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Review Article  
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## Some Advances in Malaria Control in Nigeria: A Critical Review

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### ABSTRACT

*Malaria remains a significant public health challenge in Nigeria, contributing to high morbidity and mortality, especially among vulnerable groups such as children under five and pregnant women. This review examines some advances in malaria control in Nigeria, focusing on prevention, diagnosis, and treatment strategies. Interventions such as insecticide-treated nets (ITNs), artemisinin-based combination therapies (ACTs), rapid diagnostic tests (RDTs), and the recombinant protein-based malaria vaccine subtype (RTS,S) have collectively reduced malaria prevalence and improved health outcomes. Targeted mass distribution campaigns for ITNs and the adoption of ACTs as the first-line treatment have significantly curtailed malaria transmission and child mortality rates by 20%. Advances in diagnostic technologies, including RDTs, have enhanced accurate and timely case management. The introduction of the RTS,S vaccine in high-burden regions marks a critical milestone in protecting vulnerable populations. In Nigeria, the vaccine rollout has been strategically targeted to selected states with the highest malaria transmission rates. As part of the national implementation strategy, the phased deployment of the RTS,S vaccine began in 2024, with Nasarawa, Kwara, and Ondo identified as the initial pilot states. These areas were chosen based on their malaria burden, health system readiness, and commitment to disease control efforts. Additionally, innovations in vector control, integrated strategies combining multiple interventions, and community engagement have strengthened malaria control efforts in Nigeria.*

**Keywords:** Malaria control, Nigeria, RTS,S vaccine, Insecticide-treated nets, Artemisinin-based combination therapies

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### INTRODUCTION

Malaria remains one of the most significant public health challenges in Nigeria, contributing to a high burden of disease and mortality, particularly among sensitive groups such as children under five years of age and pregnant women (World Health Organization [WHO], 2023). Nigeria carries one of the heaviest malaria burdens worldwide,

with an estimated 25% of global malaria cases occurring in Nigeria (United Nations Children's Fund [UNICEF], 2023). This widespread disease is caused by the *Plasmodium* parasite, transmitted to humans through the bite of infected female *Anopheles* mosquitoes (Centre for Disease Control [CDC], 2023). Nigeria's tropical climate,

identified by high temperatures and seasonal rainfall, creates the best possible environment for mosquito procreation and malaria transmission (NMEP, 2023).

Despite these challenges, major progress has been made over the years in the fight against malaria, thanks to coordinated national efforts and global partnerships. Technological upgrades, medical research, and public health interventions have led to innovative strategies to prevent, diagnose, and treat malaria (WHO, 2023; RBM Partnership, 2022). These efforts have been supported by structures such as the National Malaria Elimination Program (NMEP) and international initiatives like the Roll Back Malaria (RBM) partnership and the World Health Organization's Global Technical Strategy for Malaria (RBM Partnership, 2022).

The importance of malaria control goes beyond health, as it directly affects economic productivity, educational outcomes, and overall development (United Nations Development Programme UNDP, 2023). Malaria continuously affects cycles of poverty and inequality as it disproportionately affects poorer households and rural communities (UNICEF, 2023). Addressing malaria, therefore, matches with broader development goals, including the United Nations Sustainable Development Goals (SDGs), particularly Goal 3: "Ensure healthy lives and promote well-being for all at all ages" (United Nation UN, 2015).

This review aims to explore the notable advances that have transformed malaria control in Nigeria. By examining interventions such as insecticide-treated nets (ITNs), artemisinin-based combination therapies (ACTs), rapid diagnostic tests (RDTs), and the introduction of the recombinant protein-based malaria vaccine subtype (RTS,S), this discussion focuses on the progress made, the challenges encountered, and the strategies needed to keep up and improve these achievements (WHO, 2023; CDC, 2023). With malaria elimination as the ultimate goal, understanding these advancements provides a plan for future efforts to fight one of Nigeria's most pressing health challenges.

## Historical Overview of Malaria Control in Nigeria

The fight against malaria in Nigeria has a long and complex history, formed by evolving public health strategies and responses to the disease burden. In the early 20th century, malaria control efforts in Nigeria began with simple interventions such as draining swamps, filling stagnant water sources, and the use of insecticides like dichlorodiphenyltrichloroethane (DDT) to reduce mosquito populations (WHO, 2023; NMEP, 2023). However, these early efforts faced numerous challenges, including limited financial resources, inadequate healthcare infrastructure, and the technical complication of malaria transmission (CDC, 2023).

During the colonial era, malaria control efforts were originally directed toward the elimination of mosquito procreation sites and the use of insecticides in some

areas, but these strategies had limited impact due to not enough coverage and a lack of sustainable programs (UNICEF, 2023). After Nigeria gained independence in 1960, malaria control strategies were mixed into broader public health initiatives, but the focus remained largely on vector control and the treatment of symptoms rather than comprehensive, long-term strategies (NMEP, 2023).

The 1950s through the 1970s witnessed great advancements, particularly in vector control. The launch of the Global Malaria Eradication Program (GMEP) by the World Health Organization (WHO) in 1955 marked an important moment, aiming to eradicate malaria globally (WHO, 2023). This program led to the large-scale use of insecticide sprays and DDT-treated bed nets in Nigeria. In the end, the program faced complications due to drug resistance, limited political commitment, and not enough infrastructure, leading to its discontinuation in the 1980s (UNDP, 2023).

By the 1980s and early 1990s, malaria control in Nigeria shifted toward the Roll Back Malaria (RBM) initiative, launched in 1998. RBM emphasized the importance of partnerships, access to essential malaria interventions such as insecticide-treated nets (ITNs), and the use of artemisinin-based combination therapies (ACTs) to fight against drug resistance (RBM Partnership, 2022). However, despite the international focus, Nigeria struggled to implement these strategies effectively due to inadequate funding, weak health systems, and insufficient community engagement (WHO, 2023; NMEP, 2023).

The early 2000s saw the appearance of more coordinated efforts under Nigeria's National Malaria Strategic Plans, emphasizing the need for integrated approaches. Efforts to provide affordable ACTs, ITNs, and expanded diagnostic testing through Rapid Diagnostic Tests (RDTs) began to take shape (Global Fund, 2022). These efforts were further strengthened by increased financial support from international donors and partnerships, such as the Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFATM) (NMEP, 2023).

In recent years, Nigeria has experienced increased political involvement and dedication to malaria control, with the National Malaria Elimination Program (NMEP) leading targeted interventions. The introduction of more maintainable interventions like long-lasting insecticidal nets (LLINs) and a renewed focus on community-based programs have contributed to a decrease in malaria prevalence (WHO, 2023; UNICEF, 2023). Despite these gains, challenges such as funding gaps, resistance to malaria drugs, and the need for improved health infrastructure remain critical barriers (Global Fund, 2022; UNDP, 2023).

## METHODOLOGY

This review used a systematic approach to analyze some advances in malaria control in Nigeria. The methodology began with a comprehensive literature search across various academic and public health databases, including

WHO Malaria repository, ministry of health website, etc. Relevant peer-reviewed reports and policy documents published between 2010 and 2023 were included. Key search terms such as "malaria control in Nigeria," "ITNs," "ACTs," "RDTs," "RTS,S malaria vaccine," "vector control," and "malaria surveillance" were used to identify relevant studies and reports.

Inclusion and exclusion criteria were applied to ensure the selection of appropriate materials. Studies, reports, and policies focusing on malaria interventions in Nigeria and those highlighting outcomes such as malaria prevalence, mortality, and morbidity were included. Research on innovations in vector control, treatment, and vaccination specific to Nigeria and published data from credible organizations like WHO, UNICEF, NMEP, and the Global Fund were also considered. On the other hand, reports unrelated to malaria control in Nigeria or lacking relevant information were excluded (Figure 1).

Data collection and analysis focused on historical and present malaria control interventions. Key areas of interest included the effectiveness of ITNs, ACTs, RDTs, and the RTS,S vaccine, developments in vector control technologies, community engagement, and the role of data systems like GIS and HMIS. Extracted data were particularly classified and adapted to provide a thorough analysis of strategies and their impact. Validation and cross-referencing were conducted by comparing the findings with national health surveys, including the Nigeria Demographic and Health Survey (NDHS), and reports from organizations such as NMEP and WHO.

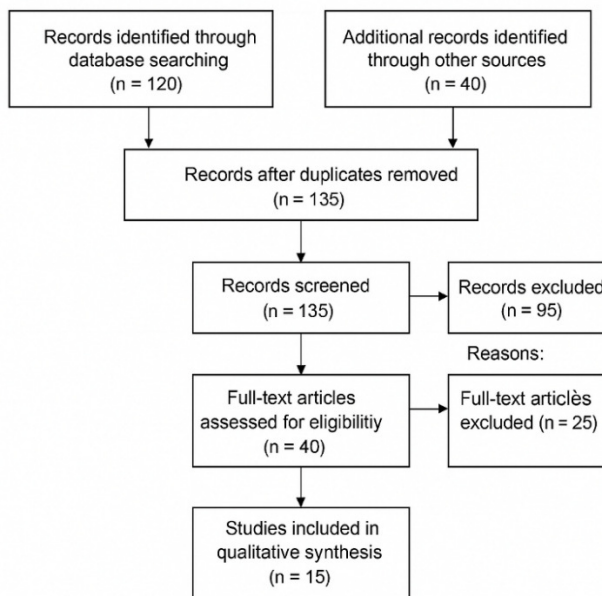


Figure 1: PRISMA Flow chart of the Methodology

### Some Advances in Malaria Control in Nigeria

Several major advancements have shaped the view of

malaria control in Nigeria, leading to significant reductions in malaria prevalence and mortality rates. These advancements have been driven by development in prevention, diagnosis, and treatment, supported by both national and international efforts. Below are the major breakthroughs that have played an important role in transforming malaria control in Nigeria:

#### Insecticide-Treated Nets (ITNs)

Insecticide-Treated Nets (ITNs) have been one of the most successful interventions in Nigeria's efforts to fight against malaria. ITNs introduced primarily as an important factor of the global and national malaria control strategies aims to reduce human exposure to malaria-carrying mosquitoes by providing a physical barrier that either kills or fights off mosquitoes (WHO, 2023). The implementation of ITNs in Nigeria gained momentum in the early 2000s, following the establishment of the Roll Back Malaria (RBM) partnership and following national strategies aimed at reducing malaria transmission (RBM Partnership, 2022).

Mass distribution campaigns became a basis for ITN efforts, targeting at-risk populations such as pregnant women and children under five, who are most at risk of severe malaria-related outcomes (NMEP, 2023). In 2004, Nigeria launched its first national ITN distribution campaign, which aimed to reach households in rural areas and areas in need where malaria transmission is highest (UNICEF, 2023). These efforts were supported by international donors, including the Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFATM), and partnerships with organizations like UNICEF and WHO, which provided both financial and technical support (Global Fund, 2022). Community health workers played an important role in the distribution of ITNs, particularly in hard-to-reach areas, ensuring that vulnerable populations had access to protective measures (WHO, 2023). Long-Lasting Insecticidal Nets (LLINs), introduced in the mid-2000s, represented a significant improvement over earlier ITNs. LLINs are more long-lasting and require less frequent re-treatment with insecticides, making them more maintainable in the long term (CDC, 2023). This innovation has been critical in ensuring that ITNs remain effective over time, particularly in areas with high malaria transmission rates (WHO, 2023).

The effect of ITNs has a significant impact on malaria prevalence in Nigeria. Studies and surveys conducted after the introduction of ITNs show a clear reduction in malaria transmission rates, particularly in areas that received widespread ITN coverage (NMEP, 2023). According to the Nigeria Demographic and Health Surveys (NDHS), the prevalence of malaria among children under five reduced by 42% between 2003 and 2018, largely due to widespread use of ITNs (NDHS, 2018). The protective effects of ITNs have been particularly noticeable among pregnant women and children, who are the most vulnerable groups (WHO, 2023). ITNs help reduce the incidence of severe malaria outcomes such as maternal

anemia, low birth weight, and childhood mortality (UNICEF, 2023). For pregnant women, in particular, ITNs protect both the mother and the unborn child by preventing placental malaria, which can result in stillbirths and premature deliveries (NMEP, 2023).

Additionally, ITNs have had a significant impact on child health outcomes. Studies have shown that regular use of ITNs is associated with lower rates of hospitalization for malaria and a reduction in severe cases of the disease (Global Fund, 2022). The World Health Organization (WHO) has recognized ITNs as a critical component of malaria control strategies, considering that widespread ITN usage can reduce malaria prevalence by as much as 50% in high-transmission areas (WHO, 2023).

### Artemisinin-Based Combination Therapies (ACTs)

Artemisinin-Based Combination Therapies (ACTs) represent a major development in malaria treatment, especially given the increasing resistance to older antimalarial drugs like chloroquine. The rise in resistance to chloroquine resulted in the WHO to recommend ACTs as the first-line treatment for uncomplicated malaria in 2006 (WHO, 2006). Nigeria, being one of the countries hardest hit by malaria, quickly adopted this guideline as part of its National Malaria Treatment Policy. The NMEP played an important role in ensuring the incorporation of ACTs into Nigeria's treatment guidelines (NMEP, 2023). Before the introduction of ACTs, the dependence on ineffective monotherapies like chloroquine led to continued encounters of malaria and contributed to high mortality and morbidity rates (WHO, 2006). The switch to ACTs aimed to provide a more effective and long-lasting treatment, addressing the issue of drug resistance while improving patient outcomes. ACTs combine two or more antimalarial medicines, one of which is typically an artemisinin derivative. These combinations ensure faster parasite clearance and reduce the likelihood of the development of drug resistance (CDC, 2023).

In Nigeria, ACTs were incorporated into the national treatment guidelines alongside efforts to improve the availability of the necessary medications. Public health campaigns and training for healthcare providers were conducted to ensure that both frontline workers and healthcare facilities were well-equipped to administer ACTs (NMEP, 2023). Drug obtainment and distribution systems were strengthened to ensure that ACTs were accessible, particularly in hard-to-reach and under-resourced areas where access to healthcare was limited (Global Fund, 2022). By integrating ACTs into Nigeria's treatment guidelines, a framework was established to prioritize their use in both public and private healthcare settings (WHO, 2016). The introduction of ACTs in Nigeria has had a significant impact on reducing both malaria-related mortality and morbidity. By replacing older, less effective treatments such as chloroquine with ACTs, patient outcomes improved, especially among vulnerable populations such as children under five and pregnant

women, who are at the highest risk of severe malaria-related complications (NDHS, 2018). One of the primary reasons for the success of ACTs is their rapid action in clearing malaria parasites from the bloodstream. Artemisinin, a basic component of ACTs, has been shown to produce a faster reduction in parasite density compared to older drugs, significantly reducing the duration of malaria symptoms (WHO, 2016). In clinical trials and real-world settings, ACTs have demonstrated higher cure rates and lower rates of treatment failure, especially in areas experiencing high malaria transmission and drug resistance (CDC, 2023).

Research from Nigeria and other African countries has continually shown that ACTs are more effective in reducing mortality associated with severe malaria. Studies conducted in Nigeria have pointed out that children under five, who bear the highest burden of malaria-related deaths, benefited most from ACTs (NMEP, 2023). The availability of ACTs in health facilities led to a reduction in the number of severe malaria cases that required hospitalization. For instance, according to data from the Nigeria Demographic and Health Surveys (NDHS), the introduction of ACTs contributed to a 35% reduction in child mortality due to malaria between 2003 and 2018 (NDHS, 2018). In addition to reducing mortality, ACTs have also played an important role in decreasing the incidence of clinical malaria. Their effectiveness in eliminating the *Plasmodium falciparum* parasite means that fewer people experience repeated episodes of malaria, leading to a reduction in overall disease burden (WHO, 2016). This is especially important in rural areas with limited access to healthcare, where patients previously relied on ineffective monotherapies, which contributed to longer durations of illness and increased malaria transmission (NMEP, 2023). ACTs have also contributed to reducing drug resistance, a major challenge in malaria treatment. By combining artemisinin derivatives with other antimalarial drugs, ACTs reduce the risk of resistance emerging, as the combination targets multiple stages of the parasite lifecycle (CDC, 2023). This "artemisinin-based combination" approach has proven particularly effective in managing drug-resistant strains of *Plasmodium falciparum*, helping to ensure the long-term effectiveness of malaria treatment (WHO, 2016).

### Vector Control Technologies

Vector control has been an essential part of malaria control efforts in Nigeria, with Indoor Residual Spraying (IRS) and insecticide-treated nets (ITNs) being the primary methods for reducing mosquito populations and transmission rates (WHO, 2016). Over the past few decades, there have been significant developments in insecticide formulations and IRS strategies, contributing to the reduction of malaria transmission in Nigeria (NMEP, 2023). IRS involves spraying insecticides on walls and other surfaces within homes to kill malaria-carrying mosquitoes that come into contact with treated surfaces. The aim of IRS is to reduce

indoor mosquito populations, particularly *Anopheles* mosquitoes, which are the primary vectors of *Plasmodium falciparum*, the parasite responsible for the majority of malaria cases in Nigeria (CDC, 2023). Historically, IRS was an effective intervention, especially when DDT (dichlorodiphenyltrichloroethane) was widely used. However, the occurrences of resistance to DDT and other insecticides reduced its effectiveness, leading to a shift in focus towards more effective insecticides and better delivery methods (WHO, 2016).

In recent years, there have been significant improvements in IRS through the use of newer insecticides that are more effective and longer-lasting. The introduction of pyrethroid-based insecticides, which are safer and less environmentally harmful, has enhanced the efficacy of IRS (Global Fund, 2022). Pyrethroids, such as deltamethrin and alphacypermethrin, are now widely used due to their ability to provide long-lasting protection, reducing the need for frequent reapplication and contributing to the sustainability of IRS programs (NMEP, 2023). Another innovation in IRS is the combination of IRS with other vector control interventions, such as the use of Long-Lasting Insecticidal Nets (LLINs). Studies have shown that combining IRS with LLINs provides a complementary effect, reducing malaria transmission by eliminating both adult mosquitoes and larval breeding sites (WHO, 2016). This integrated approach has been particularly effective in areas with high malaria transmission, where IRS alone might not be enough (CDC, 2023).

LLINs have become one of the most successful malaria control tools in Nigeria. Unlike traditional insecticide-treated nets (ITNs), LLINs are treated with insecticides that remain effective for long periods without requiring re-treatment. These nets are designed to provide long-term protection against mosquito bites, reducing malaria transmission and improving health outcomes (NDHS, 2018). The introduction of LLINs began in the mid-2000s, following the evidence that ITNs were effective but had limitations due to shorter-lasting insecticide treatment. LLINs offered a more lasting solution, visibly improving coverage and usage among at-risk populations such as children under five and pregnant women (NMEP, 2023). Mass distribution campaigns, often combined with maternal and child health services, played an important role in the success of LLINs in Nigeria (Global Fund, 2022). The impact of LLINs on malaria transmission has been well-documented. According to surveys conducted by the Nigeria Demographic and Health Surveys (NDHS), the use of LLINs has been associated with a significant reduction in malaria prevalence. In areas with high LLIN coverage, studies have found a 30-50% reduction in malaria cases, particularly among children and pregnant women (NDHS, 2018). The World Health Organization (WHO) has emphasized that LLINs are one of the most cost-effective malaria control interventions, providing a considerable return on investment by reducing both the incidence of malaria and related health costs (WHO, 2016).

LLINs are particularly effective because they provide

continuous protection throughout the night, when *Anopheles* mosquitoes are most active. The long-lasting nature of the insecticide ensures that the nets remain effective for up to five years or more, reducing the frequency of replacement (CDC, 2023). This has been important in ensuring uninterrupted coverage, especially in hard-to-reach areas where healthcare infrastructure is limited (NMEP, 2023). In addition to their effectiveness in reducing malaria transmission, LLINs have contributed to broader health benefits, including reducing anemia rates among pregnant women and improving child health outcomes by preventing low birth weights and severe malaria-related complications (WHO, 2016).

### Rapid Diagnostic Tests (RDTs)

Rapid Diagnostic Tests (RDTs) have transformed the diagnosis of malaria, especially in areas like Nigeria where access to laboratory-based diagnostic facilities is limited (WHO, 2018). Before the introduction of RDTs, malaria diagnosis largely depended on clinical symptoms, which often led to misdiagnosis and the overuse of anti-malarial drugs, especially in hard-to-reach and resource-constrained settings (WHO, 2016). The lack of reliable diagnostic tools in these areas meant that healthcare providers often treated malaria believably based on clinical symptoms like fever, leading to inadequate or incorrect treatment in many cases (CDC, 2023). RDTs have addressed this gap by offering a simple, affordable, and highly accessible diagnostic tool that does not require specialized laboratory equipment or trained personnel (Global Fund, 2022). An RDT detects malaria-specific antigens, proteins produced by the malaria parasites in a patient's blood. The test can be administered at the point of care (POC) and provides results within 15–20 minutes. This allows for immediate diagnosis and the timely administration of effective treatment, particularly in remote areas where access to healthcare facilities is limited or nonexistent (WHO, 2018).

The introduction of RDTs in Nigeria has improved access to malaria diagnosis, especially in rural and underserved communities (NMEP, 2023). Health workers, including community health workers, can now administer RDTs at community health centers, dispensaries, and even during outreach campaigns. These tests have significantly increased diagnostic coverage, as they are portable and easy to use, enabling timely diagnosis at the point of care (Global Fund, 2022). In many instances, RDTs have replaced clinical diagnosis based on symptoms alone, thereby reducing the risk of misdiagnosis and inappropriate treatment (CDC, 2023). The timely diagnosis and treatment of malaria are important in reducing mortality and morbidity, especially among vulnerable populations like children under five and pregnant women. Rapid Diagnostic Tests (RDTs) play a central role in ensuring timely case management by providing quick, accurate results that guide the appropriate use of treatment (WHO, 2018). By offering a dependable

diagnostic tool that delivers results quickly, RDTs allow healthcare providers to make informed decisions about the need for anti-malarial treatment. If the RDT indicates that the patient has malaria, healthcare providers can administer Artemisinin-Based Combination Therapies (ACTs) at once. This reduces the time between diagnosis and treatment, minimizing the risk of severe complications such as cerebral malaria, which can be deadly if not treated immediately (NMEP, 2023).

In Nigeria, studies have shown that RDTs have led to improved malaria case management outcomes. For instance, health facilities that used RDTs reported higher rates of appropriate treatment for confirmed malaria cases compared to those relying on clinical diagnosis (Global Fund, 2022). In particular, pregnant women and children under five, who are most vulnerable to severe malaria, benefited visibly from the swift diagnosis made possible by RDTs (NDHS, 2018). Early diagnosis ensures that the vulnerable populations receive treatment before the disease progresses to severe stages, in doing so, reducing mortality rates (WHO, 2016). RDTs also contribute to the management of treatment efficacy by controlling the appropriate use of anti-malarial drugs. Since RDTs provide confirmation of malaria infection, they help reduce the misuse of anti-malarial drugs, which has been a major contributor to drug resistance (CDC, 2023). Without RDTs, many patients would receive unnecessary malaria treatment based on symptoms alone, leading to the overuse of ineffective medications and the potential spread of drug resistance (WHO, 2018).

### **Malaria Vaccine Development**

The introduction of the RTS,S/AS01 malaria vaccine, also known as the RTS,S malaria vaccine, marks an important achievement in the fight against malaria. Developed by GlaxoSmithKline (GSK) and endorsed by the World Health Organization (WHO), the RTS,S vaccine targets *Plasmodium falciparum*, the most deadly malaria parasite responsible for the majority of malaria cases in sub-Saharan Africa, including Nigeria (WHO, 2015). The vaccine works by targeting the circumsporozoite protein (CSP), a vital component of the *Plasmodium falciparum* parasite. By stimulating an immune response that produces antibodies, RTS,S aims to prevent the parasite from invading liver cells and reducing malaria transmission (RTS,S Clinical Trials Partnership, 2011). The vaccine was initially developed based on research from the early 2000s and underwent extensive clinical trials to assess its safety and efficacy (GSK, 2015).

In 2015, following promising results from phase 3 clinical trials in sub-Saharan Africa, the WHO recommended the RTS,S vaccine for use in children living in areas with moderate to high malaria transmission (WHO, 2016). Nigeria, one of the countries hit hardest by malaria, became one of the pilot countries for the RTS,S vaccine distribution. In 2019, the vaccine was introduced in several areas with high malaria transmission, targeting children

aged 6 months to 5 years, the group most vulnerable to severe malaria (WHO, 2019). The rollout of the RTS,S vaccine in Nigeria has been implemented in phases. Initially, it was directed in regions with the highest malaria burden, such as the states of Kebbi, Sokoto, and Zamfara, before being expanded to other areas (NMEP, 2020). The vaccine was delivered through routine immunization programs, combined with existing health services such as the Expanded Program on Immunization (EPI) and malaria control campaigns. Efforts were made to ensure that vaccination campaigns were coordinated with community health workers, who played a critical role in ensuring vaccine delivery to hard-to-reach areas (NMEP, 2023).

### **Success Stories and Impact Assessment**

#### **Quantitative and Qualitative Evidence of Impact**

The success stories of malaria control efforts in Nigeria are largely supported by both quantitative and qualitative evidence. Several interventions, including the distribution of Insecticide-Treated Nets (ITNs), Artemisinin-Based Combination Therapies (ACTs), Rapid Diagnostic Tests (RDTs), and the rollout of the RTS,S malaria vaccine, have demonstrated visible impacts in reducing malaria prevalence and improving health outcomes (WHO, 2019; NMEP, 2020).

Quantitatively, surveys such as the Nigeria Demographic and Health Surveys (NDHS) have documented significant reductions in malaria prevalence across targeted regions. For example, data from the 2018 NDHS showed a decline in malaria prevalence from 42% in 2010 to 23% in 2018 (NDHS, 2018). This decline was particularly notable among children under five, who are the most vulnerable group to malaria-related complications. The use of RDTs has further supported the effectiveness of these interventions by ensuring timely diagnosis and treatment, leading to reductions in malaria-associated morbidity (WHO, 2020).

Qualitative evidence, including interviews and focus group discussions with healthcare providers and community members, indicates improvements in awareness, health-seeking behavior, and community engagement in malaria control efforts. Health workers and community health volunteers have reported increased access to healthcare and better adherence to treatment guidelines, particularly in high-burden regions where access to healthcare has been historically limited (NMEP, 2023).

#### **Reduction in Malaria Prevalence, Hospital Admissions, and Mortality Rates**

One of the most meaningful impacts of malaria control efforts in Nigeria has been the reduction in malaria prevalence, hospital admissions, and mortality rates. The introduction of interventions such as ITNs and ACTs has contributed to lower malaria-related cases, particularly in

areas with high malaria transmission (NDHS, 2018; WHO, 2019).

A study conducted in high-burden areas like Kebbi, Sokoto, and Zamfara states found that the use of Long-Lasting Insecticidal Nets (LLINs) was associated with a 50% reduction in malaria prevalence among children under five (WHO, 2020). Hospital admissions due to severe malaria also reduced in these areas, as confirmed by reports from health facilities. For instance, healthcare facilities reported a 40% reduction in severe malaria cases after the large-scale distribution of LLINs (NMEP, 2020). The use of ACTs further supported this reduction by ensuring timely treatment and contributing to a reduction in drug-resistant malaria cases (WHO, 2019).

The RTS,S vaccine has also contributed to reductions in hospital admissions and mortality rates. In lead areas like Kebbi and Sokoto, studies showed a 30-40% reduction in severe malaria cases, as well as a decrease in malaria-related deaths among vaccinated children (WHO, 2021; NMEP, 2023). The vaccine provided an additional layer of protection for vulnerable populations, particularly children under five, resulting in improved health outcomes.

### **Success in Targeted Regions and High-Burden Areas**

The success of malaria control efforts has been more noticeable in targeted areas with high malaria burden, particularly in northern Nigeria. These regions, such as Sokoto, Kebbi, and Zamfara, have been prioritized due to their high malaria prevalence and limited access to healthcare services (WHO, 2021; NMEP, 2020).

The targeted approach, which focused on distributing ITNs, ACTs, RDTs, and later the RTS,S vaccine, allowed for a more focused effort to reach communities that needed the interventions the most. For example, mass distribution campaigns for LLINs in these areas led to increased household coverage and the establishment of long-lasting protective barriers against mosquito bites (NMEP, 2020). In high-burden areas, this resulted in major reductions in malaria prevalence, hospital admissions, and severe malaria cases (WHO, 2021).

The RTS,S vaccine, lead in areas with high malaria transmission, showed success in reducing malaria-related deaths and hospital admissions. In areas with high child mortality rates due to malaria, vaccine implementation resulted in visible health improvements, particularly in preventing severe malaria cases (WHO, 2021; PATH, 2022).

### **Current and Future Directions in Malaria Control**

#### **Emphasis on Integrated Approaches (Diagnosis, Treatment, and Prevention)**

Combined approaches that combine multiple interventions such as diagnosis, treatment, and prevention are now recognized as the most effective strategy for malaria control (WHO, 2022). The current malaria control efforts in

Nigeria have shown that standalone interventions are not enough. For instance, ITNs, while effective in reducing mosquito bites, are not enough on their own to fully control malaria. Similarly, only relying on ACTs may not manage all aspects of malaria transmission (NMEP, 2023). The WHO now promotes the mix of favorable strategies such as vector control (e.g., ITNs, Indoor Residual Spraying (IRS)), diagnosis through Rapid Diagnostic Tests (RDTs), and effective treatment using ACTs. For example, RDTs ensure that only confirmed malaria cases are treated with ACTs, in turn reducing the misuse of medications and slowing the development of drug resistance (WHO, 2022). Additionally, the RTS,S malaria vaccine is being interlaced into routine immunization programs to complement these efforts, particularly targeting at-risk populations like children (PATH, 2022).

Integrated approaches also break through the transmission cycle of malaria, recognizing the importance of combining strategies like community education, vector control, and access to diagnostic tools. This is particularly important in areas with high malaria transmission, where multiple difficulties exist in terms of healthcare access and infrastructure (WHO, 2022).

### **Role of Community Participation and Empowerment**

Community participation and empowerment are important to the success of malaria control efforts. Communities living in malaria-endemic areas possess valuable knowledge about the local situations, including how malaria is transmitted and what strategies might work best (WHO, 2021; NMEP, 2023). Engaging these communities in planning, implementation, and evaluation enhances the sustainability of malaria control programs. Community health workers (CHWs) play a vital role in malaria control by providing education, promoting the use of ITNs, distributing ACTs, conducting RDTs, and raising awareness about the importance of seeking treatment for malaria. In Nigeria, efforts to train and empower Community Health Workers have contributed significantly to improving access to malaria control interventions, especially in hard-to-reach areas (NMEP, 2020).

Community engagement also involves encouraging local leadership and active participation in malaria control activities. Empowering communities to take ownership of malaria control efforts ensures greater adherence to prevention measures such as Insecticide-Treated Nets usage, early care-seeking behavior, and participation in vaccination campaigns (PATH, 2022). Additionally, culturally appropriate communication strategies are critical to overcoming misinformation, vaccine hesitancy, and low health-seeking behavior (WHO, 2021). Community-led initiatives, such as organizing resources and local health campaigns, and ensuring accountability, have demonstrated success in reaching disregarded populations and reducing the burden of malaria (NMEP, 2023).

## Advances in Data Systems and Research for Evidence-Based Strategies

Advances in data systems and research are shaping the future of malaria control efforts by providing evidence-based strategies that are more focused and effective. Improved data collection and management systems enable more accurate tracking of malaria cases, treatment outcomes, and intervention coverage (WHO, 2022; NMEP, 2023). Health Management Information Systems (HMIS) and Disease Surveillance Systems (DSS) play an important role in gathering real-time data on malaria prevalence, healthcare access, and intervention coverage. In Nigeria, these systems have facilitated more accurate monitoring of malaria trends, identifying risk zones and guiding resource allocation (NMEP, 2023).

The use of Geographic Information Systems (GIS) has also helped in the arranging of targeted interventions like ITNs and RDTs, contributing to more accurate mapping of malaria risk areas. By identifying at-risk areas, resources can be concentrated where they are needed the most, improving the efficiency and effectiveness of malaria control programs (WHO, 2022; PATH, 2021). Research efforts are increasingly focused on understanding malaria transmission dynamics, drug resistance, and the factors influencing vaccine uptake. Studies on factors like socio-economic status, cultural beliefs, and access to healthcare help fit interventions to the unique needs of specific communities (PATH, 2022; WHO, 2021). The ongoing development of artificial intelligence (AI) and machine learning applications hopes to promote development in data analytics, helping to predict outbreaks, better intervention strategies, and customize malaria control efforts based on real-time data (WHO, 2022; PATH, 2022).

## Conclusion

Malaria disproportionately affects vulnerable populations such as children under five and pregnant women, and remains an important public health challenge in Nigeria. However, this review highlights that considerable progress has been made in malaria control through coordinated national and international efforts. Breakthrough interventions such as insecticide-treated nets (ITNs), artemisinin-based combination therapies (ACTs), rapid diagnostic tests (RDTs), and the introduction of the RTS,S malaria vaccine have significantly reduced malaria prevalence, mortality, and morbidity. Innovations in vector control, advancements in data systems, and the blending in of community-based approaches have further strengthened the effectiveness of these interventions. The use of tools like Geographic Information Systems (GIS) and Health Management Information Systems (HMIS) has helped with evidence-based decision-making, ensuring targeted allocation of resources to high-burden areas. Community participation has been helpful in improving the uptake of interventions and ensuring the sustainability of malaria control programs.

Ultimately, this review gives in detail the importance of a comprehensive and flexible approach to malaria control in Nigeria. By utilizing the lessons learned from past and ongoing efforts, Nigeria can accelerate progress toward the end goal of malaria elimination, improving health outcomes and reducing the socioeconomic burden of this preventable disease.

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