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Clinical Review

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Burden, challenges, and control of malaria among under-5s in Nigeria

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Abstract

Malaria remains a leading cause of morbidity and mortality among children under five years in Nigeria, a country accounting for over a quarter of global malaria cases. Despite the availability of interventions, Nigeria continues to face persistent challenges in controlling malaria, especially in the under-five population, thus, the need for this review. This narrative review synthesizes peer-reviewed literature, national reports, and policy documents published since 2010. A structured search was conducted across PubMed, Google Scholar, Scopus, and relevant grey literature from the WHO, UNICEF, and the Nigerian Ministry of Health. The review adhered to SANRA guidelines to ensure methodological rigour and focused on studies reporting malaria epidemiology, interventions, and control efforts targeting children under five in Nigeria. Findings revealed a high malaria burden among children in Nigeria, with notable regional disparities. Northern states report the highest prevalence, with rural areas disproportionately affected. Contributing factors include socioeconomic deprivation, climate variability, and suboptimal coverage of interventions. Key challenges include diagnostic limitations, drug resistance, and inconsistent use of preventive

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measures. While interventions such as long-lasting insecticidal nets (LLINs), intermittent preventive therapy, and indoor residual spraying have shown effectiveness, gaps remain in coverage and implementation. Innovations in diagnostics, vaccines, and surveillance systems are promising but underutilized. Despite progress, Nigeria faces multifaceted challenges in malaria control among under-fives. A coordinated, multisectoral response involving innovative strategies, stronger health systems, and policy reforms is essential. Attention must also be directed to enhancing the acceptability, fidelity, and longevity of these interventions.

Introduction

Globally, Malaria is among the leading causes of mortality and morbidity, especially in sub-Saharan Africa [1]. By 2015, over 212 million cases with approximately 429 000 deaths were documented globally [2]. These statistics drastically increased by 2020, as over 241 million cases were reported by the World Health Organisation (WHO), with over 627 000 deaths [3]. Further, sub-Saharan Africa was significantly affected, with more than two-thirds of the cases reported among the under-five children in 2015. In 2017, Nigeria accounted for approximately 25% of all malaria cases worldwide, making it the country with the highest burden globally [1, 4]. Over the past two decades, interventions such as indoor residual spraying and long-lasting insecticidal nets have significantly reduced the malaria burden. These interventions have contributed to a significant reduction in the malaria burden [5, 6]. However, there are several hindrances to malaria elimination interventions, such as resistance to insecticides among mosquitoes, the emergence of antimalarial drug-resistant strains, inadequate healthcare infrastructure, and socioeconomic factors that impede effective disease management [7–11]. There is still a scarcity of information on the effectiveness, challenges, and outcomes of malaria control strategies such as the Roll Back Malaria program, Action and Investment to Defeat Malaria, and the WHO Global Technical Strategy, particularly regarding their implementation in Nigeria and their overall impact on malaria eradication efforts. Therefore, this review aims to bridge this knowledge gap by synthesizing available evidence on malaria epidemiology, spatial-temporal distribution, and current interventions in Nigeria, with a particular focus on children under five.

Methodology

This review followed the SANRA (Scale for the Quality Assessment of Narrative Review Articles) guidelines to improve methodological rigour. A search was performed using terms such as ‘Malaria in Nigeria’, ‘Malaria Under-5 in Nigeria’, ‘Epidemiology of Malaria in Nigeria’, ‘Malaria Elimination in Nigeria’, ‘Malaria burden in Nigeria’, and ‘Malaria prevention among children under five’. The search included PubMed, Google Scholar, the Nigerian Ministry of Health Library, and international sources like the World Health Organisation and UNICEF. Only English-language publications were considered due to resource limitations in translating non-English articles. Studies published after 2010 were included to reflect recent epidemiological patterns, intervention strategies, and policy updates, driven by key policy changes and malaria control initiatives following the launch of the WHO Global Technical Strategy for Malaria. Eligibility criteria encompassed published research articles, systematic reviews, meta-analyses, national reports, and policy documents. Preprint servers were excluded due to concerns about the quality of non-peer-reviewed data. The study selection process was carried out independently by LNO, IA, MOY, NGB, JMG, and ESI, who screened titles and abstracts for relevance. Any disagreements were resolved through discussion with OA and MAY. The review did not follow a prospectively registered protocol, as it is a narrative review.

Epidemiology of malaria among the under-5 in Nigeria

In 2015, Nigeria accounted for over a quarter (26.6%) of the global malaria burden, with children under five years old disproportionately affected. This burden was measured using malaria incidence, prevalence, and mortality rates, as reported by the World Health Organisation (WHO) and national health agencies [12, 13]. For decades, *P. falciparum* prevalence among Nigerian children under five was assessed using microscopy as the gold standard and rapid diagnostic tests (RDTs). Microscopy ensures specificity but depends on technician expertise, whereas RDTs detect malaria antigens; however, they may sometimes lead to higher prevalence estimates. By 2018, approximately 23% of all children in Nigeria had

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positive microscopy results for P. falciparum, while 36% tested positive with a rapid diagnostic test (RDT) [14]. The observed discrepancy of 23% positivity by microscopy versus 36% by RDT could stem from several factors. RDTs might detect residual antigens from past infections, such as in patients expressing rheumatoid factor, leading to false positives, whereas microscopy identifies only current parasitaemia [15]. Evidence has further demonstrated variable durations for the specific RDTs; for example, Histidine-Rich Protein II (HRP2) kits can remain positive 15 days (5–32 days interval) post-treatment due to the persistence of this enzyme post-treatment, while Plasmodium Lactate Dehydrogenase (pLDH) kits may still be positive 2 days (1–7 days interval) post-treatment [16]. Further, some kits, especially those that detect HRP2, may fail to detect Malaria due to the presence of Plasmodium parasites with HRP2 and HRP3 deletions, which have been reported among school-going children in Nigeria [17, 18]. Parasite density can affect the positivity of these RDTs, with lower parasite density, especially in acute infections, associated with negative results, potentially underestimating malaria prevalence [16, 19].

Malaria prevalence varied significantly across Nigeria, ranging from 2% in some southern states, such as Lagos, Anambra, Imo, and Rivers states, to approximately 63% in highly endemic northern states like Sokoto, Zamfara, and Kaduna [14, 20–22]. The 2018 NDHS reported higher malaria rates in the north, with Kebbi State reaching 52.2% among children under five. These disparities highlight regional differences in transmission, healthcare access, and control interventions. In 2018, the United Nations Children's Fund (UNICEF) reported Nigeria's malaria incidence rate as 277 per 1000 individuals at risk, reflecting national-level data [23]. Also, the malaria burden has a wide geographical variation among the different states in Nigeria. Rural Nigeria tend to have a higher malaria prevalence among children under five, estimated at 26% compared to 11% in urban settings [24]. The 2018 Demographic and Health Survey further demonstrates a higher malaria prevalence in the north compared to the south, with some states like Kebbi State having up to 52.2% of children below five years testing positive for malaria on microscopy [14]. The Northwest zone had the highest prevalence, ranging between 33.8% to 52%, and the South-south zone had the lowest prevalence, ranging between 2% and 15.6% by 2018, as demonstrated in Fig. 1 [14]. Lagos State in the Southwest has the lowest (1.8%) prevalence among the states. Notably, there has been a decline in malaria prevalence between 2010 and 2021 in both urban and rural areas from 23% to 11% and 48% to 27%, respectively. Household wealth is a significant factor in malaria elimination, with reductions from 31% in the lowest wealth quintile to 5% in the highest wealth quintile [24].

Seasonal patterns of malaria transmission in Nigeria have varied over time. Malaria cases typically rise during the rainy season, from August to December each year [14, 25]. The post-rainy season increase in cases varies but is generally observed, driven by higher mosquito breeding. The rainy season in Nigeria typically lasts from April to October in the south and from June to September in the north. Thus, implementing mosquito-control strategies during this period is critical. Rising temperatures and humidity from global warming have also contributed to increased mosquito populations in many parts of the country [26–30]. With these changes, the country was expected to see an increase in malaria prevalence. However, there has been an average annual decline (2.3%) in prevalence, driven by concerted efforts [14]. Among children under 5 years of age, there has also been a downward trend in malaria prevalence, from 42% in 2010 to 22% in 2021. A recent projection using mathematical modelling, however, showed that continuing with the current preventive approaches would lead to a 5% increase in malaria incidence by 2025 and a 9% increase by 2030, compared with 2020 [31]. However, malaria mortality was predicted to remain the same by 2030 [1, 31–34]. Significantly, these trends still demonstrate the impact of malaria on the country, warranting enhanced action to eliminate its effects.

Impact of malaria on child health and mortality rates

Over 30% of deaths in children under five are attributed to malaria, highlighting the disease's severity in Nigeria. Besides, Nigeria carries a disproportionate burden of the global malaria problem. In 2022 alone, 26.8% of global malaria cases and 31.1% of deaths occurred in Nigeria, and 78% of these deaths were in children under five [1, 4, 13, 33–40]. The impact of malaria extends beyond the child's health. Both families and healthcare providers face significantly high costs. Families often pay out-of-pocket expenses, estimated at $12.57 for outpatient care and $23.20 for inpatient care. These costs are particularly burdensome considering Nigeria's high poverty rates, forcing families to make difficult choices that can further impact their children's health. Healthcare providers also face substantial costs, reaching $30.42 for outpatient care and $48.02 for inpatient care, excluding significant

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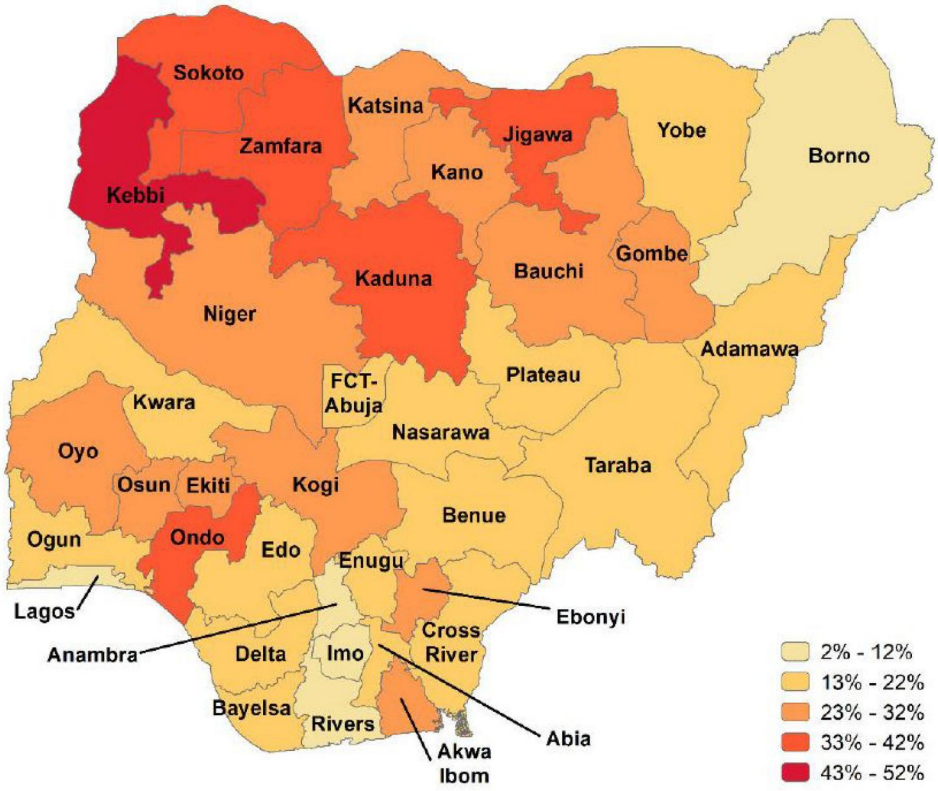


Figure 1 Prevalence of Malaria among children under five by state [14].

upfront capital investments. The total cost of treatment can reach a staggering $1928.37 or more for inpatient care [41–44]. It reflects a comprehensive tally of expenses, including accommodation, staff, tests, medications, and procedures, driven by the intensity and complexity of care required.

Challenges in malaria diagnosis and treatment for under-5s in Nigeria

Limited access to diagnostic tools and healthcare facilities is a major obstacle to effective malaria management in Nigeria. For example, Edwards et al. reported low availability of malaria RDTs across both outlet types, with significantly lower availability in PPMVs than in pharmacies (22.1% vs 13.6%) [45, 46]. Additionally, the accessibility of healthcare facilities, especially in rural areas, and the nonuniform distribution of health facilities across Nigeria, lead to an overreliance on clinical diagnosis, resulting in misdiagnosis and inappropriate treatment [47]. Further, the accuracy and reliability of malaria diagnostic tests in young children are limited by varying sensitivity levels. Rapid diagnostic tests (RDTs), while simple to use, have restricted sensitivity and specificity, particularly in regions with low malaria transmission. In Southern Nigeria, the approximate malaria prevalence is 53%, with RDTs demonstrating 29% sensitivity and 89% specificity. Ogunfowokan et al. reported positive and negative predictive values of 75% and 53%, respectively [48]. Besides, RDTs have moderate sensitivity compared to microscopy, suggesting the need for improved accuracy of these tests in malaria-endemic areas. This presents a significant challenge to malaria elimination, as it reduces reliance on a single test for accurate diagnosis. A combination of RDTs and microscopy is recommended to accurately estimate malaria prevalence among children under five.

The availability and accessibility of antimalarial drugs present critical challenges in Nigeria. Artemisinin-based combination therapies (ACTs) are recommended as first-line treatment for uncomplicated malaria, yet stockouts and supply chain issues are highly prevalent. For example, in Lagos, 37.5% of hospitals did not have ACTs in stock at the time of their visit, and these drugs had been unavailable for more than 3 weeks [49]. Ajogbasile et al. reported emerging resistance in some regions, threatening the effectiveness of ACTs [50]. If artemisinin

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resistance spreads, it could increase malaria-related morbidity and mortality, escalating healthcare costs, and undermining global efforts to control and eliminate malaria.

Effectiveness of malaria prevention strategies for under-5s

Malaria prevention in Nigeria among children under five relies on two main strategies: Chemoprophylaxis among pregnant women and protection from mosquito bites through methods like personal protection and vector control [51]. Strategies for protection against mosquito bites involve the use of insecticide-treated mosquito bed nets (ITNs), indoor residual spraying (IRS), larviciding, and elimination of mosquito breeding sites. ITNs, especially the long-lasting insecticidal nets, have been widely utilized with about 71% coverage and have shown significant progress in reducing prevalence and mortality among children under five in Nigeria, for example, there has been a decrease in malaria prevalence according to microscopy among children from 48% to 30% in the North Western Region between 2010 and 2021 [24, 52–54]. Evidence shows that over 87% of households own ITNs, with a range between 31% and 45% in the Southwest by 2024. Notably, Ekiti, Edo, Enugu, Abia, and Rivers states had the lowest ownership of ITNs, reported at 17%–30%, as demonstrated in Fig. 2 [20]. These proportions significantly impact malaria elimination in the country.

However, the Use of ITNs among children under age 5 decreased from 52% in 2018 to 41% in 2021, then increased slightly to 43% in 2024 [20]. Several challenges emerged predisposing to this disparity, including inconsistent use, failure to meet distribution coverage targets, and the emergence of insecticide resistance [20]. The inconsistency in use and inability to meet distribution targets can be attributed to supply chain inefficiencies, lack of public awareness, sociocultural beliefs, and economic barriers [22]. IRS has also shown effectiveness in reducing malaria transmission with varying coverage across states: Delta state (56.3%), Nasarawa (99.3%), and Akwa Ibom state (77.2%) in 2020; however, the modified form of IRS used wears off within 24 h [55]. Therefore, this IRS method requires repeated use, which becomes cost-intensive in the long run, thus, reducing usage and coverage in households due to financial challenges,

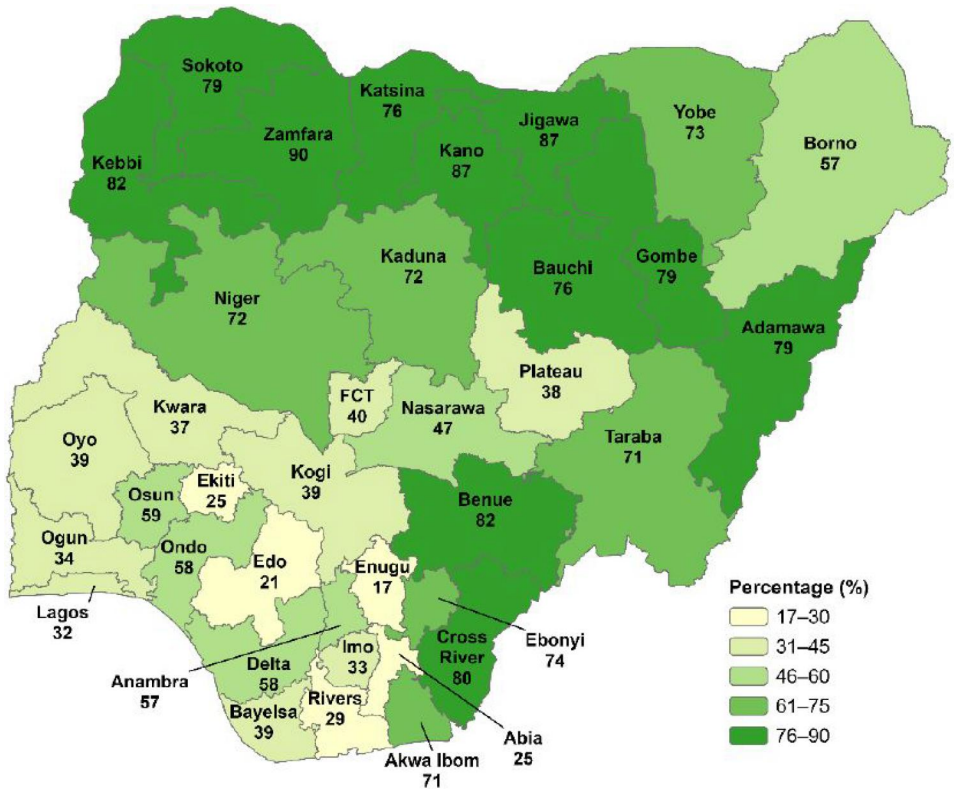


Figure 2 Percentage of households owning at least one ITN [20].

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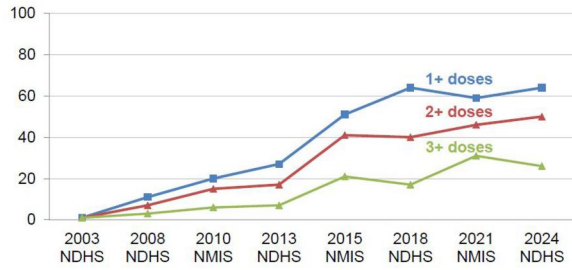


Figure 3 Trends in IPT among pregnant mothers in Nigeria over the different years [20].

operational costs, and community acceptance [55–57]. Additionally, another malaria prevention strategy is intermittent preventive therapy (IPT), which is administered to pregnant women (IPTp) and infants (IPTi). Over the years, IPT has gained traction and utilization in Nigeria, as demonstrated in Fig. 3.

While IPTp has been integrated into antenatal care (ANC) services, challenges such as low coverage, stockouts, and sociocultural barriers reduce its uptake (about 18.7% 2nd ANC visits) IPTi using sulfadoxine-pyrimethamine (SP) has not been implemented in Nigeria despite the 2010 WHO policy recommendation [20, 52, 58]. The implementation deficit has been due to concerns about SP safety in infants and the fear of SP resistance in most African countries [59]. Amidst these challenges, community-based interventions have played a crucial role in providing accurate information about malaria and improving knowledge, attitudes, and practices among caregivers of children under five in Nigeria [59–61]. These interventions use various community networks and channels to promote ITN use, sanitation practices, early diagnosis, and treatment of malaria. While these interventions have achieved significant milestones in malaria elimination and prevention, several challenges remain to meet the WHO malaria elimination strategy by 2030.

Innovations and interventions aimed at reducing malaria burden in under-5s

In 2022, the WHO developed a World Malaria Day theme, '*Harness innovation to reduce the malaria disease burden and save lives*', that highlighted issues such as insufficient funding for malaria programs, drug resistance, and weak health systems, all of which are directly linked to malaria control [62]. To combat malaria, numerous interventions and technological innovations have been developed globally that have contributed immensely to the malaria response [63, 64]. These innovations include vector control, diagnostics, drugs, vaccines, and surveillance. Their use has been effective in rapidly reducing malaria transmission [65, 66]. Other vector control innovations include spatial repellants, larvicides, insecticide paints, toxic, durable wall liners, outdoor barrier sprays, and attractive, toxic sugar baits [63, 67]. Malaria diagnosis involves identifying malaria parasites or antigens in the host's blood. Microscopy, a standard technique, has been the earliest conventional method used for malaria diagnosis, alongside the recent rapid molecular method. Various molecular approaches, such as flow cytometry, basic immunoassay concept of malaria rapid diagnostic test kits, and enzyme-linked immunosorbent assay, have been used to detect Plasmodium parasites [68]. Other methods, such as loop-mediated isothermal amplification (LAMP) and polymerase chain reaction (PCR) (real-time PCR, Multiplex PCR, and nested PCR), are being utilized in research and the diagnosis of malaria. Some Expert Systems have been developed with different artificial intelligence (AI) techniques and algorithms to assist in the swift and accurate diagnosis of malaria in Nigeria [69].

Malaria preventive methods such as Intermittent Preventive Therapy in infants (IPTi) and seasonal Malaria Chemoprevention (SMC) have been key in fighting against malaria. Yet, these have not been implemented nationally, except for a few clinical trials that have evaluated their efficacy [59]. Artemisinin-based combination therapy (ACT), specifically Artesunate-Amodiaquine or Artemether-Lumefantrine, is currently used to treat malaria effectively. Also, immunization is considered one of the most important, cost-effective, and effective tools to reduce the burden of vaccine-preventable diseases [70, 71] Currently, two malaria vaccines are available for use, and the first is RTS, S/AS01, which has been approved by the WHO following successful test programs [72]. The second is the R21/Matrix-M™ vaccine, which the WHO has licensed after it has demonstrated considerable efficacy and safety in a Phase III clinical study. The R21 vaccine was launched in December 2024 with a phased rollout, starting in Bayelsa in the South and Kebbi in the North, states with the highest malaria prevalence in the country. The rollout was supported by the Vaccine Alliance (GAVI), which donated 846 200 doses, and by the Nigerian government, which purchased 153 800 doses [73].

Role of government and NGOs in malaria control programs for under-5s

Currently, coordination of all malaria control programs in the country is carried out by the National Malaria Elimination Programme (NMEP), with oversight from the Federal Ministry of Health (FMOH) [73]. In addition,

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the Malaria Partner's Forum consists of Multinational Organisations such as WHO and UNICEF; bilateral organizations such as the Presidential Malaria Initiative-USAID (PMI-USAID); and implementing agencies such as Family Health International (FHI) 360 and IHVN [73, 74]. PMI-S, in conjunction with NMEP, continues to provide technical support and input, encourages the use of science and technology, and has facilitated capacity building through training and retraining of health care workers, with supportive supervision activities [75, 76]. The PMI in 2022 also succeeded in one of the northwestern states, like Kebbi, reaching over a million children with a three-day course of the sulfadoxine-pyrimethamine and amodiaquine (SPAQ) combination, with an average coverage of 99% across cycles 1–4 [77]. Malaria prevalence fell from 42% in 2010 to 22% in 2021. Ownership of LLINs increased from 42% in 2010 to 56% in 2021, while usage among children improved from 29% to 41% [78]. These strategies, however, varied among states.

Future directions for research and policy in malaria management among under-5s in Nigeria

Globally, initiatives such as the Malaria Eradication Research Agenda (malERA) in 2011 and the malERA Refresh in 2017 are robust in emphasizing the need for broader research on malaria eradication. The initiatives hinge on strategies such as vaccine development, drug resistance, and vector control [79, 80]. By 2013, the Malaria Vaccines Technology Roadmap was updated to include the development of *P. vivax* and *P. falciparum* by 2030 with at least 75% efficacy against clinical malaria and reduction in malaria parasite transmission [81]. Single Encounter Radical Cure and Prophylaxis (SERCaP) was likewise developed and is highly recommended for future technological innovation to achieve improved outcomes in Malaria control [82]. Approaches such as efficient genome-editing techniques based on CRISPR/Cas9 have been utilized at different stages of the mosquito's life cycle. They include the Transmission Blocking Vaccine (TBV), the Blood Stage Vaccine (BSV), and the Anti-infection Vaccine [83, 84]. By December 2024, the Nigerian government had included malaria vaccination into the National Immunisation programme for children under five, highlighting significant progress towards malaria elimination [85]. However, some other approaches are still lacking in Nigeria, creating significant impacts and gaps in malaria control and prevention.

Strengths and limitations of the study

As a narrative review, our study synthesizes existing literature without the systematic approach of a meta-analysis. While this allowed for a broad exploration of diverse perspectives and statistics about Malaria under 5s in Nigeria, some specific questions, such as quantitative assessments of efficacy, comparative analysis of interventions, or precise causal links, remain unanswered.

Conclusion

Nigeria continues to grapple with Malaria among children under five. Comprehensive interventions are mandatory to mitigate the disease and improve their quality of life. Some of the challenges identified concerning malaria diagnosis and treatment included the absence of various testing kits, such as RDTs and buffers. These challenges can be addressed with innovative strategies, such as molecular testing, chemoprevention, and vaccination. However, these remain limited in Nigeria, and thus, require action from key stakeholders, including the Ministry of Health, partner organizations, and global initiatives, to ensure immediate implementation.

Author contributions

Lenz Nwachinemere Okoro (Conceptualization [equal], Writing—original draft [equal], Writing—review & editing [equal]), Michael Oppong Yeboah (Writing—original draft [equal], Writing—review & editing [equal]), Naya Gadzama Bulus (Writing—original draft [equal], Writing—review & editing [equal]), Jonathan Mawutor Gmanyami (Writing—original draft [equal], Writing—review & editing [equal]), Esther Ladidi Ismaila (Writing—original draft [equal], Writing—review & editing [equal]), Ovye Ahgu (Writing—original draft [equal], Writing—review & editing [equal]), Elijah Ogbu Otokpa (Writing—original draft [equal], Writing—review & editing [equal]), Eneh Nchiek Edet (Writing—original draft [equal], Writing—review & editing [equal]), Joy Malle Dogo (Writing—original draft [equal], Writing—review & editing [equal]), Tom Didimus Ediamu (Writing—original draft [equal], Writing—review & editing [equal]), Lorna Atimango (Writing—original draft [equal], Writing—review & editing [equal]), and Isaac Isiko (Conceptualization [equal], Writing—review & editing [equal])

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Conflicts of interest

The authors declare no competing interests.

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Consent for publication

All authors consent to the publication of the review paper.

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