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# Maternal-Infant Transmission of Malaria

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**ABSTRACT**

Maternal-infant transmission of malaria remains a critical public health concern, particularly in regions where malaria is endemic. This review explores the complex mechanisms of transmission, including placental malaria, vertical transmission during childbirth, and postnatal transmission through breastfeeding. Malaria during pregnancy significantly impacts both maternal and neonatal health, leading to severe complications such as anemia, preterm birth, low birth weight, and neonatal malaria. The placenta serves as a central site for parasite sequestration, leading to adverse pregnancy outcomes and increasing the risk of congenital malaria. Despite advancements in malaria control strategies, including intermittent preventive treatment (IPTp), insecticide-treated nets (ITNs), and rapid diagnostic tests (RDTs), maternal-infant transmission continues to present challenges, particularly in resource-limited settings. The emergence of drug-resistant malaria strains and insecticide-resistant mosquitoes further complicates prevention efforts. This review evaluates current diagnostic and therapeutic approaches, highlighting the need for safer, more effective interventions that address the unique needs of pregnant women and their infants. Research gaps remain, particularly in understanding the long-term effects of in utero malaria exposure, improving diagnostic accuracy for low-density infections, and developing vaccines suitable for pregnant women. Addressing these gaps is essential for reducing the burden of maternal-infant malaria transmission and improving outcomes for mothers and infants in high-risk areas.

**Keywords** Maternal-infant transmission, malaria, pregnancy, Plasmodium falciparum, prevention, treatment

## INTRODUCTION

Malaria remains one of the most pressing public health challenges globally, especially in tropical and subtropical regions where the disease is endemic [1]. The World Health Organization (WHO) estimates that in 2022, there were 247 million cases of malaria worldwide, resulting in over 619,000 deaths, with the majority occurring in sub-Saharan Africa. This region bears the brunt of the malaria burden due to the presence of the most virulent species, *Plasmodium falciparum*, and the highly efficient mosquito vector, *Anopheles gambiae*. The disease not only affects individuals but also has far-reaching socio-economic impacts, exacerbating poverty and impeding development.

Among the populations most vulnerable to malaria, pregnant women and their infants stand out. Pregnancy induces physiological changes that increase a woman's susceptibility to malaria infection, and maternal malaria can lead to severe complications such as anemia, placental malaria, and preterm birth [2]. Moreover, the transmission of malaria from a pregnant mother to her infant, either in utero, during delivery, or postnatally, is a significant concern. This vertical transmission can result in congenital malaria, low birth weight, neonatal morbidity, and in severe cases, neonatal mortality. Maternal-infant transmission of malaria, therefore, represents a critical intersection between maternal health and child survival, requiring specialized attention and targeted interventions.

The complexities of maternal-infant malaria transmission are rooted in the unique interactions between the parasite, the mother's immune system, and the developing fetus. The placenta, a vital organ for nutrient and waste exchange between the mother and fetus, becomes a key site for malaria infection. *Plasmodium falciparum* parasites can sequester in the placenta, evading maternal immune responses and potentially crossing into the fetal bloodstream. This placental malaria is associated with adverse pregnancy outcomes, including intrauterine growth restriction, stillbirth, and increased risk of malaria in the newborn [3].

Despite significant progress in malaria control, maternal-infant transmission remains a persistent challenge, particularly in resource-limited settings. The current strategies for preventing and managing malaria in pregnancy include intermittent preventive treatment (IPTp), the use of insecticide-treated nets (ITNs), and

prompt diagnosis and treatment of malaria episodes. However, these interventions are not universally effective, and coverage remains suboptimal in many high-burden areas. Additionally, the emergence of drug-resistant malaria strains and insecticide-resistant mosquito populations poses new challenges to existing control measures [4].

This review aims to understand the mechanisms of maternal-infant malaria transmission, assess its impact on maternal and neonatal health, evaluate diagnostic, therapeutic, and preventive strategies, and identify gaps in current research. It will examine the role of the placenta in parasite sequestration, maternal immune responses, and factors influencing vertical transmission during pregnancy, childbirth, and postnatal periods. The review will also discuss the challenges of implementing preventive measures in high-burden settings and the need for new tools to address emerging threats. The review will also propose potential research avenues and strategies for improving management and control of maternal-infant malaria transmission.



## Mechanisms of Maternal-Infant Transmission

Malaria transmission is a complex process that occurs through various pathways, including placental transmission during pregnancy, vertical transmission during childbirth, and postnatal transmission through breastfeeding [5]. Placental malaria is characterized by the accumulation of infected red blood cells (iRBCs) within the placenta, leading to inflammation, impaired placental function, and adverse pregnancy outcomes. This is driven by parasite sequestration and the maternal inflammatory response. Placental malaria increases the risk of severe anemia, maternal mortality, and congenital malaria, where the infant is born with malaria parasites in their bloodstream. Vertical transmission occurs when the infant comes into contact with infected maternal blood during childbirth or shortly thereafter. The risk of vertical transmission is influenced by factors such as the presence of malaria parasites in maternal blood at the time of childbirth and the nature of the delivery process itself. Postnatal transmission occurs when the mother has an active malaria infection and parasites are present in her bloodstream. These parasites can be transferred to the infant through breast milk, especially if there are microabrasions or other entry points in the infant's digestive tract. Breastfeeding is typically considered safe and protective against many infections, but in cases where the mother has an untreated or poorly managed malaria infection, there is a potential risk of transmitting the parasites to the infant [6]. Understanding these mechanisms is crucial for developing effective interventions to protect pregnant women and their infants from the devastating effects of malaria.

## Impact on Maternal Health

Malaria during pregnancy is a significant public health concern, particularly in regions where the disease is endemic. It can cause severe complications that endanger both the mother and the fetus. Pregnant women are particularly vulnerable to malaria due to changes in immunity, increased susceptibility to infection, and the presence of the placenta as a reservoir for Plasmodium parasites. Maternal complications include anemia, preterm birth, and severe maternal illness [7]. Anemia is a common and serious condition, resulting from the destruction of red blood cells by malaria parasites. Preterm birth is associated with respiratory distress syndrome, sepsis, and long-term developmental delays in the infant. Cerebral malaria, a life-threatening condition characterized by seizures, altered consciousness, and coma, can result in long-term neurological deficits or death. Managing malaria in pregnant women presents unique challenges, including diagnostic difficulties and the need to balance the risks and benefits of treatment. Diagnosing malaria in pregnant women can be challenging due to symptoms that overlap with common pregnancy-related conditions and lower parasitemia levels in placental malaria. Treatment risks include balancing effective infection clearing with potential risks to the fetus. Malaria during pregnancy poses significant risks to maternal health, with complications such as anemia, preterm birth, and severe maternal illness [8]. Addressing these challenges requires a comprehensive approach that includes early detection, appropriate treatment, and preventive measures to protect the health of both the mother and the infant.

## Impact on Neonatal Health

Malaria has a profound impact on neonatal health, with potential immediate and long-term consequences for infants born to mothers who have experienced malaria during pregnancy. The developing fetus and newborn are particularly vulnerable to the effects of malaria, which can result in a range of complications that may affect their survival, growth, and development [9]. Neonatal complications associated with maternal malaria include low birth weight (LBW), which is defined as a birth weight of less than 2,500 grams, and neonatal malaria, which occurs when a newborn is infected with malaria parasites either in utero, during delivery, or shortly after birth. Neonatal malaria can present with symptoms such as fever, irritability, feeding difficulties, and anemia, and can be life-threatening if not promptly diagnosed and treated. Higher mortality rates are associated with malaria-related neonatal complications, particularly in regions where the disease is endemic. The combination of LBW, prematurity, and neonatal malaria increases the risk of early neonatal death. The high mortality rates highlight the need for effective prevention and management strategies to protect the health of both mothers and infants. Beyond the immediate neonatal period, there is growing evidence that exposure to malaria in utero can have long-lasting effects on an infant's health and development, manifesting as cognitive and developmental delays, increased

susceptibility to infections, and chronic health conditions [10]. Addressing the long-term impacts requires a holistic approach that includes early intervention, ongoing monitoring, and support for children exposed to malaria in utero to ensure they achieve their full developmental potential.

**Diagnostic and Therapeutic Strategies**

The management of malaria during pregnancy is crucial due to the unique physiological changes and potential risks of antimalarial medications [11]. Various diagnostic methods and therapeutic strategies are employed, each with its strengths and limitations. Microscopy remains the gold standard for malaria diagnosis, but its effectiveness is diminished in detecting low-density infections, which are common in pregnant women. Rapid Diagnostic Tests (RDTs) offer a convenient and quick method for diagnosing malaria, but their sensitivity can vary, leading to missed diagnoses. Polymerase Chain Reaction (PCR) is a highly sensitive diagnostic method that detects malaria parasite DNA in blood samples, but its widespread application in routine prenatal care is limited by practical constraints. The choice of diagnostic method often depends on resources available, the need for rapid results, and the level of parasitemia expected in the patient population. A combination of these diagnostic tools may be employed to improve accuracy and ensure timely treatment [12]. Treatment involves careful consideration of both the efficacy and safety of antimalarial medications, aiming to eradicate the malaria infection while minimizing risks to the fetus. Primary options for treatment include chloroquine, quinine, and Artemisinin-Based Combination Therapies (ACTs). Complication management is essential for preventing adverse outcomes, including blood transfusions for severe anemia and supportive care for other complications. The complexity of treatment underscores the need for ongoing research to develop safer and more effective interventions, particularly in resource-limited settings where the burden of malaria is highest.



**Prevention Strategies**

Preventing malaria in pregnant women and infants is crucial for reducing the disease's impact on maternal and neonatal health [13]. Comprehensive prevention strategies are essential, including Intermittent Preventive Treatment (IPT), Insecticide-Treated Nets (ITNs), Environmental Management, and Community Education. Intermittent Preventive Treatment (IPT) involves administering a full therapeutic dose of an antimalarial drug at predetermined intervals during pregnancy, regardless of whether the woman is infected with malaria. IPT has been shown to significantly reduce the risk of maternal anemia, placental malaria, low birth weight, and preterm delivery, as well as lowering neonatal mortality rates. However, the implementation of IPT faces challenges such as resistance to SP, limited access to antenatal care, low awareness among pregnant women, and logistical difficulties in delivering medication. Insecticide-Treated Nets (ITNs) are an effective tool for preventing malaria, particularly for pregnant women and young children [14]. They provide a physical barrier that protects individuals from mosquito bites and kills or repels mosquitoes due to the insecticide coating. Consistent use of ITNs can reduce malaria transmission by up to 50% and decrease child mortality rates by about 20%. However, the effectiveness of ITNs depends on consistent and correct usage, which can be hindered by factors such as discomfort, cultural practices, and concerns about insecticide safety. Environmental management plays a significant role in reducing the breeding and survival of malaria vectors, thereby decreasing the risk of transmission. Vector control strategies aim to reduce the population of Anopheles mosquitoes, but require sustained efforts and community cooperation. Community education programs are essential for promoting preventive measures and addressing challenges associated with each strategy.

**Current Research and Gaps**

The fight against maternal-infant malaria transmission has seen significant progress, but there are still critical areas that need further research to enhance our understanding and improve intervention strategies. Recent advancements in diagnostic techniques, treatment protocols, and new preventive measures have led to improved detection methods, especially in low-density infections common during pregnancy [15, 16, 17, 18]. Improved Rapid Diagnostic Tests (RDTs) have made them more reliable and easier to use in resource-limited settings. New antimalarial drugs are being developed, particularly for drug-resistant strains of Plasmodium falciparum. These drugs aim to offer better efficacy with fewer side effects for both the mother and the fetus. Vaccine development is also a promising area of research, with the RTS,S/AS01 (Mosquirix) vaccine showing some efficacy in children and potential use in pregnant women. However, several research gaps remain, including long-term impact studies, improved diagnostic tools, vaccine efficacy and safety for pregnant women, understanding drug resistance, social and behavioral research, and integration of maternal-infant health programs [19, 20, 21]. Longitudinal studies could provide insights into how early exposure to malaria affects children as they grow, inform medical management and public health policies, and help develop more effective strategies to protect pregnant women and infants from malaria. Addressing these research gaps will be essential for developing more effective and sustainable strategies to protect pregnant women and infants from malaria, ultimately reducing the burden of this devastating disease.

## CONCLUSION

Maternal-infant transmission of malaria continues to be a significant public health challenge, particularly in regions where malaria is endemic. The intricate mechanisms by which Plasmodium falciparum interacts with the maternal and fetal systems underscore the complexity of managing this disease during pregnancy. The impact on maternal and neonatal health is profound, with severe consequences such as anemia, preterm birth, low birth weight, and neonatal mortality. Despite advancements in diagnostic tools, therapeutic approaches, and preventive strategies, the burden of maternal-infant malaria transmission remains high.

Current research has made strides in improving diagnostic techniques, developing new antimalarial drugs, and exploring vaccine options. However, critical gaps persist, particularly in understanding the long-term impacts of maternal-infant malaria, enhancing diagnostic tools for use during pregnancy, and developing vaccines that are safe and effective for pregnant women. Addressing these gaps is essential for improving the outcomes for both mothers and their infants.

To combat the ongoing threat of maternal-infant malaria transmission, it is imperative to continue investing in research, particularly in areas that have been underexplored. Longitudinal studies, more sensitive diagnostic tools, and integrated health programs are crucial for advancing our understanding and enhancing our ability to prevent and treat malaria in pregnant women and their infants. Through sustained efforts in research, policy, and community engagement, we can reduce the burden of malaria and improve maternal and neonatal health outcomes in high-burden region

## REFERENCES


1. Ataíde, R., Mwapasa, V., & Rogerson, S.J. (2021). Malaria during pregnancy: Intermittent preventive treatment with sulfadoxine-pyrimethamine (IPTp-SP) remains a highly effective strategy in sub-Saharan Africa. Journal of Travel Medicine, 28(7), taab082. https://doi.org/10.1093/jtm/taab082
2. Ekpono, E. U., Aja, P. M., Ibiam, U. A., Alum, E. U., &Ekpono, U. E. Ethanol Root-extract of Sphenocentrumjollyanum Restored Altered Haematological Markers in Plasmodium berghei-infected Mice. Earthline Journal of Chemical Sciences. 2019; 2(2): 189-203. https://doi.org/10.34198/ejcs.2219.189203.
3. Chua, C.L., Brown, G., Hamilton, J.A., & Boeuf, P. (2023). Placental malaria: pathogenesis and implications for fetal health. Frontiers in Immunology, 14, 1168200. https://doi.org/10.3389/fimmu.2023.1168200
4. Menéndez, C., Mayor, A., & Walker, P.G.T. (2022). Malaria in pregnancy: How can we eliminate it? Trends in Parasitology, 38(8), 628-640. https://doi.org/10.1016/j.pt.2022.05.003
5. Desai, M., Gutman, J., & Mwandama, D. (2021). Malaria in pregnancy: An update on approaches to reduce maternal and infant morbidity and mortality. Expert Review of Anti-Infective Therapy, 19(12), 1567-1585. https://doi.org/10.1080/14787210.2021.1969941
6. Rogerson, S.J., Hviid, L., Duffy, P.E., Leke, R.G.F., & Taylor, S.M. (2023). Malaria in pregnancy: Pathogenesis and immunity. The Lancet Infectious Diseases, 23(3), e127-e139. https://doi.org/10.1016/S1473-3099(22)00581-6
7. Egwu, C.O., Aloke, C., Chukwu, J., Nwankwo, J.C., Irem, C., Nwagu, K.E., Nwite, F., Agwu, A.O., Alum, E., Offor, C.E. and Obasi, N.A. Assessment of the Antimalarial Treatment Failure in Ebonyi State, Southeast Nigeria. J Xenobiot. 2023 Jan 3;13(1):16-26. doi: 10.3390/jox13010003.
8. Anchang-Kimbi, J.K., Achidi, E.A., Nkegoum, B., & Leke, R.G.F. (2022). Congenital and neonatal malaria: A neglected tropical disease. Parasites & Vectors, 15, 112. https://doi.org/10.1186/s13071-022-05264-3
9. Alum, E, U., Ugwu O, P, C., Egba S, I., Uti D, E., Alum, B, N., (2024). Climate Variability and Malaria Transmission: Unraveling the Complex Relationship. INOSR Scientific Research 11(2):16-22. https://doi.org/10.59298/INOSRSR/2024/1.1.21622
10. Dellicour, S., Tatem, A.J., Guerra, C.A., Snow, R.W., & ter Kuile, F.O. (2021). The global impact of malaria in pregnancy: Estimating the population at risk across stable transmission zones. PLoS Medicine, 18(5), e1003647. https://doi.org/10.1371/journal.pmed.1003647
11. Arévalo-Herrera, M., Lopez-Perez, M., Medina, L., Moreno, A., Gutierrez, J.B., & Herrera, S. (2023). Congenital malaria in areas of low transmission: A rare but potentially serious event. Journal of Infectious Diseases, 227(2), 298-306. https://doi.org/10.1093/infdis/jiad005
12. Obeagu, E. I., Alum, E. U. and Ugwu, O. P. C. Hepcidin: The Gatekeeper of Iron in Malaria Resistance NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN MEDICAL SCIENCES. 2023; 4(2):1-8. https://doi.org/10.59298/NIJRMS/2023/10.1.1400
13. Ouédraogo, A.L., González, R., Pons-Duran, C., & Menéndez, C. (2022). Placental malaria and the risk of malaria in infants: A systematic review and meta-analysis. Journal of Infectious Diseases, 225(12), 2101-2113. https://doi.org/10.1093/infdis/jiab628

14. World Health Organization (WHO). (2022). WHO guidelines for malaria, 2022 update. Geneva: World Health Organization. https://apps.who.int/iris/handle/10665/353579
15. Egwu, C. O., Aloke, C., Chukwu, J., Agwu, A., Alum, E.,Tsamesidis, I, et al. A world free of malaria: It is time for Africa to actively champion and take leadership of elimination and eradication strategies. Afr Health Sci. 2022 Dec;22(4):627-640. doi: 10.4314/ahs.v22i4.68.
16. Kungu, E., Inyangat, R., Ugwu, O.P.C. and Alum, E. U. Exploration of Medicinal Plants Used in the Management of Malaria in Uganda. NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN MEDICALSCIENCES(2023).4(1):101-108.https://nijournals.org/wp-content/uploads/2023/10/NIJRMS-41101-108-2023.docx.pdf
17. Okechukwu PC Ugwu, Okwesili FC Nwodo, Parker E Joshua, Christian E Odo, Abubakar Bawa, EC Ossai, CC Adonu Anti-malaria and hematological analyses of ethanol leaf extract of Moringa oleifera on malaria infected mice *International Journal of Pharmacy and Biological Science* (2013). *3(1) 360-371.*
18. Okechukwu PC Ugwu, OFC Nwodo, PE Joshua, CE Odo, EC Ossai, B Aburbakar. Ameliorative effects of ethanol leaf extract of *Moringa oleifera* on the liver and kidney markers of malaria infected mice. (2013). *2(2) 43-52.*
19. Okechukwu PC Ugwu, Okwesili FC Nwodo, Parker E Joshua, Christian E Odo, Emmanuel C Ossai The effect of ethanol leaf extract of *Moringa oleifera* on the lipid profile of malaria infected mice *Journal of applied science* (2013). *4(1) 1324-1332.*
20. Enechi OC, CC Okpe, GN Ibe, KO Omeje, PC Ugwu Okechukwu. Effect of Buchholzia coriacea methanol extract on haematological indices and liver function parameters in Plasmodium berghei-infected mice Global Veterinaria (2016) 16(1) 57-66.
21. OKECHUKWU PAUL-CHIMA Ugwu Anti-Malaria Effect of Ethanol Extract of Moringa Oleifera (Agbaji) Leaves on Malaria Induced Mice. *University of Nigeria Nsukka,* (2011). *39.*

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