

Review Article

Comparative Review on the Current Prevalence and Distribution of Malaria Cases in Western Ethiopia: Hotspot Areas, Economic Burden, and Strategic Interventions

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Abstract

Background: Malaria remains a critical public health challenge in Western Ethiopia, particularly in hotspot areas such as the Wollega Zones, Gambella, and Benishangul-Gumuz. These regions experience high transmission rates due to favorable ecological and climatic conditions for *Anopheles* mosquito breeding. This comparative review examines the current prevalence and distribution of malaria in these hotspot areas, assesses the economic burden of the disease, and evaluates the strategic interventions implemented to combat it. **Methods:** A systematic review of recent studies and epidemiological data was conducted to analyze the prevalence and distribution of malaria cases in Western Ethiopia. The economic impact was assessed through healthcare costs, productivity losses, and household financial burden. Strategic interventions, including vector control, community engagement, healthcare infrastructure, and research efforts, were evaluated for their effectiveness in reducing malaria transmission and mitigating its economic impact. **Results:** The review found that malaria prevalence in Western Ethiopia remains high, with significant seasonal variations and geographic disparities. Hotspot areas exhibit higher transmission rates due to ecological conditions and socioeconomic factors. The economic burden of malaria is substantial, affecting healthcare systems, workforce productivity, and household finances. While vector control measures such as insecticide-treated bed nets (ITNs) and indoor residual spraying (IRS) have shown positive outcomes, challenges such as insecticide resistance and logistical issues persist. Community engagement and improvements in healthcare infrastructure have enhanced the effectiveness of malaria control efforts, though further research and development are necessary to address ongoing challenges. **Conclusion:** Malaria continues to impose a significant public health and economic burden in Western Ethiopia, particularly in hotspot areas. A multifaceted approach that includes robust vector control, community involvement, strengthened healthcare infrastructure, and ongoing research and development is essential for sustainable malaria control. Effective implementation of these strategies can reduce malaria prevalence, alleviate economic impacts, and improve health outcomes for affected populations in Western Ethiopia.

Keywords

Malaria, Prevalence, Distribution, Economic Burden, Western Ethiopia, Hotspot Areas, Vector Control, Strategic Interventions

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1. Introduction

Malaria continues to pose a major public health threat across sub-Saharan Africa, with Western Ethiopia being especially hard-hit [1, 2]. The Wollega Zones, Gambella, and Benishangul-Gumuz regions are recognized as significant malaria hotspots (Adugna et al., 2022). This is primarily due to their favorable ecological and climatic conditions, which provide ideal environments for the breeding of *Anopheles mosquitoes*, the primary vectors of malaria. These regions face exceptionally high malaria transmission rates, which have profound implications for both public health and the local economy. The persistent presence of malaria results in numerous health challenges, including high morbidity and mortality rates, particularly among vulnerable groups such as children and pregnant women. The burden of frequent malaria outbreaks places enormous strain on the healthcare systems, often leading to overcrowded health facilities and a shortage of medical supplies and personnel [4, 5].

Recent research has underscored the severity of malaria in the Wollega Zones, particularly in East Wollega, where the prevalence remains alarmingly high. *Plasmodium falciparum* and *Plasmodium vivax* are the predominant species identified. The findings emphasize the urgent need for continuous vector control measures and community-based interventions to mitigate transmission rates [6-11]. In East Wollega, reported a high prevalence of 25.6% among young children, linked to factors such as proximity to stagnant water and lack of insecticide-treated bed nets (ITNs) [12]. Taffese et al [13] emphasized the need for timely vector control measures, especially during the rainy season. In West Wollega, high rate of malaria prevalence were reported [14-16], this alarming rate of malaria prevalence were associated with practices and implementation of indoor residual spraying (IRS) has led to significant reductions in malaria cases; however, challenges such as insecticide resistance. In Kellel Wollega, agricultural practices that create water pools have exacerbated mosquito breeding and pointed out gaps in community knowledge regarding malaria prevention. The economic impact of malaria is substantial, straining productivity and pushing families into poverty due to the high costs associated with treatment and prevention. Addressing malaria effectively requires improvements in healthcare infrastructure, better access to diagnostic tools and antimalarial drugs, and ongoing research to tackle emerging challenges such as drug resistance and environmental changes.

Gambella, located in Western Ethiopia, is one of the regions most affected by malaria due to its favorable ecological and climatic conditions for *Anopheles* mosquito breeding. The region's proximity to water bodies and its seasonal rainfall patterns create ideal breeding grounds for mosquitoes, making it a malaria hotspot. Recent research studies and reports have provided valuable insights into the prevalence, distribution, and economic burden of malaria in various areas within Gambella. Despite significant advances in malaria

control in the Horn of Africa, Ethiopia continues to face high rates of morbidity and mortality from the disease. Lare, a district in the Gambella region near the Ethio-South Sudan border, has the highest malaria prevalence in the country.

Benishangul-Gumuz has also been a focal point of malaria research. According to a survey by [17] the prevalence of malaria in this region is influenced by agricultural practices that create breeding grounds for mosquitoes. The study called for integrated pest management strategies and improved agricultural practices to mitigate malaria transmission. The economic burden of malaria in Western Ethiopia is substantial. Healthcare systems are strained by the high demand for diagnosis, treatment, and hospitalization. Additionally, malaria significantly affects productivity, particularly in the agricultural sector, which is a primary source of livelihood in these regions. Households bear considerable financial burdens due to out-of-pocket expenses for malaria treatment and prevention, often pushing families into poverty.

Malaria remains a major public health challenge in sub-Saharan Africa, with Western Ethiopia being particularly affected. The Wollega Zones, Gambella, and Benishangul-Gumuz are key malaria hotspots due to their favorable ecological and climatic conditions that support *Anopheles* mosquito breeding. These regions experience high malaria transmission rates, leading to severe health and economic impacts. Malaria causes high morbidity and mortality, especially among vulnerable groups like children and pregnant women, straining healthcare systems with overcrowded facilities and shortages of medical supplies and personnel.

Economically, malaria's impact is profound. Frequent illness among the working population results in significant productivity losses, affecting subsistence and commercial farming, which is crucial in these agrarian communities. Families also face considerable out-of-pocket expenses for medical treatment and preventive measures like insecticide-treated bed nets (ITNs) and indoor residual spraying (IRS).

In the Wollega Zones, studies reveal high prevalence of both *Plasmodium falciparum* and *Plasmodium vivax*, with transmission rates peaking during the rainy season due to increased mosquito breeding sites. Similarly, in Gambella, seasonal rains boost mosquito populations and malaria cases, compounded by inadequate access to healthcare and preventive measures. Benishangul-Gumuz also struggles with malaria, exacerbated by agricultural practices that create standing water, thus enhancing mosquito breeding. Suggested strategies include integrated pest management and improved agricultural practices to reduce breeding sites and transmission rates.

Efforts to control malaria, such as ITNs and IRS, have had some success but face challenges like insecticide resistance and distribution difficulties. Community engagement and education are crucial for promoting preventive measures, but

ongoing efforts are necessary to sustain these initiatives. Effective malaria management requires continuous investment in healthcare infrastructure, including diagnostic tools, anti-malarial drugs, and trained professionals. Ongoing research is essential to address emerging challenges such as drug resistance and climate change impacts on malaria transmission.

In summary, malaria poses a significant health and economic challenge in Western Ethiopia. Addressing it effectively requires a comprehensive approach involving robust vector control, community engagement, healthcare infrastructure improvement, and continuous research. This review provides an in-depth analysis of the current malaria situation in Western Ethiopia, examining prevalence, distribution, economic impact, and the effectiveness of strategic interventions based on recent research.

Understanding local variations in malaria prevalence and impact is crucial for developing effective malaria control strategies. Local differences in transmission are influenced by factors such as climate, ecology, and socio-economic conditions. Recognizing these variations allows for the design of targeted interventions that address the specific needs and challenges of each area, ensuring that resources are allocated efficiently. This tailored approach helps in reducing malaria cases and associated morbidity, particularly among vulnerable groups like children and pregnant women. Additionally, localized data enhances surveillance and monitoring, enabling better tracking of malaria patterns and adaptation of strategies to emerging trends or resistance. It also supports informed policymaking by providing context-specific insights for developing effective policies. Furthermore, understanding local impacts aids in addressing the economic consequences of malaria, such as lost productivity and treatment costs, and helps in constructing targeted economic support programs. Overall, grasping local variations is essential for constructing sustainable malaria control efforts that improve health outcomes and community engagement.

Western Ethiopia, particularly the Wollega zones, is a significant hotspot for malaria transmission due to a confluence of environmental, socioeconomic, and epidemiological factors. The region's warm and humid climate, combined with seasonal rainfall, creates optimal breeding conditions for *Anopheles* mosquitoes, the primary vectors of malaria [18]. The area's diverse topography, including lowland valleys and highland plateaus, contributes to varying mosquito activity levels, with lowland areas offering abundant breeding sites due to stagnant water [19]. Additionally, high levels of migration and mobility related to agricultural work facilitate the spread of malaria across different areas [20]. Insecticide resistance among malaria vectors presents a significant challenge to effective vector control, diminishing the efficacy of traditional methods [21]. Malaria remains endemic in Western Ethiopia, with seasonal peaks typically occurring after the rainy season, reflecting the ongoing public health challenge in managing and reducing malaria transmission in this region [22]. Malaria prevalence and transmission dynamics in the

Wollega zones of Western Ethiopia are influenced by various environmental, socio-economic, and vector-related factors. This region, characterized by its high altitude and variable topography, experiences seasonal fluctuations in malaria transmission.

2. Prevalence of Malaria

Malaria is endemic in the Wollega zones, with prevalence rates often peaking following the rainy season. Studies have shown that the incidence of malaria in this region is closely linked to seasonal rainfall patterns, which create abundant breeding sites for *Anopheles* mosquitoes [9, 22]. The prevalence is typically higher in lowland areas compared to highland regions due to more favorable conditions for mosquito breeding in the former. The transmission dynamics of malaria in Wollega are shaped by several key factors:

- 1) **Vector Species and Behavior:** The primary malaria vectors in the Wollega zones are *Anopheles gambiae* and *Anopheles arabiensis*. These species are highly adapted to the local environmental conditions, with *An. gambiae* being more prevalent in the lowland areas and *An. arabiensis* in both highland and lowland regions [23]. The mosquitoes exhibit peak feeding activity during the evening and night, which coincides with the increased human activity in the region.
- 2) **Climate and Seasonal Variation:** The region experiences a bimodal rainfall pattern, with two main rainy seasons creating ideal conditions for mosquito breeding. The high temperatures and increased humidity during these periods enhance vector survival and malaria transmission [18].
- 3) **Socioeconomic Factors:** Agricultural practices, including irrigation for crops, create additional mosquito breeding sites. Limited access to healthcare and malaria prevention tools, such as insecticide-treated bed nets, contributes to higher transmission rates [24, 25]. Migration and mobility associated with seasonal agricultural work further facilitate the spread of malaria.
- 4) **Vector Control Measures:** Efforts to control malaria in Wollega include the use of insecticide-treated bed nets and indoor residual spraying. However, insecticide resistance among local mosquito populations challenges the effectiveness of these measures [26].

3. Public Health Implications

Malaria in the Wollega zones poses significant public health challenges, including high morbidity and occasional mortality. The disease burden is exacerbated by the region's remote and underserved areas, where healthcare access is limited. Effective malaria control strategies in Wollega require a multifaceted approach, including improved vector control, enhanced surveillance, and community-based inter-

ventions [8]. The Gambella Region of Western Ethiopia presents unique epidemiological factors influencing malaria transmission and patterns of occurrence. This region is notable for its tropical climate, proximity to major rivers, and other environmental and socio-economic features that affect malaria dynamics [27].

Unique Epidemiological Factors

1. Tropical Climate

Temperature and Humidity: Gambella's tropical climate, characterized by high temperatures and humidity, provides a conducive environment for the breeding and survival of *Anopheles* mosquitoes. The consistent warmth throughout the year supports year-round mosquito activity and malaria transmission [28, 29].

2. Proximity to Rivers

Breeding Sites: The region's numerous rivers and floodplains create ideal breeding conditions for malaria vectors. Seasonal flooding and river overflow lead to the formation of temporary stagnant water bodies, which are perfect breeding sites for *Anopheles* mosquitoes [18]. These conditions increase the mosquito population and, consequently, malaria transmission rates.

3. Vegetation and Land Use

Forests and Agriculture: Gambella's extensive forested areas and agricultural activities further affect malaria dynamics. Forests provide resting sites for mosquitoes, while agricultural practices, including irrigation, contribute to the creation of additional breeding sites [27].

Patterns of Malaria Occurrence

1. Seasonal Variability

Rainy Seasons: Malaria transmission in Gambella exhibits strong seasonal patterns, with peak transmission occurring shortly after the rainy seasons. The region typically experiences two main rainy periods: one from March to May and another from September to November. These periods contribute to the proliferation of mosquito breeding sites [25, 30].

2. Dry Seasons

Reduced Transmission: During the dry seasons, from December to February and June to August, the number of breeding sites diminishes as river levels drop and temporary water bodies dry up. Consequently, malaria transmission tends to decrease, although it does not stop completely [9].

3. Year-Round Transmission

Endemic Nature: Despite seasonal fluctuations, malaria remains endemic in Gambella, with transmission occurring throughout the year due to the region's persistent warm and humid conditions. The consistent presence of mosquito breeding sites ensures that malaria transmission does not cease completely even during drier periods [27].

Public Health Implications

1. Vector Control Challenges

Resistance and Coverage: Efforts to control malaria in Gambella face challenges related to vector resistance to insecticides and difficulties in reaching remote areas. Comprehensive vector control strategies, including the use of

insecticide-treated bed nets and indoor residual spraying, are critical but require adaptation to local conditions [26, 31].

2. Health Infrastructure

Access to Care: Limited healthcare infrastructure in remote areas of Gambella complicates the management of malaria. Improving healthcare access and strengthening malaria surveillance are essential for effective control and treatment [27, 32].

3. Community Engagement

Prevention Education: Increasing community awareness about malaria prevention and promoting the use of preventive measures are crucial for reducing transmission. Public health campaigns and education can help mitigate the impact of malaria in the region [18]. The Benishangul-Gumuz Region of Western Ethiopia experiences varied malaria transmission dynamics across its districts, influenced significantly by environmental factors. Here's a detailed overview:

Transmission Dynamics across Different Districts

1. District Variation:

Lowland Districts: Districts such as Metekel and Asosa are characterized by lowland areas with abundant riverine systems and seasonal flooding. These conditions favor extensive mosquito breeding sites, resulting in higher malaria transmission rates. Seasonal peaks in transmission are often observed shortly after the rainy seasons, when water bodies are most prevalent [27, 31].

Highland Districts: Districts such as Bambasi, which are situated at higher elevations, typically experience lower malaria transmission rates due to cooler temperatures that are less conducive to mosquito breeding. However, even in these areas, malaria transmission can still occur, particularly in the lower parts of the districts where temperatures are warmer [27].

2. Seasonal Patterns:

Rainy Seasons: The Benishangul-Gumuz Region generally experiences two main rainy seasons: the long rains from March to May and the short rains from September to November. Malaria transmission tends to peak shortly after these periods due to the creation of new mosquito breeding sites from increased rainfall [18]. **Dry Seasons:** During the dry seasons, from June to August and December to February, the number of breeding sites decreases as water bodies dry up. Consequently, malaria transmission tends to decline, though transmission rates can remain significant in certain lowland areas where water sources persist [33].

Impact of Environmental Factors on Malaria Prevalence

1. Climate and Temperature:

The region's diverse climate, ranging from tropical in lowlands to more temperate in highlands, influences malaria prevalence. Warmer temperatures in lowland areas promote higher mosquito activity and faster development of malaria parasites within mosquitoes, leading to increased transmission rates [14, 30]. High humidity levels in the region support mosquito survival and proliferation. Areas with high humidity, particularly in the lowlands, see more persistent mosquito

populations and higher malaria prevalence [27].

2. Water Bodies and Flooding:

Major rivers such as the Baro and the Dabus create numerous breeding sites for mosquitoes, particularly during the rainy seasons. Seasonal flooding can lead to widespread mosquito breeding, significantly affecting malaria transmission [18]. Agricultural practices, especially irrigation, also contribute to malaria risk by creating additional mosquito breeding sites. Irrigated fields can retain water and foster mosquito populations, impacting local malaria dynamics [28], [31].

3. Vegetation and Land Use:

Dense forested areas provide shelter for mosquitoes, while agricultural activities, such as rice paddies and irrigation, create favorable conditions for mosquito breeding. The interplay between these environmental factors influences malaria transmission across different districts [34].

4. Human Settlements and Migration:

Population Density: Districts with higher population densities, particularly in lowland areas, often experience higher malaria transmission rates due to increased human-mosquito contact. Migration patterns related to agricultural work and other economic activities can influence malaria spread [21].

Public Health Implications

1. Targeted Interventions:

Tailored Strategies: Effective malaria control strategies need to be tailored to the specific environmental and epidemiological conditions of each district. For example, highland districts may benefit more from targeted surveillance and community education, while lowland districts may require enhanced vector control measures [35].

2. Surveillance and Monitoring:

Enhanced Surveillance: Implementing robust surveillance systems to monitor malaria incidence and vector populations is crucial for managing malaria in diverse environments. Continuous monitoring can help adapt control measures to changing environmental conditions [18].

3. Community Engagement:

Awareness Programs: Engaging local communities in malaria prevention efforts, such as using insecticide-treated bed nets and improving sanitation to reduce mosquito breeding sites, is essential for controlling malaria [32].

5. Mitigation Strategies and Interventions

Vector Control

In the Wollega Zones Gambella and Asossa regions, vector control strategies, such as the implementation of insecticide-treated nets (ITNs) and indoor residual spraying (IRS), are crucial for reducing malaria transmission [26]. ITNs provide a protective barrier against mosquito bites during the night, while IRS targets adult mosquitoes resting indoors. Despite their effectiveness, achieving high coverage poses several challenges. Similarly, IRS programs face difficulties related to insecticide resistance, logistical constraints, and maintaining consistent spraying schedules. Addressing these challenges requires strengthening supply chains, enhancing

local coordination, and exploring alternative insecticides to combat resistance [36].

Healthcare Strengthening

Improving healthcare infrastructure in the Wollega Zones Gambella and Asossa regions involves enhancing the availability and accessibility of diagnostic tools such as rapid diagnostic tests (RDTs). RDTs offer a quick and reliable means of diagnosing malaria, which is essential for prompt treatment and reducing transmission [27, 32]. Alongside diagnostics, treatment protocols need to be updated regularly based on current malaria strains and resistance patterns. Strengthening health system capacity includes training healthcare personnel, expanding health facilities, and ensuring a steady supply of antimalarial drugs. Effective management of these aspects is vital for improving malaria case detection, treatment, and overall health system resilience [31, 32].

Community Engagement

Community engagement plays a significant role in malaria control within the Wollega Zones Gambella and Asossa regions, education campaigns aimed at increasing awareness about malaria prevention and treatment are essential for changing behaviors and promoting the use of ITNs and IRS. Local participation in malaria prevention efforts, including community-led initiatives and involvement in vector control activities, enhances the effectiveness of these strategies. By fostering community ownership and collaboration, interventions are more likely to succeed and be sustained over time. Empowering communities through education and active participation helps in overcoming barriers to malaria prevention and treatment, ultimately leading to a reduction in malaria burden in the region. In the Wollega Zones, Gambella and Asossa regions, effective malaria mitigation strategies and interventions are crucial for controlling the disease. The approach includes vector control measures, healthcare strengthening, and community engagement. Here's a comprehensive look at these strategies:

Implementation of ITNs and IRS Programs:

Insecticide-Treated Nets (ITNs): ITNs are a key component of malaria control efforts in Gambella. The nets are designed to protect individuals from mosquito bites during the night, when the *Anopheles* mosquitoes are most active. The distribution of ITNs is typically carried out through health campaigns and routine services [37]. **Indoor Residual Spraying (IRS):** IRS involves spraying the interior walls of homes with insecticides that kill mosquitoes. This method targets mosquitoes resting indoors, providing another layer of protection against malaria. IRS programs are often implemented on a rotational basis, targeting areas with high malaria transmission [38].

Effectiveness and Challenges in Achieving High Coverage:

Effectiveness: Both ITNs and IRS have been shown to significantly reduce malaria transmission by decreasing mosquito populations and human exposure to bites. Studies in Gambella have demonstrated reductions in malaria incidence following widespread distribution and use of these interven-

tions [18]. Challenges: Achieving high coverage can be challenging due to factors such as logistical issues in distributing ITNs to remote areas, resistance of mosquito populations to insecticides, and variability in IRS application. Insecticide resistance reduces the effectiveness of IRS, while maintenance and proper use of ITNs require continuous community education and support [27].

2. Healthcare Strengthening

Availability and Accessibility of Diagnostic Tools:

Rapid Diagnostic Tests (RDTs): RDTs are crucial for the timely diagnosis of malaria. They allow for quick and accurate detection of malaria parasites, which is essential for effective treatment. RDTs are distributed through health facilities and community health workers, but accessibility can be limited in remote areas [39]. **Microscopy:** While microscopy remains the gold standard for malaria diagnosis, it requires trained personnel and well-equipped laboratories, which may be lacking in some areas of Gambella.

Treatment Protocols and Health System Capacity:

Treatment Protocols: The standard treatment for uncomplicated malaria includes artemisinin-based combination therapies (ACTs). Ensuring that these medications are available and used correctly is vital for reducing malaria morbidity and mortality [40]. **Health System Capacity:** Strengthening health systems involves improving the availability of diagnostic tools and medications, training healthcare workers, and enhancing healthcare infrastructure. In Gambella, challenges include inadequate health facilities in remote areas and a shortage of trained personnel (Teklehaimanot, 2013).

3. Community Engagement

Role of Community Education and Behavior Change:

Education Campaigns: Community education plays a significant role in malaria prevention. Awareness campaigns about the use of ITNs, the importance of IRS, and symptoms of malaria can help change behaviors and increase the uptake of preventive measures. Education programs are often conducted through local health centers, schools, and community gatherings [18]. **Behavior Change:** Efforts to promote behavior change include encouraging the consistent use of ITNs, adherence to malaria treatment protocols, and seeking timely medical care. Behavior change communication strategies aim to address misconceptions and promote practices that reduce malaria risk [27].

Local Participation in Malaria Prevention Efforts:

Community Involvement: Local participation is critical for successful malaria prevention. Engaging community members in planning and implementing malaria control activities helps ensure that interventions are culturally appropriate and effectively address local needs. Community health workers play a vital role in mobilizing local support and facilitating access to prevention and treatment services [27]. **Partnerships:** Collaborations with local organizations, leaders, and stakeholders can enhance the reach and impact of malaria interventions. Building partnerships helps to leverage resources and expertise for more effective malaria control [8, 26, 30].

Vaccine Development

The development of malaria vaccines represents a critical frontier in combating the disease. Significant progress has been made in vaccine research, with candidates such as the RTS, S/AS01 vaccine showing promise in clinical trials. This vaccine, targeted primarily at *Plasmodium falciparum*, has demonstrated moderate efficacy in reducing malaria incidence in young children. However, challenges persist, including the need for more effective vaccines with longer-lasting protection, adaptation to various malaria strains, and scaling up production and distribution. The potential impact of successful malaria vaccines could be transformative, significantly reducing transmission rates and decreasing the overall malaria burden, particularly in high-prevalence areas like the Wollega Zones, Gambela Region, and Benishangul-Gumuz.

Surveillance and Response

Effective malaria control relies heavily on robust surveillance and response systems. In the Wollega Zones, Gambela Region, and Benishangul-Gumuz, surveillance systems are essential for tracking malaria cases, identifying hotspots, and assessing trends. Improved data collection and analysis enable timely and targeted interventions. During outbreaks and seasonal peaks, rapid response strategies are crucial for controlling the spread of malaria. These strategies may include enhanced case detection, expedited distribution of insecticide-treated nets (ITNs) and indoor residual spraying (IRS), and the deployment of mobile health teams to affected areas. Strengthening surveillance and response capabilities ensures that public health authorities can quickly adapt to changing patterns of malaria transmission, effectively manage, and mitigate outbreaks.

Conclusion and Future Perspective

The Gambella and Benishangul-Gumuz regions of Western Ethiopia face significant challenges in malaria control due to their unique environmental conditions, including tropical climates, extensive river systems, and seasonal flooding. Effective mitigation strategies have been implemented, focusing on vector control, healthcare strengthening, and community engagement. However, achieving sustainable malaria control requires addressing ongoing challenges and adapting strategies to evolving conditions. The future of malaria control in the Gambella and Benishangul-Gumuz regions hinges on integrating innovative technologies, strengthening health systems, engaging communities, and fostering collaboration. By addressing current challenges and embracing new approaches, it is possible to achieve more sustainable and effective malaria control, ultimately reducing the burden of this disease and improving public health outcomes in these regions.

Abbreviations

ITNs	Insecticide-Treated Nets
IRS	Indoor Residual Spraying
RDT	Rapid Diagnostic Tests

Conflicts of Interest

There is no conflict of interest.

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