Austin Journal of Infectious Diseases

Open Access

Austin Publishing Group

Review Article

The Epidemiology and Estimation of Malaria Burden Among Pregnant Women Attending Antenatal Care in Nigeria

Matthew Chibunna Igwe[1,2]*; Uwakwe Divinefavour Chizitaram[2]; Ude Pearl Chizurumpke[2]

[1]Department of Public Health, School of Allied Health Sciences, Kampala International University, Western Campus, Ggaba Road, Kansanga, Uganda

[2]Department of Medical Laboratory Science, Faculty of Basic Medical Sciences, College Medicine, Enugu State University of Science and Technology, Enugu

***Corresponding author:** **Matthew Chibunna Igwe**
Department of Public Health, School of Allied Health Sciences, Kampala International University, Western Campus, Ggaba Road, Kansanga, Uganda.
Tel: +2348035891358
Email: igwechibunna@gmail.com

Received: September 16, 2024
Accepted: October 03, 2024
Published: October 10, 2024

Abstract

Malaria poses a significant public health challenge in Nigeria, particularly affecting pregnant women due to their altered immune states. Malaria prevalence among pregnant women ranged from 11% to 67%, reflecting significant regional disparities. The burden was substantial, with adverse outcomes including maternal anemia (up to 60%), low birth weight (up to 30%), preterm delivery, and increased maternal and neonatal mortality. Key risk factors were low socio-economic status, limited healthcare access, inadequate use of preventive measures like Insecticide-Treated Nets (ITNs) and Intermittent Preventive Treatment (IPTp), and regional variations in transmission intensity. This review highlights the high prevalence and severe burden of malaria among pregnant women attending ANC in Nigeria, with significant regional disparities. Effective implementation of preventive measures and health policies is crucial. Further research is needed to explore long-term outcomes and targeted interventions.

Keywords: Malaria burden; Antenatal care; Epidemiology; Maternal health; Preventive measures; ITNs; IPTp

Abbreviations: SDGs: Sustainable Development Goals; ANC: Antenatal Care; MiP: Malaria in Pregnancy; ITNs: Insecticide-Treated Nets; IPTp: Intermittent Preventive Treatment in Pregnancy; IRS: Indoor Residual Spraying; GIS: Geographic Information Systems; PAF: Population Attributable Fraction

Aim

To analyze the epidemiology of malaria among pregnant women attending Antenatal Care (ANC) in Nigeria and estimates the associated burden to inform health policies and intervention strategies.

Rationale

This review addresses the public health challenge of malaria among pregnant women in Nigeria, a leading cause of maternal and neonatal morbidity and mortality. Malaria during pregnancy has severe consequences, yet data gaps hinder effective interventions. The review aims to highlight these gaps, emphasizing the need for accurate burden assessments and region-specific strategies due to Nigeria's diverse geography. Socioeconomic, educational, and cultural factors influence access to malaria prevention and antenatal care. By critically assessing current methods of burden estimation, this review seeks to improve data reliability, inform public health policies, and support global health initiatives like the Sustainable Development Goals (SDGs).

Citation: Igwe MC, Chizitaram UD, Chizurumpke UP. The Epidemiology and Estimation of Malaria Burden Among Pregnant Women Attending Antenatal Care in Nigeria. Austin J Infect Dis. 2024; 11(2): 1100.

Methodology

A comprehensive literature search was conducted using databases such as PubMed, Google Scholar, Scopus, Web of Science, and African Journals Online (AJOL). Studies published in the last ten years focusing on malaria prevalence, incidence, and outcomes among pregnant women in Nigeria were included. Data extraction covered study design, sample size, diagnostic methods, and maternal-fetal outcomes. Quality assessment used the Newcastle-Ottawa Scale and Cochrane Risk of Bias Tool. Both qualitative and quantitative syntheses were employed, with meta-analysis conducted where feasible. The review included 45 studies from various regions in Nigeria.

The selection criteria for this review aim to ensure a thorough and rigorous evaluation of studies and data sources concerning malaria burden among pregnant women in Nigeria.

Inclusion Criteria: The review includes epidemiological studies such as cohort, cross-sectional, case-control, and randomized controlled trials. Systematic reviews and meta-analyses relevant to malaria in pregnancy are also considered. Studies must focus on pregnant women attending Antenatal Care (ANC) across urban and rural settings in Nigeria, representing different malaria transmission regions (north, south, east, west). The review covers studies published within the past 12 years to capture recent trends and interventions, with clear and transparent reporting of data sources, collection methods, and statistical analyses.

Exclusion Criteria: Studies with poor methodology, significant biases, or incomplete data reporting are excluded. Additionally, studies on non-pregnant women or outside Nigeria, those lacking specific pregnancy-related outcomes, or published before the 12-year timeframe are omitted.

Introduction

Malaria remains a critical public health challenge in Nigeria, with pregnant women being among the most vulnerable populations. Due to immunological changes during pregnancy, pregnant women are more susceptible to malaria infection and its severe complications. This increased vulnerability has significant implications for maternal and neonatal health, including heightened risks of anemia, Low Birth Weight (LBW), preterm delivery, and increased maternal and neonatal mortality [1]. Nigeria, as the most populous country in Africa, contributes substantially to the global malaria burden, accounting for approximately 27% of global malaria cases and 24% of malaria deaths [2]. The epidemiology of malaria among pregnant women in Nigeria is complex and varies significantly across different regions and communities. The prevalence rates of malaria among pregnant women attending Antenatal Care (ANC) in Nigeria range from 11% to 67%, indicating significant regional disparities influenced by ecological, socio-economic, and healthcare access factors [3-4].

The burden of malaria in pregnancy (MiP) is profound, with substantial impacts on both maternal and fetal health. Maternal anemia, a common consequence of malaria infection, affects up to 60% of pregnant women in some regions, leading to increased risks of maternal morbidity and mortality [5]. Additionally, malaria in pregnancy is a leading cause of adverse birth outcomes such as low birth weight and preterm delivery, which are major contributors to neonatal morbidity and mortality [6]. The economic burden of malaria is also significant, exacerbating healthcare costs and impacting household economies, particularly in resource-limited settings [7-8].

Several factors contribute to the high prevalence and burden of malaria among pregnant women in Nigeria. Socio-economic determinants, such as poverty, low educational levels, and inadequate housing conditions, are strongly associated with increased malaria risk [9]. Additionally, limited access to quality healthcare services and inadequate coverage of preventive measures, including Insecticide-Treated Nets (ITNs) and Intermittent Preventive Treatment in Pregnancy (IPTp), further exacerbate the issue [10]. Regional variations in malaria transmission intensity necessitate tailored intervention strategies to address specific local challenges effectively [11]. Efforts to control malaria in pregnancy in Nigeria have focused on the distribution of ITNs and the administration of IPTp during ANC visits. While these interventions have shown benefits, their implementation remains inconsistent, especially in rural and underserved areas [7, 12]. Strengthening health systems, improving access to preventive measures, and ensuring consistent implementation of national malaria control policies are crucial steps toward reducing the malaria burden among pregnant women [13].

Epidemiology of Malaria in Pregnant Women in Nigeria

Malaria continues to be a significant public health challenge among pregnant women in Nigeria, with varying prevalence rates reported across different regions. Recent studies have indicated prevalence rates ranging from 11% to 67% among pregnant women attending Antenatal Care (ANC) clinics in Nigeria [3-4]. These variations in prevalence are influenced by factors such as geographical location, climate, socio-economic status, and access to healthcare services.

The incidence of malaria among pregnant women in Nigeria is influenced by seasonal variations in malaria transmission, with peak transmission typically occurring during the rainy season. Pregnant women residing in areas with high malaria transmission intensity are at increased risk of experiencing multiple malaria episodes during pregnancy [14]. This repeated exposure to malaria parasites contributes to the cumulative burden of malaria and its associated adverse outcomes, including maternal anemia and low birth weight. High prevalence and incidence rates of malaria in pregnancy have significant implications for maternal and fetal health outcomes. Maternal complications, such as severe anemia and placental malaria, are more common among pregnant women with higher parasite burdens [1]. Adverse fetal outcomes, including low birth weight, preterm delivery, and intrauterine growth restriction, are also more prevalent in areas with elevated malaria transmission intensity [6].

Nigeria's malaria burden exhibits substantial regional variations, influenced by ecological factors, including climate and geography, which affect malaria transmission dynamics. For instance, the southern regions, characterized by high rainfall and dense vegetation, typically report higher malaria prevalence compared to the drier northern regions [4]. Furthermore, the effectiveness of malaria control interventions, such as the distribution of Insecticide-Treated Nets (ITNs) and Intermittent Preventive Treatment in Pregnancy (IPTp), varies across regions, further contributing to these disparities [11]. Several factors contribute to the high prevalence of malaria among pregnant women in Nigeria. Socio-economic determinants play a crucial role, with poverty, low educational levels, and inadequate housing conditions being strongly associated with increased malaria risk [9]. Limited access to quality healthcare services exacerbates the problem, as does the inconsistent implementation of preventive measures like ITNs and IPTp [10].

The burden of malaria in pregnancy (MiP) is profound, significantly impacting both maternal and fetal health. Maternal anemia, a common complication of malaria, affects up to 60% of pregnant women in some regions, leading to increased risks of maternal morbidity and mortality [5]. Malaria in pregnancy is also a leading cause of adverse birth outcomes, including Low Birth Weight (LBW) and preterm delivery, which are major contributors to neonatal morbidity and mortality [6]. Additionally, malaria-induced maternal anemia can result in severe fatigue and reduced physical capacity, further compromising maternal health and pregnancy outcomes [1].

The economic impact of malaria on pregnant women and their families is substantial. The costs associated with treatment, coupled with lost productivity due to illness, place a significant financial burden on households, particularly in resource-limited settings. Malaria prevention and treatment during pregnancy also strain healthcare resources, underscoring the need for effective and sustainable malaria control strategies [8].

Efforts to control malaria in pregnancy in Nigeria have primarily focused on the distribution of ITNs and the administration of IPTp during ANC visits. While these interventions have shown benefits, their implementation remains inconsistent, especially in rural and underserved areas [12]. Strengthening health systems, improving access to preventive measures, and ensuring consistent implementation of national malaria control policies are crucial steps toward reducing the malaria burden among pregnant women [13].

Burden of Malaria in Pregnancy

Malaria in Pregnancy (MiP) poses a significant threat to maternal health, leading to severe complications such as anemia, which is one of the most prevalent consequences. Anemia in pregnant women, resulting from malaria infection, affects up to 60% in some regions of Nigeria [5]. This condition not only compromises maternal health but also increases the risk of maternal mortality due to severe anemia-induced complications [1]. The physiological demands of pregnancy exacerbate the impact of malaria, making pregnant women particularly susceptible to severe disease and its complications [15].

The adverse effects of MiP extend to the fetus and neonate, with malaria being a significant contributor to poor birth outcomes. Low Birth Weight (LBW) is a critical consequence of malaria during pregnancy, affecting up to 30% of births in high-transmission areas [6]. LBW is a major risk factor for neonatal morbidity and mortality, as well as long-term developmental issues. Preterm delivery is another serious outcome associated with MiP, increasing the risk of neonatal death and long-term health problems [1]. Malaria during pregnancy significantly contributes to maternal mortality. The risk of death from severe malaria is notably higher in pregnant women compared to non-pregnant women [16]. The immune changes during pregnancy, coupled with the physiological burden, make pregnant women more vulnerable to severe malaria complications, which can be fatal if not promptly and effectively treated [15].

The economic burden of MiP is substantial, impacting both healthcare systems and household economies. The costs associated with malaria treatment during pregnancy, including hospitalizations and medications, place a significant financial strain on families, particularly in resource-limited settings. Additionally, the indirect costs, such as lost productivity and the long-term economic impact of adverse birth outcomes, further exacerbate the financial burden [8]. The burden of MiP also extends to the healthcare system, which is often strained by the high demand for services related to malaria prevention and treatment. Healthcare facilities in malaria-endemic regions of Nigeria frequently face challenges such as shortages of medications, diagnostic tools, and trained healthcare personnel [10]. These limitations hinder the effective management of malaria in pregnancy, contributing to higher morbidity and mortality rates.

Risk Factors for Malaria in Pregnancy

Socioeconomic Risk Factors and Their Impact

Lower educational attainment is directly linked to higher malaria incidence among pregnant women due to a lack of knowledge about preventive measures and treatment options [17]. Women with less education often have limited awareness of the importance of using Insecticide-Treated Nets (ITNs) and adhering to Intermittent Preventive Treatment in Pregnancy (IPTp), leading to higher infection rates [18]. Educational interventions targeting pregnant women can enhance malaria prevention practices and reduce the overall burden [19]. Economic status significantly affects malaria susceptibility and treatment outcomes. Pregnant women from low-income household's face barriers to accessing healthcare, purchasing ITNs, and affording transportation to ANC clinics, resulting in delayed or missed opportunities for malaria prevention and treatment [20]. Poverty also exacerbates housing conditions, increasing exposure to malaria vectors [21]. Addressing economic barriers through subsidized healthcare services and free distribution of ITNs

can mitigate these impacts [17]. Occupational exposure, particularly in rural and agricultural settings, heightens malaria risk among pregnant women due to increased contact with Anopheles mosquitoes during outdoor activities [22]. Women working in fields or living in proximity to breeding sites are more likely to suffer from malaria, emphasizing the need for targeted interventions such as the provision of protective clothing and education on peak biting times [1].

Environmental Risk Factors and Their Impact

Geographic disparities in malaria transmission are influenced by climatic conditions such as rainfall, temperature, and humidity, which affect mosquito breeding and malaria transmission dynamics [23]. Pregnant women in regions with perennial or seasonal malaria are at higher risk due to continuous exposure to infected mosquitoes [24]. Seasonal variations necessitate adaptive malaria control measures, including intensified vector control during peak transmission seasons [21].

Substandard housing without adequate barriers against mosquitoes, such as window screens or treated nets, increases malaria transmission among pregnant women [19]. Poor housing is often associated with lower socioeconomic status, compounding the risk. Improvements in housing infrastructure and community-wide mosquito control initiatives can significantly reduce malaria incidence [25]. Living near water bodies such as rivers, lakes, and stagnant pools, which serve as mosquito breeding sites, elevates malaria risk for pregnant women (Nwaorgu et al., 2017) [26]. This proximity increases vector density and the likelihood of transmission. Environmental management strategies, such as draining stagnant water and implementing larvicidal treatments, are crucial in reducing this risk [22].

Biological Risk Factors and Their Impact

Pregnancy alters the immune system, leading to increased susceptibility to malaria due to the modulation necessary to prevent fetal rejection [1]. This immunological shift results in higher parasite densities and more severe clinical manifestations of malaria in pregnant women compared to non-pregnant individuals [27]. Strategies to bolster immune function through nutritional supplements and prophylactic treatments are essential in managing this risk [28]. Gravidity, or the number of pregnancies a woman has had, influences malaria risk. Primigravidae and secundigravidae face higher risks due to the lack of acquired immunity from previous pregnancies, leading to higher parasite densities and adverse outcomes [17]. This highlights the need for targeted interventions such as prioritized IPTp for first-time and second-time pregnant women [20]. HIV infection exacerbates malaria severity in pregnant women due to immunosuppression, resulting in higher parasitemia and increased risk of complications [19]. Co-infected women require integrated care that addresses both malaria and HIV to improve health outcomes and reduce maternal and fetal mortality [28].

Behavioral Risk Factors and Their Impact

Inconsistent or non-use of preventive measures like ITNs and IPTp significantly contributes to malaria burden among pregnant women [18]. Behavioral factors such as misconceptions about the safety of IPTp during pregnancy or discomfort associated with ITNs can hinder their use, increasing exposure to malaria [21]. Educational campaigns and community engagement are crucial to improving compliance with preventive practices [25]. Delays in seeking treatment for malaria symptoms and reliance on traditional medicine rather than formal healthcare services lead to untreated or inadequately treated malaria cases. Pregnant women who delay ANC visits or avoid medical treatments due to cultural beliefs or lack of knowledge about the benefits of modern medicine face higher risks of severe malaria and adverse pregnancy outcomes. Improving healthcare accessibility and building trust in modern medical practices are essential to mitigating this impact [19,22 & 26].

Preventive Measures and Challenges

Insecticide-Treated Nets (ITNs)

Impact of ITNs: ITNs are a cornerstone of malaria prevention, reducing malaria transmission by providing a physical and chemical barrier against mosquito bites. Studies show that ITNs can reduce malaria prevalence by 50% in pregnant women and children in endemic regions. ITNs are especially effective in areas with high transmission rates, where they significantly decrease the incidence of malaria-related complications in pregnancy [29-30]. Despite their efficacy, ITN usage among pregnant women in Nigeria faces significant barriers. Distribution and ownership of ITNs do not always translate to consistent use due to factors such as discomfort, heat, and misconceptions about safety during pregnancy (Alonso et al., 2019). Additionally, the efficacy of ITNs can be compromised by insecticide resistance in mosquito populations, which reduces the protective effect of treated nets [31-32]

Intermittent Preventive Treatment in Pregnancy (IPTp)

Impact of IPTp: IPTp with Sulfadoxine-Pyrimethamine (SP) is recommended for all pregnant women in malaria-endemic areas to reduce the burden of malaria. IPTp has been shown to decrease the risk of maternal malaria, anemia, and low birth weight in newborns (van Eijk et al., 2019). The World Health Organization (WHO) recommends at least three doses of IPTp-SP during pregnancy. The uptake of IPTp-SP in Nigeria is hindered by several factors. Coverage is often inadequate due to gaps in ANC attendance, stockouts of SP, and healthcare workers' non-compliance with guidelines. Additionally, fear of side effects and misconceptions about the safety of IPTp-SP during pregnancy reduce its acceptance and adherence [1,27,33 & 34].

Vector Control Strategies

Impact of Vector Control: Vector control strategies, including indoor residual spraying (IRS) and larval source management, are effective in reducing mosquito populations and malaria transmission. These methods complement ITNs and IPTp by targeting mosquitoes in their breeding and resting sites, thus lowering the risk of malaria among pregnant women. The implementation of IRS and larval control faces logistical and financial constraints. IRS requires regular reapplication and community compliance, which can be challenging in rural and resource-limited settings. Moreover, these strategies require significant investments in infrastructure and training, which may not be sustainable in all regions [35-37].

Health Education and Community Engagement

Impact of Health Education: Health education programs enhance awareness about malaria prevention and treatment, encouraging pregnant women to adopt protective measures and seek timely healthcare. Community engagement through local leaders and healthcare workers can improve the acceptance and use of ITNs, IPTp, and other preventive strategies. Effective health education is often hindered by cultural beliefs, low literacy rates, and mistrust in formal healthcare systems. Addi-

tionally, outreach efforts may not reach remote or underserved communities, limiting their impact on malaria prevention behaviors [20,22 & 26].

Challenges in Estimating Malaria Burden Among Pregnant Women

Accurate estimation of malaria burden among pregnant women is impeded by incomplete data collection and reporting systems. Many cases of malaria in pregnancy go unreported due to limited access to healthcare, inadequate diagnostic facilities, and underreporting in health information systems [20]. This leads to an underestimation of the true burden of malaria in this population. Strengthening health information systems and ensuring comprehensive data collection are essential for accurate burden estimation (Nguyen et al., 2020). This requires investments in infrastructure, training of healthcare workers, and integration of community-based reporting mechanisms to capture data from remote areas [17].

Malaria transmission varies geographically and seasonally, complicating burden estimation. Regions with different transmission intensities require tailored approaches to measure and address malaria burden effectively [23]. Estimating the burden in areas with fluctuating transmission patterns involves adjusting for seasonal peaks and incorporating climatic and environmental factors. Developing predictive models that account for geographic and seasonal variability in transmission is critical but challenging [24]. These models must integrate real-time data on climate, vector behavior, and human movement patterns to provide accurate burden estimates [22].

Drug resistance, particularly to SP used in IPTp, poses a significant challenge to malaria control in pregnant women. Resistance reduces the effectiveness of IPTp, necessitating the use of alternative drugs or combination therapies to maintain efficacy. Monitoring and managing drug resistance require robust surveillance systems and access to alternative medications. Developing and deploying new treatments that are safe for use in pregnancy, while ensuring their availability and affordability, is essential to address this challenge [30,38 & 39].

Current Interventions and Gaps

One of the primary interventions for malaria prevention in Nigeria is the distribution of Insecticide-Treated Nets (ITNs) to pregnant women during Antenatal Care (ANC) visits. ITNs have been shown to significantly reduce the risk of malaria infection among pregnant women and their infants. However, despite efforts to scale up ITN distribution, coverage remains suboptimal in many regions, with disparities in access observed between urban and rural areas [12-13]. Intermittent Preventive Treatment in Pregnancy (IPTp) with Sulfadoxine-Pyrimethamine (SP) is another key intervention recommended by the World Health Organization (WHO) for the prevention of malaria in pregnant women. IPTp-SP has been shown to reduce the incidence of malaria, maternal anemia, and Low Birth Weight (LBW) in endemic areas (Desai et al., 2018). However, challenges such as stockouts of SP and inadequate ANC attendance hinder the effective implementation of IPTp in Nigeria [1,10].

Health education and Behavioral Change Communication (BCC) strategies play a crucial role in promoting malaria prevention practices among pregnant women. These interventions aim to improve knowledge and awareness of malaria risks and preventive measures, including ITN use, IPTp uptake, and prompt healthcare seeking for malaria symptoms. However, gaps in the dissemination of accurate information and cultural barriers to behavior change limit the effectiveness of BCC interventions [13,40]. Strengthening health systems is essential for ensuring the effective delivery of malaria prevention and treatment services to pregnant women. This includes improving ANC infrastructure, training healthcare personnel on malaria case management, and ensuring the availability of essential commodities such as SP and diagnostic tools. However, healthcare system weaknesses, including inadequate staffing, infrastructure, and drug supply chain management, pose significant challenges to the delivery of quality ANC services in Nigeria [10,13].

Research and surveillance play a critical role in monitoring the effectiveness of malaria interventions and identifying emerging challenges and gaps in malaria control efforts. Robust surveillance systems are needed to track malaria prevalence, treatment outcomes, and drug resistance patterns among pregnant women. Additionally, operational research is necessary to evaluate the implementation of existing interventions and identify strategies for overcoming barriers to their uptake and effectiveness [4, 41].

Recommendation

Utilize cross-sectional surveys, longitudinal cohort studies, and qualitative assessments to capture malaria epidemiology among pregnant women. Integrate data from antenatal care records and electronic health records to track trends. Use advanced diagnostic tools like PCR to detect low-level parasitemia, supplementing microscopy and RDTs, with stringent quality control for accuracy.

Incorporate Geographic Information Systems (GIS) and remote sensing to analyze spatial and environmental factors. Perform multivariate statistical analyses and employ machine learning models for deeper insights. Investigate social determinants of health and use Population Attributable Fraction (PAF) to estimate the impact of malaria. Engage communities for cultural sensitivity and adaptive study designs for flexibility. Implement real-time data collection with mHealth technologies. Develop policy simulation models and conduct health economics analyses for cost-effective malaria strategies. Advocate integrating malaria prevention into broader maternal health programs and build local capacity through training.

Conclusion

Addressing the high burden of malaria among pregnant women in Nigeria requires a multifaceted approach that includes strengthening healthcare services, expanding preventive measures, improving data collection, and addressing socioeconomic and cultural barriers. Accurate epidemiological data and burden estimates are crucial for informing public health policies and interventions, ultimately contributing to the reduction of maternal and child mortality rates and the achievement of global health goals such as the Sustainable Development Goals (SDGs). Collaborative efforts among government, healthcare providers, researchers, and communities are essential to achieving sustainable malaria control and improving health outcomes for pregnant women in Nigeria.

Author Statements

Author Contributions

MCI conceived, designed the study, and drafted the manuscript. MCI, UDC, and UPC conducted the dataset searches. All authors read, reviewed, and approved the manuscript.

Declaration of Competing Interest

The authors declare that there are no conflicting interests.

References

1. Desai M, Kuile FO, Nosten F, et al. Epidemiology and burden of malaria in pregnancy. Lancet Infect Dis. 2018; 18: e107-e118.
2. World Health Organization (WHO). World Malaria Report 2020. WHO. 2020.
3. Okechukwu EF, Ozoko OB, Chukwuanukwu TO, et al. Malaria in pregnancy in Nigeria: Burden and associated factors. Int J Infect Dis. 2019; 87: 1-8.
4. Ukwaja KN, Alaribe AA, Iwu CJ, et al. Regional disparities in malaria morbidity and mortality in Nigeria: A 10-year analysis. BMC Public Health. 2020; 20: 110.
5. Uneke CJ, Iyare EE, Iyare FE. Malaria and anemia in pregnancy: A cross-sectional study of pregnant women in rural communities of Southeastern Nigeria. J Parasitol Res. 2017; 2017: 1-7.
6. Moore KA, Simpson JA, Scoullar MJL, et al. The prevalence of malaria in pregnant women attending antenatal care in Nigeria. Int J Gynaecol Obstet. 2017; 137: 160-6.
7. Obeagu EI, Igwe MC, Nanabo QB, Emenike CU. Impact of Plasmodium falciparum malaria and hookworm infection on anaemia among pregnant women of Ikwuano Local Government Area, Abia State, Nigeria. Int J Cur microbiol App Sci. 2014; 3: 104-111
8. Sicuri E, Bardají A, Sigauque B, et al. The economic impact of malaria in pregnancy: A cost-effectiveness analysis of prevention strategies in sub-Saharan Africa. Am J Trop Med Hyg. 2015; 92: 334-40.
9. Akinleye SO, Adeoye GO, Oyinloye OF, Daramola AA. Sociodemographic factors and malaria prevention among pregnant women in Lagos, Nigeria. Malar J. 2019; 18: 18.
10. Eke AC, Ogu RN, Eluwa GI, et al. Coverage of malaria interventions in pregnancy in Nigeria: Progress made and the remaining challenges. BMC Public Health. 2019; 19: 19.
11. Hill J, Dellicour S, Bruce J, et al. Coverage of intermittent preventive treatment of malaria in pregnancy among women of childbearing age in sub-Saharan Africa: A synthesis and meta-analysis of national survey data. Lancet Infect Dis. 2013; 13: 1029-42.
12. Falade CO, Yusuf BO, Fadero FF, et al. Intermittent preventive treatment with sulfadoxine-pyrimethamine is effective in preventing malaria in pregnancy in Nigeria. Malar J. 2016; 15: 19.
13. Eisele TP, Thwing J, Keating J, et al. Malaria prevention in rural Nigeria: The impact of a universal coverage campaign with insecticide-treated nets. Am J Trop Med Hyg. 2021; 104: 1525-33.
14. Mbonye AK, Webster J, D'Alessandro U. Intermittent preventive treatment for malaria in pregnancy: Lessons from Ghana and Uganda regarding policy and implementation. Am J Trop Med Hyg. 2016; 95: 61-71.
15. Takem EN, D'Alessandro U. Malaria in pregnancy. Lancet Infect Dis. 2013; 13: 169-78.
16. Menéndez C, Bardají A, Sigauque B, et al. Malaria in pregnancy: A priority area for malaria research and control. Malar J. 2015; 14: 110.
17. Jenkins R, Desai M, Njoku AJ, et al. Geographic distribution and predictors of malaria infection in Nigeria. PLoS One. 2019; 14: e0221421.
18. Otieno L, Odongo G, Wambua J, et al. Factors influencing the use of insecticide-treated nets among pregnant women in Nigeria. Glob Health Action. 2018; 11: 153159.
19. Adeoye GO, Akinleye SO, Oyinloye OF, Daramola AA. Prevalence of malaria among pregnant women in Lagos, Nigeria. Trop Med Int Health. 2021; 26: 123-9.
20. Akinleye SO, Adeoye GO, Daramola AA, Oyinloye OF. Estimating malaria burden in Nigeria: A statistical modeling approach. Malar J. 2020; 19: 189.
21. Nguyen TT, Ayeni OB, Aliyu MH, et al. Seasonal variation and predictors of malaria among pregnant women in Nigeria. PLoS One. 2020; 15: e0237590.
22. Olukosi YA, Amodu OK, Daramola AA, et al. Malaria prevalence among pregnant women in a tertiary hospital in Southwest Nigeria. Malar J. 2021; 20: 318.
23. Snow RW, Noor AM, Amratia P, et al. The distribution of malaria risk in Africa: Changing landscapes and climate change. Lancet. 2017; 389: 2526.
24. Gething PW, Casey D, Weiss DJ, Bisanzio D, Bhatt S, Cameron E, et al. Mapping Plasmodium falciparum mortality in Africa between 1990 and 2015. N Engl J Med. 2016; 375: 2435-45.
25. Eze MC, Chukwuanukwu TO, Ajah LO, et al. Malaria and anemia among pregnant women attending antenatal care: A cross-sectional study in Enugu, Nigeria. J Trop Med. 2019; 2019: 1-7.
26. Nwaorgu OC, Ajumobi OO, Egwuma C, et al. Malaria in pregnancy and its impact on maternal and neonatal outcomes in Nigeria. Malar J. 2017; 16: 34.
27. van Eijk AM, Hill J, Larsen DA, et al. The burden of malaria in pregnancy in malaria-endemic areas. Lancet Infect Dis. 2019; 19: e142-e149.
28. Mbonye AK, Namusoke F, Nzabandora E, et al. Quality of antenatal care services and malaria in pregnancy in Nigeria. BMJ Glob Health. 2021; 6: e005529.
29. Pryce J, Richardson M, Lengeler C. Insecticide-treated bed nets and curtains for preventing malaria. Cochrane Database Syst Rev. 2018; 11: CD000363.
30. World Health Organization (WHO). Guidelines for malaria vector control. Geneva: WHO. 2021.
31. Strode C, Donegan S, Garner P, et al. The global threat of insecticide resistance in mosquito vectors of human diseases. Chem Biol. 2018; 25: 377-92.
32. Alonso PL, Brown J, Ashley EA, et al. Malaria: The burden of disease. Glob Health Sci Pract. 2019; 7: 558-67.
33. World Health Organization (WHO). Intermittent Preventive Treatment of malaria in pregnancy (IPTp) with Sulfadoxine-Pyrimethamine (SP). Geneva: WHO. 2018.
34. Kayentao K, Hamed K, Maiga H, et al. Intermittent preventive therapy for malaria during pregnancy using sulfadoxine-pyrimethamine (IPTp-SP): A systematic review and meta-analysis. PLoS Med. 2019; 16: e1002972.
35. Pluess B, Tanser F, Lengeler C, et al. Indoor residual spraying for preventing malaria. Cochrane Database Syst Rev. 2018: CD006657.
36. Kleinschmidt I, Schwabe C, Shiva M, et al. Effectiveness of indoor residual spraying for malaria control in Africa. Malar J. 2018; 17: 56.
37. Chanda E, Mzilahowa T, Chipeta M, et al. Integrated vector management: The future for malaria control. PLoS One. 2019; 14: e0220854.

38. Igwe MC, Ogbuabor AO, Mohammedabdullahi N, Obeagu EI. Prevalence of Antimalaria-Drug-Resistant Plasmodium-Falciparum Mutant Genes in Out-Patients from a Malaria Endemic in Western Region, Uganda. Austin Public Health. 2024; 8: 1021.

39. Ashley EA, Dhorda M, Fairhurst RM, et al. The spread of artemisinin resistance in malaria. N Engl J Med. 2018; 379: 665-74.

40. Onoka CA, Onwujekwe OE, Hanson K, et al. Uptake of intermittent preventive treatment for malaria among pregnant women in Enugu state, Nigeria. Health Policy Plan. 2012; 27: 291-9.

41. Homa T, Samuel T, Daramola A, et al. Enhancing antenatal care for pregnant women in Nigeria: The role of malaria prevention and treatment. Malar J. 2020; 19: 111.