

## The Effect of Maternal Malaria on Infant Immunization Outcomes

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### Abstract

Maternal malaria remains a critical public health issue, impacting not only maternal health but also the health and development of the infant. This review explores the effects of maternal malaria on infant immunization outcomes, emphasizing how prenatal exposure to malaria can influence vaccine efficacy and overall immunization success. Maternal malaria can alter the infant's immune system, potentially leading to reduced responses to vaccines due to compromised immune development, maternal antibody transfer, and inflammation. Epidemiological evidence highlights that maternal malaria is associated with diminished vaccine responses in infants, affecting vaccines such as those for measles, hepatitis B, and Haemophilus influenzae type b (Hib). This reduced efficacy can compromise the effectiveness of immunization programs and impact overall health outcomes for infants born to malaria-affected mothers. Factors such as low birth weight and preterm birth, often associated with maternal malaria, further complicate the vaccination process. Public health interventions must integrate malaria prevention and treatment with immunization strategies to address this challenge effectively. Measures such as improved malaria control, enhanced vaccination protocols, and community-based approaches are essential for mitigating the adverse effects of maternal malaria on infant health. Future research and comprehensive public health programs are crucial for developing effective solutions and improving immunization outcomes in affected populations.

**Keywords:** *Maternal Malaria, Infant Immunization, Immunization Outcomes, Malaria in Pregnancy, Vaccine Efficacy, Infant Health, Prenatal Exposure, Public Health Interventions*

### Introduction

**Maternal malaria** is a significant global health issue that affects millions of pregnant women and their infants each year, particularly in malaria-endemic regions. Malaria during pregnancy poses risks to both maternal and infant health, impacting pregnancy outcomes and increasing the risk of adverse neonatal conditions. One critical but often underexplored consequence of maternal malaria

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is its effect on infant immunization outcomes. Immunization is a fundamental public health intervention that protects infants from infectious diseases, yet maternal malaria can complicate this process, potentially diminishing the efficacy of vaccines and affecting overall infant health. **Prenatal exposure to malaria** can disrupt the normal development of the infant's immune system. Maternal malaria is associated with altered immune responses in the infant, including impaired antibody production and altered cellular immunity. These disruptions can influence how effectively infants respond to vaccines, which are designed to stimulate the immune system and provide protection against various infectious diseases. Understanding the mechanisms through which maternal malaria affects infant immune responses is crucial for developing strategies to improve immunization outcomes.<sup>1-7</sup>

**Maternal malaria can lead to various immune system alterations** in infants through several mechanisms. One key factor is the transfer of malaria-specific antibodies from the mother to the infant. While these antibodies can provide some level of protection, they may also interfere with the infant's ability to respond effectively to vaccines. Additionally, maternal malaria-induced inflammation and anemia can impact fetal immune development, potentially compromising the infant's response to immunization. These effects highlight the need for a comprehensive understanding of how maternal health conditions influence vaccination efficacy. **Epidemiological studies** have shown that maternal malaria can negatively impact vaccine efficacy in infants. Research has indicated that infants born to mothers with malaria during pregnancy may have reduced responses to routine vaccines, such as those for measles, hepatitis B, and Haemophilus influenzae type b (Hib). These findings underscore the importance of considering maternal health status when evaluating vaccination outcomes and designing public health interventions. The potential reduction in vaccine efficacy due to maternal malaria highlights a critical area for further investigation and intervention.<sup>8-12</sup>

**The impact of maternal malaria on vaccine outcomes** extends beyond reduced vaccine efficacy. Infants born to malaria-affected mothers are at higher risk for conditions such as low birth weight and preterm birth, which can further complicate their ability to receive and respond to vaccines. Ensuring timely and complete vaccination for these infants is essential to mitigate the potential adverse effects of maternal malaria and ensure optimal health outcomes. Addressing these challenges requires a multifaceted approach that integrates malaria prevention and treatment with immunization strategies. **Public health interventions** are essential for addressing the dual challenges of malaria and immunization. Integrating malaria prevention measures, such as the use of insecticide-treated bed nets (ITNs) and intermittent preventive treatment in pregnancy (IPTp), with immunization programs can help reduce the prevalence of maternal malaria and its impact on infant health. Additionally, strategies to enhance vaccine delivery and monitor vaccine responses in infants born to malaria-affected mothers are critical for improving immunization outcomes. **Community-based approaches** can also play a crucial role in addressing the challenges associated with maternal malaria and immunization. Educating communities about the importance of malaria prevention and vaccination, as well as ensuring access to both malaria treatment and immunization services, can enhance the effectiveness of public health programs. Engaging community health workers and local organizations in these efforts can help improve coverage and adherence to both malaria and vaccination interventions.<sup>13-18</sup>

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## Maternal Malaria and Immune System Development

Maternal malaria, an infection of pregnant women by *Plasmodium* parasites, has profound effects on both maternal and fetal health. One critical but often overlooked aspect is its impact on the developing infant's immune system. The fetal immune system undergoes significant development in utero, laying the groundwork for the infant's ability to respond to infections and vaccines postnatally. Maternal malaria can interfere with this crucial developmental process, potentially compromising the infant's immune responses and affecting long-term health outcomes. Maternal malaria can affect the development of the fetal immune system in several ways. In utero exposure to malaria can lead to alterations in the infant's immune cell populations and cytokine profiles. Studies have shown that infants born to mothers with malaria during pregnancy may exhibit altered lymphocyte profiles, including changes in T-cell subsets and B-cell responses. These changes can impact the infant's ability to mount an effective immune response to pathogens and vaccines. Maternal malaria can influence the transfer of antibodies from the mother to the infant. While maternal antibodies provide some level of passive immunity to the infant, they can also interfere with the infant's ability to produce its own immune responses. The presence of malaria-specific antibodies in the infant can potentially inhibit the effectiveness of vaccines designed to elicit an immune response by mimicking the infection. Maternal malaria-induced inflammation and anemia can have adverse effects on fetal immune development. The inflammatory environment in the placenta and the maternal circulation can alter the signaling pathways involved in immune system maturation. Additionally, maternal anemia associated with malaria can impact the delivery of essential nutrients and cytokines required for optimal immune development, further compromising the infant's immune system.<sup>19-28</sup>

Placental malaria, characterized by the sequestration of malaria parasites in the placenta, can lead to localized inflammation and immune modulation. This placental inflammation can affect the transfer of immune mediators and nutrients to the fetus, influencing the development of the fetal immune system. The presence of malaria antigens and inflammatory cytokines in the placenta can alter the development of fetal immune cells and their responses to infections. Maternal malaria can disrupt the normal immune interactions between the mother and fetus. The maternal immune system's response to malaria may lead to the release of pro-inflammatory cytokines and other mediators that cross the placenta and impact fetal immune development. These interactions can result in an altered immune milieu in the fetus, potentially affecting its ability to respond to future infections and vaccinations. Infants exposed to maternal malaria may have reduced responses to vaccines, including those for common infectious diseases such as measles, hepatitis B, and *Haemophilus influenzae* type b (Hib). The altered immune system development resulting from maternal malaria can lead to suboptimal vaccine-induced immunity, increasing the risk of vaccine-preventable diseases in these infants. Given the potential impact of maternal malaria on vaccine responses, there may be a need for adjusted vaccination schedules or additional booster doses for infants born to malaria-affected mothers. Research into optimizing vaccine regimens for this population can help enhance vaccine effectiveness and improve health outcomes. Addressing the impact of maternal malaria on infant immune system development requires an integrated approach that combines malaria prevention and treatment with immunization strategies. Ensuring effective malaria control during pregnancy, alongside routine immunization practices, can help mitigate the

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adverse effects on infant immune responses. Educating communities about the importance of malaria prevention and its impact on infant health can enhance the effectiveness of public health interventions. Community-based programs that promote the use of insecticide-treated bed nets, malaria screening, and timely vaccinations can help improve health outcomes for both mothers and infants.<sup>29-38</sup>

## **Epidemiological Evidence**

Epidemiological studies play a crucial role in understanding the relationship between maternal malaria and infant immunization outcomes. By examining patterns and trends in malaria prevalence, vaccine efficacy, and related health outcomes, researchers can assess the impact of maternal malaria on the effectiveness of vaccination programs. Epidemiological evidence indicates that maternal malaria can adversely affect the efficacy of vaccines administered to infants. Studies have shown that infants born to mothers with malaria during pregnancy often have diminished immune responses to routine vaccines, such as those for measles, hepatitis B, and *Haemophilus influenzae* type b (Hib). For example, research conducted in malaria-endemic regions has demonstrated that infants exposed to maternal malaria have lower seroconversion rates and reduced antibody levels following vaccination compared to infants born to non-malaria-affected mothers. The reduced vaccine efficacy observed in infants exposed to maternal malaria is thought to be related to several factors, including altered immune system development and the transfer of maternal malaria-specific antibodies. These factors can interfere with the infant's ability to mount an effective immune response to vaccines. Additionally, the inflammatory environment associated with maternal malaria can impact the infant's immune system, further compromising vaccine effectiveness.<sup>39-43</sup>

The prevalence of maternal malaria and its impact on immunization outcomes can vary significantly by geographic region. In high malaria-endemic areas, such as sub-Saharan Africa, the prevalence of maternal malaria is higher, and its effects on infant health and vaccine responses are more pronounced. Studies in these regions have consistently shown a correlation between maternal malaria and reduced vaccine efficacy, highlighting the need for targeted public health interventions. Epidemiological studies have also identified additional risk factors that exacerbate the impact of maternal malaria on infant health. Factors such as low birth weight, preterm birth, and maternal anemia are often associated with maternal malaria and can further influence vaccine outcomes. Infants born with these conditions may have compromised immune systems and reduced capacity to respond to vaccines effectively. The evidence linking maternal malaria to reduced vaccine efficacy underscores the importance of integrating malaria prevention and treatment with immunization programs. Public health strategies should address both malaria control and vaccination to mitigate the adverse effects on infant health. This includes implementing malaria prevention measures such as the use of insecticide-treated bed nets (ITNs) and intermittent preventive treatment in pregnancy (IPTp), alongside routine vaccination practices. Given the impact of maternal malaria on vaccine responses, there may be a need to adjust vaccination strategies for infants born to malaria-affected mothers. This could include additional booster doses, modified vaccine schedules, or enhanced monitoring of vaccine responses. Research into optimizing vaccination regimens for this population is essential for improving health

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outcomes and ensuring the effectiveness of immunization programs. Community-based interventions that promote both malaria prevention and immunization adherence are critical for addressing the challenges associated with maternal malaria. Educating communities about the importance of malaria prevention, timely vaccinations, and the potential impact of maternal health on infant health can enhance the effectiveness of public health programs. Ensuring equitable access to healthcare services, including malaria prevention, treatment, and immunization, is essential for improving health outcomes. Addressing barriers such as limited healthcare infrastructure, transportation, and cost is crucial for achieving comprehensive coverage and enhancing the effectiveness of public health interventions.<sup>44-60</sup>

### **Public Health Interventions**

Addressing the impact of maternal malaria on infant immunization outcomes requires a multifaceted approach that integrates malaria prevention and treatment with comprehensive immunization strategies. Effective public health interventions can help mitigate the adverse effects of maternal malaria on both maternal and infant health, ensuring that infants receive optimal protection through vaccination. Integrating malaria prevention and treatment with immunization programs is crucial for addressing the dual challenges of malaria and vaccine efficacy. Strategies such as the provision of insecticide-treated bed nets (ITNs) and intermittent preventive treatment in pregnancy (IPTp) should be combined with routine vaccination services. This integrated approach ensures that pregnant women receive effective malaria prevention while also receiving timely immunizations for their infants. To improve immunization outcomes for infants born to malaria-affected mothers, vaccination programs may need to be adapted. This could involve implementing additional booster doses, modifying vaccine schedules, or enhancing monitoring of vaccine responses. Public health initiatives should focus on ensuring that infants receive complete and timely vaccinations, particularly in high malaria-endemic areas where maternal malaria is prevalent. Community-based programs play a vital role in promoting malaria prevention and vaccination adherence. Educating communities about the importance of malaria prevention measures, such as ITNs and IPTp, as well as the need for timely vaccinations, can enhance the effectiveness of public health interventions. Community health workers can play a key role in disseminating information and supporting pregnant women and caregivers in adhering to both malaria prevention and immunization practices. Ensuring equitable access to healthcare services is essential for improving health outcomes. Public health programs should focus on increasing access to malaria prevention, treatment, and vaccination services, particularly in underserved and remote areas. This includes addressing barriers such as transportation, healthcare infrastructure, and affordability, which can impact the effectiveness of malaria and immunization programs.<sup>61-79</sup>

Maternal anemia and malnutrition, which are often associated with malaria, can further impact infant health and vaccination outcomes. Public health interventions should include strategies to address anemia and improve maternal nutrition, such as providing iron and folic acid supplements and promoting healthy diets. These measures can help enhance maternal health and improve the overall development of the infant's immune system. Educating pregnant women about the importance of malaria prevention, antenatal care, and proper nutrition is crucial for improving maternal and infant health outcomes. Public health campaigns should focus on providing accurate

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information and resources to support pregnant women in maintaining their health and adhering to recommended practices for malaria prevention and immunization. Regular monitoring and evaluation of vaccine efficacy in the context of maternal malaria are essential for identifying potential issues and adjusting strategies as needed. Public health programs should include robust surveillance systems to track vaccine coverage, efficacy, and outcomes in infants born to malaria-affected mothers. This information can inform adjustments to vaccination protocols and improve overall program effectiveness. Surveillance of malaria trends and the effectiveness of prevention and treatment measures is crucial for adapting public health strategies. Monitoring malaria prevalence and treatment outcomes can help identify emerging issues and guide the implementation of targeted interventions to reduce the impact of maternal malaria on infant health.<sup>80-89</sup>

## Conclusion

Maternal malaria is a significant public health concern with profound implications for both maternal and infant health. The impact of maternal malaria on infant immunization outcomes underscores the need for integrated public health strategies that address both malaria prevention and effective vaccination. Epidemiological evidence highlights how maternal malaria can reduce vaccine efficacy and complicate the health of infants born to malaria-affected mothers, making it essential to adopt comprehensive approaches to mitigate these effects. Integrating malaria prevention and treatment with immunization programs is crucial for improving health outcomes. Measures such as insecticide-treated bed nets (ITNs) and intermittent preventive treatment in pregnancy (IPTp) should be combined with robust vaccination schedules to ensure that both maternal and infant health needs are met. Tailoring vaccination strategies for infants exposed to maternal malaria, including potential adjustments to vaccine regimens and additional booster doses, can enhance vaccine effectiveness and improve health outcomes. Effective public health interventions require strong community engagement and equitable access to healthcare services. Educating communities about malaria prevention and vaccination, addressing barriers to healthcare access, and improving maternal nutrition are essential components of a comprehensive strategy. Community-based programs and health system strengthening efforts can help ensure that preventive and therapeutic measures reach those most in need.

## References

1. Uneke CJ. Impact of placental *Plasmodium falciparum* malaria on pregnancy and perinatal outcome in sub-Saharan Africa: part III: placental malaria, maternal health, and public health. *The Yale journal of biology and medicine*. 2008;81(1):1.
2. Gontie GB, Wolde HF, Baraki AG. Prevalence and associated factors of malaria among pregnant women in Sherkole district, Benishangul Gumuz regional state, West Ethiopia. *BMC Infectious Diseases*. 2020; 20:1-8.
3. Obeagu EI, Agreen FC. Anaemia among pregnant women: A review of African pregnant teenagers. *J Pub Health Nutri*. 2023; 6 (1). 2023;138. [links/63da799664fc860638054562/Anaemia-among-pregnant-women-A-review-of-African-pregnant-teenagers.pdf](https://links/63da799664fc860638054562/Anaemia-among-pregnant-women-A-review-of-African-pregnant-teenagers.pdf).

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4. Obeagu EI, Ezimah AC, Obeagu GU. Erythropoietin in the anaemias of pregnancy: a review. *Int J Curr Res Chem Pharm Sci*. 2016;3(3):10-8. [links/5710fae108ae846f4ef05afb/ERYTHROPOIETIN-IN-THE-ANAEMIAS-OF-PREGNANCY-A-REVIEW.pdf](https://epjournals.com/journals/EJSRR/links/5710fae108ae846f4ef05afb/ERYTHROPOIETIN-IN-THE-ANAEMIAS-OF-PREGNANCY-A-REVIEW.pdf).
5. Obeagu EI, Adepoju OJ, Okafor CJ, Obeagu GU, Ibekwe AM, Okpala PU, Agu CC. Assessment of Haematological Changes in Pregnant Women of Ido, Ondo State, Nigeria. *J Res Med Dent Sci*. 2021;9(4):145-8. [links/608a6728a6fdccaebdf52d94/Assessment-of-Haematological-Changes-in-Pregnant-Women-of-Ido-Ondo.pdf](https://epjournals.com/journals/EJSRR/links/608a6728a6fdccaebdf52d94/Assessment-of-Haematological-Changes-in-Pregnant-Women-of-Ido-Ondo.pdf).
6. Obeagu EI, Obeagu GU. Sick Cell Anaemia in Pregnancy: A Review. *International Research in Medical and Health Sciences*. 2023 ;6(2):10-3. <http://irmhs.com/index.php/irmhs/article/view/111>.
7. Jakheng SP, Obeagu EI. Seroprevalence of human immunodeficiency virus based on demographic and risk factors among pregnant women attending clinics in Zaria Metropolis, Nigeria. *J Pub Health Nutri*. 2022; 5 (8). 2022;137. [links/6317a6b1acd814437f0ad268/Seroprevalence-of-human-immunodeficiency-virus-based-on-demographic-and-risk-factors-among-pregnant-women-attending-clinics-in-Zaria-Metropolis-Nigeria.pdf](https://epjournals.com/journals/EJSRR/links/6317a6b1acd814437f0ad268/Seroprevalence-of-human-immunodeficiency-virus-based-on-demographic-and-risk-factors-among-pregnant-women-attending-clinics-in-Zaria-Metropolis-Nigeria.pdf).
8. Obeagu EI, Obeagu GU, Chukwueze CM, Ikpenwa JN, Ramos GF. Evaluation of Protein C, Protein S and Fibrinogen of Pregnant Women with Malaria in Owerri Metropolis. *Madonna University journal of Medicine and Health Sciences*. 2022;2(2):1-9.
9. Bonilla FA, Oettgen HC. Adaptive immunity. *Journal of Allergy and Clinical Immunology*. 2010;125(2): S33-40.
10. Obeagu EI, Obeagu GU, Chukwueze CM, Ikpenwa JN, Ramos GF. EVALUATION OF PROTEIN C, PROTEIN S AND FIBRINOGEN OF PREGNANT WOMEN WITH MALARIA IN OWERRI METROPOLIS. *Madonna University journal of Medicine and Health Sciences* ISSN: 2814-3035. 2022;2(2):1-9.
11. Obeagu EI, Ibeh NC, Nwobodo HA, Ochei KC, Iwegbulam CP. Haematological indices of malaria patients coinfectd with HIV in Umuahia. *Int. J. Curr. Res. Med. Sci*. 2017;3(5):100-104.
12. Feeney ME. The immune response to malaria in utero. *Immunological reviews*. 2020 ;293(1):216-229.
13. Opeyemi AA, Obeagu EI. Regulations of malaria in children with human immunodeficiency virus infection: A review. *Medicine*. 2023;102(46): e36166.
14. Obeagu EI, Chijioke UO, Ekelozie IS. Malaria rapid diagnostic test (RDTs). *Ann Clin Lab Res*. 2018;6(4):275.
15. Ogomaka IA, Obeagu EI. Methods of Breast Feeding as Determinants of Malaria Infections among Babies in IMO State, Nigeria. *International Journal of Medical Science and Dental Research*. 2019;2(01):17-24.
16. Obeagu EI, Ikpenwa JN, Chukwueze CM, Obeagu GU. Evaluation of protein C, protein S and fibrinogen of pregnant women in Owerri Metropolis. *Madonna University Journal of Medicine and Health Sciences*. 2022;2(1):292-8. <https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/57>.

**Citation:** Obeagu EI, Obeagu GU. The Effect of Maternal Malaria on Infant Immunization Outcomes. *Elite Journal of Scientific Research and Review*, 2024; 2(4): 77-89

17. Obeagu EI, Obeagu GU, Adepoju OJ. Evaluation of haematological parameters of pregnant women based on age groups in Olorunsogo road area of Ido, Ondo state. *J. Bio. Innov*11 (3). 2022:936-941.
18. Obeagu EI, Obeagu GU, Egba SI, Emeka-Obi OR. Combatting Anemia in Pediatric Malaria: Effective Management Strategies. *Int. J. Curr. Res. Med. Sci.* 2023;9(11):1-7.
19. Hassan AO, Oso OV, Obeagu EI, Adeyemo AT. Malaria Vaccine: Prospects and Challenges. *Madonna University journal of Medicine and Health Sciences* ISSN: 2814-3035. 2022;2(2):22-40.
20. Obeagu EI, Ogbonna US, Nwachukwu AC, Ochiabuto O, Enweani IB, Ezeoru VC. Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(4):10-9.
21. Moya-Alvarez V, Abellana R, Cot M. Pregnancy-associated malaria and malaria in infants: an old problem with present consequences. *Malaria journal*. 2014; 13:1-10.
22. Obeagu EI. An update on utilization of antenatal care among pregnant Women in Nigeria. *Int. J. Curr. Res. Chem. Pharm. Sci.* 2022;9(9): 21-6.DOI: [10.22192/ijcrps.2022.09.09.003](https://doi.org/10.22192/ijcrps.2022.09.09.003)
23. Okoroiwu IL, Obeagu EI, Obeagu GU. Determination of clot retraction in pregnant women attending antenatal clinic in federal medical centre Owerri, Nigeria. *Madonna University Journal of Medicine and Health Sciences*. 2022;2(2):91-97. <https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/67>.
24. Obeagu EI, Hassan AO, Adepoju OJ, Obeagu GU, Okafor CJ. Evaluation of Changes in Haematological Parameters of Pregnant Women Based on Gestational Age at Olorunsogo Road Area of Ido, Ondo State. Nigeria. *Journal of Research in Medical and Dental Science*. 2021;9(12):462-.[links/61b1e32f0c4bfb675178bfa7/Evaluation-of-Changes-in-Haematological-Parameters-of-Pregnant-Women-Based-on-Gestational-Age-at-Olorunsogo-Road-Area-of-Ido-Ondo-State-Nigeria.pdf](https://www.researchgate.net/publication/358117877/Evaluation-of-Changes-in-Haematological-Parameters-of-Pregnant-Women-Based-on-Gestational-Age-at-Olorunsogo-Road-Area-of-Ido-Ondo-State-Nigeria/pdf).
25. Anyiam AF, Obeagu EI, Obi E, Omosigho PO, Ironde EA, Arinze-Anyiam OC, Asiyah MK. ABO blood groups and gestational diabetes among pregnant women attending University of Ilorin Teaching Hospital, Kwara State, Nigeria. *International Journal of Research and Reports in Hematology*. 2022 Jun 21;5(2):113-121.
26. Obeagu EI. Gestational Thrombocytopaenia. *J Gynecol Women's Health*. 2023;25(3):556163. [links/64b01aa88de7ed28ba95fccb/Gestational-Thrombocytopaenia.pdf](https://www.researchgate.net/publication/368117877/Gestational-Thrombocytopaenia/pdf).
27. Obeagu EI, Ogbonna US, Nwachukwu AC, Ochiabuto O, Enweani IB, Ezeoru VC. Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(4):10-19.
28. Dobaño C, Berthoud T, Manaca MN, Nhabomba A, Guinovart C, Aguilar R, Barbosa A, Groves P, Rodríguez MH, Jimenez A, Quimice LM. High production of pro-inflammatory cytokines by maternal blood mononuclear cells is associated with reduced maternal malaria but increased cord blood infection. *Malaria Journal*. 2018; 17:1-3.
29. Obeagu EI, Busari AI, Uduchi IO, Ogomaka IA, Ibekwe AM, Vincent CC, Chijioke UO, Okafor CJ, Okoroiwu HU, Adike CN. Age-Related Haematological Variations in Patients with Asymptomatic Malaria in Akure, Ondo State, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(42B):218-24.

**Citation:** Obeagu EI, Obeagu GU. The Effect of Maternal Malaria on Infant Immunization Outcomes. *Elite Journal of Scientific Research and Review*, 2024; 2(4): 77-89



30. Ogomaka IA, Obeagu EI. Malaria in Pregnancy Amidst Possession of Insecticide Treated Bed Nets (ITNs) in Orlu LGA of Imo State, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(41B):380-386.
31. Ogbonna CO, Obeagu EI, Ufelle SA, Ogbonna LN. Evaluation of haematological alterations in children infected by Plasmodium falciparum Species in Enugu, Enugu State, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(1):38-45.
32. Appay V. The physiological role of cytotoxic CD4+ T-cells: the holy grail? *Clinical & Experimental Immunology*. 2004;138(1):10-13.
33. Okorie HM, Obeagu EI, Obarezi HC, Anyiam AF. Assessment of some inflammatory cytokines in malaria infected pregnant women in Imo State Nigeria. *International Journal of Medical Science and Dental Research*. 2019;2(1):25-36.
34. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA. Assessment of some haematological parameters in malaria infected pregnant women in Imo state Nigeria. *Int. J. Curr. Res. Biol. Med*. 2018;3(9):1-4.
35. Nwosu DC, Obeagu EI, Ezenwuba C, Agu GC, Amah H, Ozims SJ, Nwanjo HU, Edward A, Izuchukwu IF, Amadike JN, Nwagwu AJ. Antioxidant status of children with Plasmodium falciparum malaria in Owerri municipal council of Imo state. *Int. J. Curr. Res. Chem. Pharm. Sci*. 2016;3(8):40-46.
36. Harrington WE, Kakuru A, Jagannathan P. Malaria in pregnancy shapes the development of foetal and infant immunity. *Parasite immunology*. 2019;41(3): e12573.
37. Okamgba OC, Nwosu DC, Nwobodo EI, Agu GC, Ozims SJ, Obeagu EI, Ibanga IE, Obioma-Elemba IE, Ihekaire DE, Obasi CC, Amah HC. Iron Status of Pregnant and Post-Partum Women with Malaria Parasitaemia in Aba Abia State, Nigeria. *Annals of Clinical and Laboratory Research*. 2017;5(4):206.
38. Anyiam AF, Arinze-Anyiam OC, Omosigho PO, Ibrahim M, Irondi EA, Obeagu EI, Obi E. Blood Group, Genotype, Malaria, Blood Pressure and Blood Glucose Screening Among Selected Adults of a Community in Kwara State: Implications to Public Health. *Asian Hematology Research Journal*. 2022;6(3):9-17.
39. Madekwe CC, Madekwe CC, Obeagu EI. Inequality of monitoring in Human Immunodeficiency Virus, Tuberculosis and Malaria: A Review. *Madonna University journal of Medicine and Health Sciences*. 2022;2(3):6-15.
40. Offie DC, Ibekwe AM, Agu CC, Esimai BN, Okpala PU, Obeagu EI, Ufelle SA, Ogbonna LN. Fibrinogen and C-Reactive Protein Significance in Children Infected by Plasmodium falciparum Species in Enugu, Enugu State, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(15):1-8.
41. Obeagu EI, Ogunnaya FU. PREGNANCYINDUCED HAEMATOLOGICAL CHANGES: A KEY TO MATERNAL AND CHILD HEALTH. *European Journal of Biomedical*. 2023;10(8):42-43. [links/64c890bddb38b20d6dad2c5c/PREGNANCY-INDUCED-HAEMATOLOGICAL-CHANGES-A-KEY-TO-MATERNAL-AND-CHILD-HEALTH.pdf](https://epjournals.com/links/64c890bddb38b20d6dad2c5c/PREGNANCY-INDUCED-HAEMATOLOGICAL-CHANGES-A-KEY-TO-MATERNAL-AND-CHILD-HEALTH.pdf)
42. Obeagu EI, Ofodile AC, Okwuanaso CB. A review of urinary tract infections in pregnant women: Risks factors. *J Pub Health Nutri*. 2023; 6 (1). 2023; 137:26-35. [links/63c3a9116fe15d6a571e8bba/A-review-of-urinary-tract-infections-in-pregnant-women-Risks-factors.pdf](https://epjournals.com/links/63c3a9116fe15d6a571e8bba/A-review-of-urinary-tract-infections-in-pregnant-women-Risks-factors.pdf).

**Citation:** Obeagu EI, Obeagu GU. The Effect of Maternal Malaria on Infant Immunization Outcomes. *Elite Journal of Scientific Research and Review*, 2024; 2(4): 77-89

43. Obeagu EI, Obeagu GU, Musiimenta E. Post partum haemorrhage among pregnant women: Update on risks factors. *Int. J. Curr. Res. Med. Sci.* 2023;9(2): 14-17.DOI: [10.22192/ijcrms.2023.09.02.003](https://doi.org/10.22192/ijcrms.2023.09.02.003)
44. Obeagu EI, Obeagu GU, Ogunnaya FU. Deep vein thrombosis in pregnancy: A review of prevalence and risk factors. *Int. J. Curr. Res. Chem. Pharm. Sci.* 2023;10(8): 14-21.DOI: [10.22192/ijcrps.2023.10.08.002](https://doi.org/10.22192/ijcrps.2023.10.08.002)
45. Arama C, Quin JE, Kouriba B, Östlund Farrants AK, Troye-Blomberg M, Doumbo OK. Epigenetics and malaria susceptibility/protection: A missing piece of the puzzle. *Frontiers in Immunology*. 2018; 9:1733.
46. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA. Assessment of some haematological parameters in malaria infected pregnant women in Imo state Nigeria. *Int. J. Curr. Res. Biol. Med.* 2018;3(9): 1-4.DOI: [10.22192/ijcrbm.2018.03.09.001](https://doi.org/10.22192/ijcrbm.2018.03.09.001)
47. Onyenweaku FC, Amah HC, Obeagu EI, Nwandikor UU, Onwuasoanya UF. Prevalence of asymptomatic bacteriuria and its antibiotic susceptibility pattern in pregnant women attending private ante natal clinics in Umuahia Metropolitan. *Int J Curr Res Biol Med.* 2017;2(2): 13-23.DOI: [10.22192/ijcrbm.2017.02.02.003](https://doi.org/10.22192/ijcrbm.2017.02.02.003)
48. Okoroiwu IL, Chinedu-Madu JU, Obeagu EI, Vincent CC, Ochiabuto OM, Ibekwe AM, Amaechi CO, Agu CC, Anoh NV, Amadi NM. Evaluation of Iron Status, Haemoglobin and Protein Levels of Pregnant Women in Owerri Metropolis. *Journal of Pharmaceutical Research International*. 2021;33(27A):36-43.
49. Obeagu EI, Njar VE, Obeagu GU. Infertility: Prevalence and Consequences. *Int. J. Curr. Res. Chem. Pharm. Sci.* 2023;10(7):43-50.
50. Emeka-Obi OR, Ibeh NC, Obeagu EI, Okorie HM. Evaluation of levels of some inflammatory cytokines in preeclamptic women in owerri. *Journal of Pharmaceutical Research International*. 2021;33(42A):53-65.
51. Broen K, Brustoski K, Engelmann I, Luty AJ. Placental Plasmodium falciparum infection: causes and consequences of in utero sensitization to parasite antigens. *Molecular and biochemical parasitology*. 2007;151(1):1-8.
52. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA. Assessment of coagulation parameters in malaria infected pregnant women in Imo state, Nigeria. *International Journal of Current Research in Medical Sciences*. 2018;4(9):41-49.
53. Ogbonna LN, Ezeoru VC, Ofodile AC, Ochiabuto OM, Obi-Ezeani CN, Okpala PU, Okafor CJ, Obeagu GU, Busari AI, Obeagu EI. Gender Based Variations of Haematological Parameters of Patients with Asymptomatic Malaria in Akure, Ondo State, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(8):75-80.
54. Eberendu IF, Ozims SJ, Agu GC, Amah HC, Obasi CC, Obioma-Elemba JE, Ihekaire DE, Ibanga IE, Amah CC, Obeagu EI, Nwosu DC. Impact of human activities on the breeding of mosquitoes of human disease in Owerri metropolis, Imo state. *Int J Adv Res Biol Sci IJARBS*. 2017;4(12):98-106.
55. Obeagu EI, Ofodile AC, Okwuanaso CB. A review on socio economic and behavioral aspects of malaria and its control among children under 5 years of age in Africa. *J Pub Health Nutri.* 2023; 6 (1): 136.
56. Djontu JC, Siewe Siewe S, Mpeke Edene YD, Nana BC, Chomga Foko EV, Bigoga JD, Leke RF, Megnekou R. Impact of placental Plasmodium falciparum malaria infection on

**Citation:** Obeagu EI, Obeagu GU. The Effect of Maternal Malaria on Infant Immunization Outcomes. *Elite Journal of Scientific Research and Review*, 2024; 2(4): 77-89

- the Cameroonian maternal and neonate's plasma levels of some cytokines known to regulate T cells differentiation and function. *Malaria journal*. 2016; 15:1-1.
57. Obeagu EI, Faduma MH, Uzoma G. Ectopic Pregnancy: A Review. *Int. J. Curr. Res. Chem. Pharm. Sci.* 2023;10(4): 40-4.DOI: [10.22192/ijcrps.2023.10.04.004](https://doi.org/10.22192/ijcrps.2023.10.04.004)
  58. Obeagu EI, Gamade SM, Obeagu GU. The roles of Neutrophils in pregnancy. *Int. J. Curr. Res. Med. Sci.* 2023;9(5): 31-35.DOI: [10.22192/ijcrms.2023.09.05.005](https://doi.org/10.22192/ijcrms.2023.09.05.005)
  59. Obeagu EI, Obeagu GU. Molar Pregnancy: Update of prevalence and risk factors. *Int. J. Curr. Res. Med. Sci.* 2023;9(7): 25-28.DOI: [10.22192/ijcrms.2023.09.07.005](https://doi.org/10.22192/ijcrms.2023.09.07.005)
  60. Kabyemela E, Gonçalves BP, Prevots DR, Morrison R, Harrington W, Gwamaka M, Kurtis JD, Fried M, Duffy PE. Cytokine profiles at birth predict malaria severity during infancy. *PloS one*. 2013;8(10):e77214.
  61. Ibebuike JE, Ojie CA, Nwokike GI, Obeagu EI, Nwosu DC, Nwanjo HU, Agu GC, Ezenwuba CO, Nwagu SA, Akujuobi AU. Barriers to utilization of maternal health services in southern senatorial district of Cross Rivers state, Nigeria. *International Journal of Advanced Multidisciplinary Research*. 2017;4(8): 1-9.DOI: [10.22192/ijamr.2017.04.08.001](https://doi.org/10.22192/ijamr.2017.04.08.001)
  62. Emmanuel G, Martin O, Peter OS, Obeagu EI, Daniel K. Factors Influencing Early Neonatal Adverse Outcomes among Women with HIV with Post Dated Pregnancies Delivering at Kampala International University Teaching Hospital, Uganda. *Asian Journal of Pregnancy and Childbirth*. 2023;6(1):203-211.  
<http://research.sdpublishers.net/id/eprint/2819/>.
  63. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA. Assessment of coagulation parameters in malaria infected pregnant women in Imo state, Nigeria. *International Journal of Current Research in Medical Sciences*. 2018;4(9): 41-9.DOI: [10.22192/ijcrms.2018.04.09.006](https://doi.org/10.22192/ijcrms.2018.04.09.006)
  64. Obeagu EI, Obeagu GU. Postpartum haemorrhage among women delivering through spontaneous vaginal delivery: Prevalence and risk factors. *Int. J. Curr. Res. Chem. Pharm. Sci.* 2023;10(8): 22-6.DOI: [10.22192/ijcrps.2023.10.08.003](https://doi.org/10.22192/ijcrps.2023.10.08.003)
  65. Obeagu E, Eze RI, Obeagu EI, Nnatuanya IN, Dara EC. ZINC LEVEL IN APPARENTLY PREGNANT WOMEN IN URBAN AREA. *Madonna University journal of Medicine and Health Sciences*. 2022;2(1):134-48.  
<https://www.journal.madonnauniversity.edu.ng/index.php/medicine/article/view/40>.
  66. Ogomaka IA, Obeagu EI. Malaria in Pregnancy Amidst Possession of Insecticide Treated Bed Nets (ITNs) in Orlu LGA of Imo State, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(41B):380-386.
  67. Obeagu EI, Ogunnaya FU, Obeagu GU, Ndidi AC. SICKLE CELL ANAEMIA: A GESTATIONAL ENIGMA. *migration*. 2023; 17:18.
  68. Harrington WE, Kakuru A, Jagannathan P. Malaria in pregnancy shapes the development of foetal and infant immunity. *Parasite immunology*. 2019;41(3):e12573.
  69. Ifeanyi OE, Uzoma OG. A review on erythropietin in pregnancy. *J. Gynecol. Womens Health*. 2018;8(3):1-4.  
[https://www.academia.edu/download/56538560/A\\_Review\\_on\\_Erythropietin\\_in\\_Pregancy.pdf](https://www.academia.edu/download/56538560/A_Review_on_Erythropietin_in_Pregancy.pdf).
  70. Ifeanyi OE. A review on pregnancy and haematology. *Int. J. Curr. Res. Biol. Med*. 2018;3(5): 26-8.DOI: [10.22192/ijcrbm.2018.03.05.006](https://doi.org/10.22192/ijcrbm.2018.03.05.006)

**Citation:** Obeagu EI, Obeagu GU. The Effect of Maternal Malaria on Infant Immunization Outcomes. *Elite Journal of Scientific Research and Review*, 2024; 2(4): 77-89

71. Nwosu DC, Nwanjo HU, Obeagu EI, Ibebuikie JE, Ezeama MC. Ihekireh. Changes in liver enzymes and lipid profile of pregnant women with malaria in Owerri, Nigeria. *International Journal of Current Research and Academic Review*. 2015;3(5):376-383.
72. Ibebuikie JE, Ojie CA, Nwokike GI, Obeagu EI, Nwosu DC, Nwanjo HU, Agu GC, Ezenwuba CO, Nwagu SA, Akujuobi AU. Factors that influence women's utilization of primary health care services in Calabar Cros river state, Nigeria. *Int. J. Curr. Res. Chem. Pharm. Sci*. 2017;4(7):28-33.
73. Elemchukwu Q, Obeagu EI, Ochei KC. Prevalence of Anaemia among Pregnant Women in Braithwaite Memorial Specialist Hospital (BMSH) Port Harcourt. *IOSR Journal of Pharmacy and Biological Sciences*. 2014;9(5):59-64.
74. Natama HM, Moncunill G, Rovira-Vallbona E, Sanz H, Sorgho H, Aguilar R, Coulibaly-Traoré M, Somé MA, Scott S, Valéa I, Mens PF. Modulation of innate immune responses at birth by prenatal malaria exposure and association with malaria risk during the first year of life. *BMC medicine*. 2018; 16:1-5.
75. Akandinda M, Obeagu EI, Katonera MT. Non Governmental Organizations and Women's Health Empowerment in Uganda: A Review. *Asian Research Journal of Gynaecology and Obstetrics*. 2022;8(3):12-26.
76. Gamde MS, Obeagu EI. IRON DEFICIENCY ANAEMIA: ENEMICAL TO PREGNANCY. *European Journal of Biomedical*. 2023;10(9):272-275.  
[links/64f63358827074313ffaae7b/IRON-DEFICIENCY-ANAEMIA-ENEMICAL-TO-PREGNANCY.pdf](https://doi.org/10.15406/ejbs.2023.10.00272).
77. Emeka-Obi OR, Ibeh NC, Obeagu EI, Okorie HM. Evaluation of levels of some inflammatory cytokines in preeclampsic women in owerri. *Journal of Pharmaceutical Research International*. 2021;33(42A):53-65.
78. Emeka-Obi OR, Ibeh NC, Obeagu EI, Okorie HM. Studies of Some Haemostatic Variables in Preeclampsic Women in Owerri, Imo State, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(42B):39-48.
79. Obeagu EI, Obeagu GU. Postpartum haemorrhage among women delivering through spontaneous vaginal delivery: Prevalence and risk factors. *Int. J. Curr. Res. Chem. Pharm. Sci*. 2023;10(8):22-26.
80. Obeagu EI, Obeagu GU. Sick Cell Anaemia in Pregnancy: A Review. *International Research in Medical and Health Sciences*. 2023;6(2):10-13.
81. Mutabingwa TK, Bolla MC, Li JL, Domingo GJ, Li X, Fried M, Duffy PE. Maternal malaria and gravidity interact to modify infant susceptibility to malaria. *PLoS medicine*. 2005;2(12):e407.
82. Gamble C, Ekwaru PJ, Garner P, Ter Kuile FO. Insecticide-treated nets for the prevention of malaria in pregnancy: a systematic review of randomised controlled trials. *PLoS medicine*. 2007;4(3):e107.
83. Okoko BJ, Enwere G, Ota MO. The epidemiology and consequences of maternal malaria: a review of immunological basis. *Acta tropica*. 2003;87(2):193-205.
84. Dobaño C, Berthoud T, Manaca MN, Nhabomba A, Guinovart C, Aguilar R, Barbosa A, Groves P, Rodríguez MH, Jimenez A, Quimice LM. High production of pro-inflammatory cytokines by maternal blood mononuclear cells is associated with reduced maternal malaria but increased cord blood infection. *Malaria Journal*. 2018; 17:1-3.

**Citation:** Obeagu EI, Obeagu GU. The Effect of Maternal Malaria on Infant Immunization Outcomes. *Elite Journal of Scientific Research and Review*, 2024; 2(4): 77-89

85. Umbers AJ, Stanisić DI, Ome M, Wangnapi R, Hanieh S, Unger HW, Robinson LJ, Lufele E, Baiwog F, Siba PM, King CL. Does malaria affect placental development? Evidence from in vitro models. *PLoS One*. 2013;8(1):e55269.
86. Arama C, Quin JE, Kouriba B, Östlund Farrants AK, Troye-Blomberg M, Doumbo OK. Epigenetics and malaria susceptibility/protection: A missing piece of the puzzle. *Frontiers in Immunology*. 2018; 9:1733.
87. Gbedande K, Carpio VH, Stephens R. Using two phases of the CD 4 T cell response to blood-stage murine malaria to understand regulation of systemic immunity and placental pathology in *Plasmodium falciparum* infection. *Immunological reviews*. 2020;293(1):88-114.
88. Lindsay SW, Thomas MB, Kleinschmidt I. Threats to the effectiveness of insecticide-treated bednets for malaria control: thinking beyond insecticide resistance. *The Lancet Global Health*. 2021;9(9):e1325-1331.
89. Akinleye SO, Falade CO, Ajayi IO. Knowledge and utilization of intermittent preventive treatment for malaria among pregnant women attending antenatal clinics in primary health care centers in rural southwest, Nigeria: a cross-sectional study. *BMC pregnancy and childbirth*. 2009; 9:1-9.