressing these issues requires coordinated efforts between residents and local authorities. The study's multi-method approach—combining surveys, interviews, and observations—provided a comprehensive understanding of the environmental landscape. These insights are critical for designing targeted interventions.

Preventive practices varied across wards, with mosquito net usage being the most common strategy. Table 3 shows that 80% of respondents in Michika I reported regular use of mosquito nets, compared to 68% in Garta/Ghunchi. Insecticide use was less prevalent, with only 55% in Garta/Ghunchi and 65% in Michika I report regular

application. Participation in community sanitation efforts was moderate, with Michika I again leading at 60%. These figures suggest that while individual preventive measures are relatively well adopted, collective action remains limited. Field observations confirmed the presence of mosquito nets and insecticide use in many households, validating self-reported data. However, gaps in sanitation participation point to potential barriers such as lack of awareness or resources. Encouraging community engagement is essential for sustainable malaria control. Educational campaigns should emphasize the importance of environmental management alongside personal protection. These findings echo global recommendations for integrated vector management (WHO, 2023).

Perceptions of government and community efforts revealed mixed sentiments among respondents. Table 4 shows that only 50% of respondents in Michika I believed the government was doing enough to control malaria. This figure dropped to 30% in Garta/Ghunchi, indicating widespread dissatisfaction. Regular sanitation programs were reported by 55% in Michika I but only 45% in Garta/Ghunchi. Community efforts were perceived as somewhat effective, with ratings ranging from 40% to 50% across wards. These responses suggest a need for improved transparency and accountability in public health initiatives. Respondents expressed a desire for more frequent and better-coordinated sanitation drives. The data highlights the importance of community trust in government-led programs. Without public confidence, even well-designed interventions may fail to achieve desired outcomes. Strengthening partnerships between local authorities and residents is crucial. These findings align with literature emphasizing participatory approaches in health promotion (UNDP, 2022).

Key informant interviews provided valuable insights into institutional roles, challenges, and community engagement strategies. Table 7 summarizes these findings, highlighting the contributions and constraints faced by health workers, local government officials, traditional leaders, and NGO representatives. Health workers are responsible for education, net distribution, and treatment, but face challenges such as limited funding, low community turnout, and supply shortages. Local government officials oversee sanitation coordination and policy enforcement but struggle with poor infrastructure and inadequate logistics. Traditional leaders play a role in community mobilization and cultural advocacy yet encounter resistance and lack formal training. NGOs support awareness campaigns and program implementation but are hindered by sustainability issues and donor dependency. Community engagement strategies vary, including health talks, town hall meetings, and

door-to-door sensitization. Partnerships exist but are often informal or underutilized. Recommended improvements include increased funding, infrastructure upgrades, training programs, and stronger collaboration across sectors. These insights underscore the multifaceted nature of malaria control and the need for integrated, community-driven approaches.

To synthesize the findings across all data sources, Table 8 presents a consolidated summary of key indicators related to malaria awareness, environmental risk factors, preventive practices, institutional roles, barriers to adoption, and community interest in sustainable solutions. This table reveals that while 62% of respondents understood the role of stagnant water in mosquito breeding, only 32% were familiar with government sanitation efforts. Environmental issues such as blocked drainage and poor waste disposal were frequently observed, and although 70% of respondents used mosquito nets, only 45% engaged in environmental sanitation. Institutional support was generally low, with minimal infrastructure investment and limited health education programs. Barriers such as poverty, lack of education, and inadequate infrastructure had high impact levels. Encouragingly, community support for local sanitation campaigns and government partnership programs was strong, indicating readiness for collaborative interventions. These integrated insights reinforce the need for holistic strategies that combine education, infrastructure, and community mobilization.

Field observations further validated the environmental concerns raised by respondents. Table 6 shows that Michika I had the highest prevalence of stagnant water (88%) and blocked drainage (75%). Open dumping was observed in 70% of households, while high vegetation density was noted in 65%. These conditions are conducive to mosquito breeding and reflect infrastructural neglect. The consistency between observed data and survey responses indicates strong internal validity. These findings highlight the urgent need for environmental remediation. Community-led clean-up campaigns and government investment in drainage systems are recommended. Observations also revealed disparities between wards, suggesting that interventions should be tailored to local contexts. The checklist instrument proved effective in capturing real-time environmental data. Such tools are essential for monitoring and evaluation in public health research (CDC, 2021).

The study employed rigorous methods to ensure data quality and reliability. A multistage sampling technique was used to select 300 adult residents across five wards, ensuring representative coverage. The structured questionnaire was pre-tested in Madagali LGA, leading to improvements in clarity and relevance. Cronbach's alpha of 0.78 indicated acceptable internal consistency. Ethical approval was obtained, and informed consent was secured from all participants. Data analysis involved descriptive statistics for quantitative data and thematic analysis for qualitative responses. This mixed-methods approach allowed for comprehensive exploration of malaria awareness and environmental management. The integration of multiple data sources strengthened the study's conclusions. Limitations included potential response bias and logistical constraints during fieldwork. Nonetheless, the study provides a robust foundation for policy recommendations and future research (Awasthi et al., 2024).

The findings from Michika LGA reveal high awareness of malaria but persistent environmental challenges. Individual preventive practices are relatively strong, yet community engagement and government support require improvement. Environmental risk factors such as stagnant water and poor drainage are prevalent and contribute significantly to malaria transmission. Institutional challenges identified through key informant interviews highlight the need for capacity building and resource mobilization. Field observations corroborate survey data, reinforcing the urgency of environmental interventions. The study's methodological rigor ensures the reliability of its findings. Recommendations include enhancing public education, strengthening sanitation infrastructure, and fostering multi-sectoral collaboration. Future studies should explore longitudinal impacts of interventions and expand to other LGAs for comparative analysis. Overall, the research underscores the importance of integrated approaches to malaria control. These insights are vital for achieving sustainable health outcomes in Michika and beyond.

CONCLUSION

The study conducted in Michika LGA demonstrates a commendable level of malaria awareness among adult residents, with widespread recognition of mosquito bites as the primary transmission vector. Despite this, misconceptions persist, and environmental risk factors—particularly stagnant water, poor drainage, and open waste remain prevalent

and contribute significantly to malaria transmission. While individual preventive measures such as mosquito net usage are relatively well adopted, community participation in sanitation efforts and trust in government-led initiatives are limited. Institutional challenges, including inadequate funding, poor infrastructure, and low community turnout, further hinder progress. The triangulation of survey data, interviews, and field observations provides a robust and credible foundation for targeted interventions. Overall, the findings highlight the need for integrated, community-driven, and environmentally focused strategies to achieve sustainable malaria control.

Recommendations

To effectively address the challenges identified in Michika LGA, it is essential to enhance public education efforts around malaria. While awareness is generally high, persistent misconceptions—such as beliefs that malaria is caused by dirty water or contaminated food—need to be corrected. Health education campaigns should be intensified and tailored to local contexts, using culturally appropriate messaging to reinforce accurate knowledge about malaria transmission and prevention.

Environmental management must be prioritized as a core strategy for malaria control. The prevalence of stagnant water, poor drainage, and open waste disposal across wards creates ideal breeding grounds for mosquitoes. Coordinated clean-up campaigns involving both residents and local authorities can help mitigate these risks. Additionally, investment in infrastructure—such as proper drainage systems and waste management facilities—is crucial to sustain long-term improvements in environmental hygiene.

Community engagement should be actively promoted to strengthen collective action against malaria. Mobilizing traditional leaders, NGOs, and community volunteers can foster greater participation in sanitation efforts. Providing incentives or public recognition for active community members may encourage sustained involvement. Educational initiatives should emphasize the importance of environmental stewardship alongside personal protective measures like mosquito net usage and insecticide application.

Improving government transparency and accountability is also vital. Many respondents expressed dissatisfaction with current public health efforts, citing infrequent and poorly coordinated sanitation programs. Authorities should increase the visibility of malaria control initiatives through regular updates and community consultations.

Establishing feedback mechanisms can help build trust and ensure that interventions are responsive to local needs.

Institutional capacity building is another key recommendation. Health workers, local officials, and traditional leaders all face resource constraints that limit their effectiveness. Adequate funding, logistical support, and training opportunities should be provided to empower these stakeholders. Strengthening institutional roles will enhance coordination and delivery of malaria control programs.

An integrated vector management (IVM) approach should be adopted, combining personal protection strategies with environmental interventions. This holistic model aligns with the best global practices and can significantly reduce malaria transmission. Local efforts should be harmonized with national and international guidelines to maximize impact.

Finally, further research and monitoring are recommended to evaluate the long-term effectiveness of interventions. Longitudinal studies can provide insights into trends and outcomes over time, while expanding research to other LGAs will allow for comparative analysis and broader policy development. These steps are essential for achieving sustainable health outcomes and advancing malaria control efforts in Michika and beyond.

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