$See \ discussions, stats, and author \ profiles \ for \ this \ publication \ at: \ https://www.researchgate.net/publication/379956826$

Malaria as a Catalyst: Spotlight on Childhood Anemia Management

Article in Haematology International Journal \cdot April 2024

CITATIONS		READS	
0		19	
2 authors:			
0	Getrude Uzoma Obeagu		Emmanuel Ifeanyi Obeagu
	Kampala International University (KIU)		Kampala International University (KIU)
	534 PUBLICATIONS 10,513 CITATIONS		1,668 PUBLICATIONS 23,164 CITATIONS
	SEE PROFILE		SEE PROFILE



Malaria as a Catalyst: Spotlight on Childhood Anemia Management

Emmanuel Ifeanyi Obeagu^{1*} and Getrude Uzoma Obeagu²

¹Department of Medical Laboratory Science, Kampala International University, Uganda ²School of Nursing Science, Kampala International University, Uganda

***Corresponding author:** Emmanuel Ifeanyi Obeagu, Department of Medical Laboratory Science, Kampala International University, Kampala, Uganda, Tel: +2348037369912; Email: emmanuelobeagu@yahoo.com; obeagu.emmanuel@kiu.ac.ug

Review Article Volume 8 Issue 1 Received Date: March 13, 2024 Published Date: April 15, 2024 DOI: 10.23880/hij-16000248

Abstract

Malaria, a devastating vector-borne disease caused by Plasmodium parasites, continues to be a major global health concern, particularly affecting children in endemic regions. This review explores the intricate relationship between malaria and childhood anemia, shedding light on the multifaceted impact of malaria as a catalyst for anemia in pediatric populations. The article delves into the epidemiological aspects of both malaria and childhood anemia, emphasizing the critical need for integrated management strategies to address this coexisting health burden. Additionally, the review highlights the latest advancements in antimalarial interventions and their potential implications for managing childhood anemia.

Keywords: Malaria; Childhood Anemia; Hemoglobin; Vector-borne Diseases; Public Health; Antimalarial Interventions; Pediatric Healthcare

Abbreviations: ACTs: Artemisinin based Combination Therapies; ITNs: Insecticide Treated Bed Nets; IFN- γ : Interferon-gamma; TNF- α : Tumor Necrosis Factor-alpha; RBCs: Red Blood Cells.

Introduction

Malaria, a formidable vector-borne disease caused by Plasmodium parasites, remains a significant global health challenge, particularly impacting children in regions where the disease is endemic [1-4]. Despite considerable progress in recent years, malaria continues to exact a heavy toll on pediatric populations, leading to increased morbidity and mortality. Compounding this challenge is the oftenoverlooked consequence of malaria - childhood anemia. Anemia, characterized by a reduction in hemoglobin levels, serves as a pervasive and debilitating consequence of repeated malaria infections. This review aims to comprehensively explore the intricate relationship between malaria and childhood anemia, shedding light on the multifaceted impact of malaria as a catalyst for anemia in vulnerable populations. The global burden of malaria disproportionately affects children, making them more susceptible to severe forms of the disease, including complications leading to anemia. Understanding the epidemiological aspects of both malaria and childhood anemia is crucial for devising targeted interventions and healthcare policies. [4-15].

Mechanistically, malaria contributes to the development of anemia through various pathways, including the direct destruction of red blood cells (hemolysis), dysregulation of erythropoiesis, and the induction of inflammatory



Haematology International Journal

responses. These intricate processes create a cycle of anemia perpetuated by recurrent malaria infections, exacerbating the health burden on affected children. A nuanced understanding of these mechanisms is vital for developing effective therapeutic strategies and preventive measures. Integrated approaches to malaria and anemia management emerge as a critical aspect of addressing the dual burden faced by children in malaria-endemic regions. Antimalarial interventions, such as insecticide-treated bed nets and antimalarial drugs, are essential components of comprehensive strategies. Moreover, integrating nutritional and hematologic support is imperative to fortify the resilience of children against the debilitating effects of both malaria and anemia. This review explores these integrated management strategies, emphasizing their potential to mitigate the impact of coexisting health challenges in pediatric populations [16-27].

As advancements continue to shape the landscape of malaria research, a deeper understanding of the interplay between malaria and childhood anemia becomes paramount. By exploring emerging trends and innovative approaches, this review aims to contribute to the ongoing discourse, providing insights into future research directions and fostering the development of more effective public health interventions for improving the well-being of children in malaria-endemic areas.

Epidemiology of Malaria and Childhood Anemia

The epidemiology of malaria and childhood anemia is a complex interplay influenced by geographical, socioeconomic and environmental factors. Malaria, caused by Plasmodium parasites transmitted through the bites of infected mosquitoes, disproportionately affects tropical and subtropical regions. Children, particularly those under the age of five, bear the brunt of the malaria burden, with sub-Saharan Africa carrying the highest prevalence and mortality rates. In malaria-endemic regions, the prevalence of childhood anemia is often closely tied to the intensity of malaria transmission. The most severe form of anemia, known as malarial anemia, is a direct consequence of Plasmodium infection. Repeated infections with the parasite lead to the destruction of red blood cells, compromising the body's ability to maintain adequate hemoglobin levels. Epidemiological studies consistently show a strong correlation between malaria prevalence and the incidence of anemia in pediatric populations [28-31].

The risk factors contributing to the coexistence of malaria and childhood anemia are multifaceted. Socio-economic disparities, limited access to healthcare, and environmental conditions conducive to mosquito breeding contribute to increased malaria transmission [32]. Malnutrition, another prevalent issue in malaria-endemic areas, further exacerbates the vulnerability of children to both diseases. Additionally, genetic factors such as hemoglobinopathies influence an individual's susceptibility to severe anemia in the context of malaria infection. Surveillance and epidemiological studies play a pivotal role in understanding the dynamics of malaria and childhood anemia. Malaria control programs utilize data on parasite prevalence, mosquito vector distribution, and treatment outcomes to tailor interventions to specific regions [33]. Concurrently, monitoring anemia prevalence provides insights into the overall health of pediatric populations, aiding in the development of integrated healthcare strategies. The introduction of control measures, such as insecticidetreated bed nets, indoor residual spraying, and antimalarial drugs, has had a significant impact on reducing malaria transmission and, consequently, the incidence of anemia in some regions. However, challenges persist, including emerging drug resistance and the changing landscape of mosquito vectors.

Mechanisms Underlying Malaria-Induced Anemia

The mechanisms underlying malaria-induced anemia are complex and multifaceted, involving intricate interactions between the Plasmodium parasite and the host's hematological system. Malaria primarily affects red blood cells (RBCs), leading to their destruction, impaired production, and dysregulation of the overall hematopoietic process. Plasmodium parasites invade RBCs during their lifecycle, leading to the destruction of infected cells. This process, known as hemolysis, results in the release of hemoglobin into the bloodstream. The accumulation of free hemoglobin can overwhelm the host's capacity to clear it, contributing to a depletion of hemoglobin levels and the onset of anemia. Malaria disrupts the normal process of erythropoiesis, the production of red blood cells. In response to infection, the release of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF- α) and interferongamma (IFN- γ) interferes with the maturation and survival of RBC precursors. This dysregulation results in insufficient production of new RBCs, exacerbating the decline in hemoglobin levels and contributing to anemia [34-39].

Beyond the destruction of infected RBCs, malaria parasites cause the sequestration of uninfected RBCs in the microvasculature [40]. This mechanical obstruction reduces the circulating pool of functional RBCs, further compromising the oxygen-carrying capacity of the blood. The host's immune response to malaria infection can contribute to anemia. Antigens released during the parasite's life cycle may stimulate the immune system to produce antibodies that recognize and destroy both infected and uninfected RBCs, leading to increased hemolysis. Malaria parasites induce changes in the structure and function of the erythrocyte membrane. These alterations, such as knobs and other surface modifications, contribute to increased adherence of infected RBCs to the endothelium and other uninfected RBCs. This sequestration in various tissues impairs blood flow and exacerbates anemia. Malaria disrupts iron homeostasis in the host, leading to altered distribution and utilization of iron. The diversion of iron from erythropoiesis to the reticuloendothelial system, coupled with increased iron loss due to hemolysis, contributes to iron deficiency and anemia.

Integrated Approaches to Malaria and Anemia Management

Integrated approachestomalaria and an emiamanagement are essential for addressing the coexisting health burden in affected populations. Recognizing the intricate relationship between malaria and anemia, comprehensive strategies that combine preventive, therapeutic, and supportive measures are crucial for improving health outcomes. Distribution and promotion of Insecticide-Treated Bed Nets (ITNs) help reduce malaria transmission by protecting individuals from mosquito bites, particularly during the night when the malaria-transmitting Anopheles mosquitoes are most active. Application of insecticides to indoor surfaces helps control mosquito populations, further reducing the risk of malaria transmission. Administering antimalarial drugs, such as sulfadoxine-pyrimethamine, to pregnant women and infants in malaria-endemic areas can prevent both malaria and its associated complications, including anemia. Ensuring timely diagnosis and treatment of malaria cases with effective antimalarial drugs, such as artemisinin-based combination therapies (ACTs), is crucial for preventing severe disease and subsequent anemia. In areas where both malaria and anemia are prevalent, careful consideration is given to iron supplementation. Coordinated efforts ensure that iron supplementation is provided alongside effective antimalarial interventions to mitigate potential adverse effects on malaria outcomes. Adequate provision of essential micronutrients, including vitamin A, folic acid, and vitamin B12, is crucial for supporting overall health and mitigating the impact of anemia [41-43].

Engaging communities in vector control efforts, such as environmental management and community-driven campaigns, helps reduce mosquito breeding sites and limit malaria transmission [44]. Raising awareness about the link between malaria and anemia fosters a better understanding within communities, encouraging individuals to seek prompt medical care, adhere to preventive measures, and participate in health promotion activities. Coordinating maternal and child health services with malaria and anemia management

Haematology International Journal

programs ensures a continuum of care. This integration is particularly critical during antenatal and postnatal care, where interventions can benefit both maternal and child health. Implementing robust surveillance systems allows for continuous monitoring of malaria and anemia prevalence, treatment outcomes, and the effectiveness of integrated interventions. Regular assessments guide program adjustments and improvements.

Conclusion

The intricate relationship between malaria and childhood anemia underscores the urgent need for integrated approaches to comprehensive healthcare. The coexistence of these health challenges in pediatric populations, particularly in malaria-endemic regions, demands multifaceted strategies that address both the infectious and hematological aspects of the diseases. The cornerstone of integrated strategies involves robust antimalarial interventions. Insecticide-treated bed nets, indoor residual spraying, and timely administration of effective antimalarial drugs play pivotal roles in reducing malaria transmission and, subsequently, the incidence of anemia in vulnerable populations. Targeting the mosquito vectors responsible for malaria transmission is crucial. Ongoing efforts to control vector populations, coupled with the development of innovative technologies, contribute to reducing the prevalence of malaria and breaking the cycle of infection-induced anemia.

Malnutrition is often intertwined with both malaria and anemia. Integrated approaches incorporate nutritional support to enhance the overall health of pediatric populations. Ensuring access to a balanced diet and essential micronutrients contributes to the resilience of children, improving their ability to combat both diseases. Strengthening healthcare infrastructure to provide early diagnosis and prompt treatment of malaria is paramount. Additionally, enhancing hematologic support, including iron supplementation and other erythropoiesis-stimulating interventions, is crucial for managing anemia and preventing its recurrence.

References

- Dhiman S, Veer V, Dev V (2018) Declining Transmission of Malaria in India: Accelerating towards Elimination. In: Manguin S, et al. (Eds.), Towards Malaria Elimination-A Leap Forward, IntechOpen, London, UK.
- malERA Refresh Consultative Panel on Tools for Malaria Elimination (2017) malERA: An Updated Research Agenda for Diagnostics, Drugs, Vaccines, and Vector Control in Malaria Elimination and Eradication. PLoS Med 14(11): e1002455.

- Cui L, Brashear A, Menezes L, Adams J (2021) Elimination of Plasmodium Vivax Malaria: Problems and Solutions. In: Rodriguez-Morales AJ (Ed.), Current Topics and Emerging Issues in Malaria Elimination, Intech Open, London, UK. 2021: 159-185.
- Sattabongkot J, Cui L, Bantuchai S, Chotirat S, Kaewkungwal J, et al. (2022) Malaria Research for Tailored Control and Elimination Strategies in the Greater Mekong Subregion. Am J Trop Med Hyg 107(4 Suppl): 152-159.
- 5. Obeagu EI, Obeagu GU, Chukwueze CM, Ikpenwa JN, Ramos GF (2022) Evaluation of Protein C, Protein S and Fibrinogen of Pregnant Women with Malaria in Owerri Metropolis. Madonna University Journal of Medicine and Health Sciences 2(2): 1-9.
- Obeagu EI, Ibeh NC, Nwobodo HA, Ochei KC, Iwegbulam CP (2017) Haematological Indices of Malaria Patients Coinfected with HIV in Umuahia. Int J Curr Res Med Sci 3(5): 100-104.
- Opeyemi AA, Obeagu EI (2023) Regulations of Malaria in Children with Human Immunodeficiency Virus Infection: A Review. Medicine 102(46): e36166.
- 8. Obeagu EI, Chijioke UO, Ekelozie IS (2018) Malaria Rapid Diagnostic Test (RDTs). Ann Clin Lab Res 6(4): 275.
- 9. Obeagu EI, Alum EU, Ugwu OP (2023) Hepcidin: The Gatekeeper of Iron in Malaria Resistance. Newport International Journal of Research in Medical Sciences 4(2): 1-8.
- Ogomaka IA, Obeagu EI (2019) Methods of Breast Feeding as Determinants of Malaria Infections among Babies in IMO State, Nigeria. International Journal of Medical Science and Dental Research 2(1): 17-24.
- 11. Obeagu EI, Obeagu GU, Egba SI, Emeka-Obi OR (2023) Combatting Anemia in Pediatric Malaria: Effective Management Strategies. Int J Curr Res Med Sci 9(11): 1-7.
- Hassan AO, Oso OV, Obeagu EI, Adeyemo AT (2022) Malaria Vaccine: Prospects and Challenges. Madonna University Journal of Medicine and Health Sciences 2(2): 22-40.
- Obeagu EI, Ogbonna US, Nwachukwu AC, Ochiabuto O, Enweani IB, et al. (2021) Prevalence of Malaria with Anaemia and HIV Status in Women of Reproductive Age in Onitsha, Nigeria. Journal of Pharmaceutical Research International 33(4): 10-19.
- 14. Obeagu EI, Busari AI, Uduchi IO, Ogomaka IA, Ibekwe

Haematology International Journal

AM, et al. (2021) Age-Related Haematological Variations in Patients with Asymptomatic Malaria in Akure, Ondo State, Nigeria. Journal of Pharmaceutical Research International 33(42B): 218-224.

- Ogomaka IA, Obeagu EI (2021) Malaria in Pregnancy Amidst Possession of Insecticide Treated Bed Nets (ITNs) in Orlu LGA of Imo State, Nigeria. Journal of Pharmaceutical Research International 33(41B): 380-386.
- Balaji SN, Deshmukh R, Trivedi V (2020) Severe Malaria: Biology, Clinical Manifestation, Pathogenesis and Consequences. J Vector Borne Dis 57(1): 1-13.
- 17. Canny SP, Orozco SL, Thulin NK, Hamerman JA (2023) Immune Mechanisms in Inflammatory Anemia. Annual Review of Immunology 41: 405-429.
- Prabhu SR, Ware AP, Saadi AV (2021) Erythrocyte miRNA Regulators and Malarial Pathophysiology. Infect Genet Evol 93: 105000.
- Ogbonna CO, Obeagu EI, Ufelle SA, Ogbonna LN (2021) Evaluation of Haematological Alterations in Children Infected by Plasmodium Falciparum Species in Enugu, Enugu State, Nigeria. Journal of Pharmaceutical Research International 33(2): 38-45.
- Okorie HM, Obeagu EI, Obarezi HC, Anyiam AF (2019) Assessment of Some Inflammatory Cytokines in Malaria Infected Pregnant Women in Imo State Nigeria. International Journal of Medical Science and Dental Research 2(1): 25-36.
- 21. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA (2018) Assessment of Some Haematological Parameters in Malaria Infected Pregnant Women in Imo State Nigeria. Int J Curr Res Biol Med 3(9): 1-14.
- Nwosu DC, Obeagu EI, Ezenwuba C, Agu GC, Amah H, et al. (2016) Antioxidant Status of Children with Plasmodium Falciparum Malaria in Owerri Municipal Council of Imo State. Int J Curr Res Chem Pharm Sci 3(8): 40-46.
- 23. Okamgba OC, Nwosu DC, Nwobodo EI, Agu GC, Ozims SJ, et al. (2017) Iron Status of Pregnant and Post-Partum Women with Malaria Parasitaemia in Aba Abia State, Nigeria. Annals of Clinical and Laboratory Research 5(4): 206.
- 24. Anyiam AF, Arinze-Anyiam OC, Omosigho PO, Ibrahim M, Irondi EA, et al. (2022) 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

Haematology International Journal

Research Journal 6(3): 9-17.

- 25. Obeagu EI, Nimo OM, Bunu UO, Ugwu OP, Alum EU (2023) Anaemia in Children Under Five Years: African Perspectives. Int J Curr Res Biol Med 8(1): 1-7.
- 26. Madekwe CC, Madekwe CC, Obeagu EI (2022) Inequality of Monitoring in Human Immunodeficiency Virus, Tuberculosis and Malaria: A Review. Madonna University Journal of Medicine and Health Sciences 2(3): 6-15.
- Offie DC, Ibekwe AM, Agu CC, Esimai BN, Okpala PU, et al. (2021) Fibrinogen and C-Reactive Protein Significance in Children Infected by Plasmodium falciparum Species in Enugu, Enugu State, Nigeria. Journal of Pharmaceutical Research International 33(15): 1-8.
- Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA (2018) Assessment of Coagulation Parameters in Malaria Infected Pregnant Women in Imo State, Nigeria. Int J Curr Res Med Sci 4(9): 41-49.
- 29. Ogbonna LN, Ezeoru VC, Ofodile AC, Ochiabuto OM, Obi-Ezeani CN, et al. (2021) Gender Based Variations of Haematological Parameters of Patients with Asymptomatic Malaria in Akure, Ondo State, Nigeria. Journal of Pharmaceutical Research International 33(8): 75-80.
- Eberendu IF, Ozims SJ, Agu GC, Amah HC, Obasi CC, et al. (2017) Impact of Human Activities on the Breeding of Mosquitoes of Human Disease in Owerri Metropolis, Imo State. Int J Adv Res Biol Sci 4(12): 98-106.
- 31. Obeagu EI, Ofodile AC, Okwuanaso CB (2023) 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 6(1): 136.
- 32. Yadav K, Dhiman S, Rabha B, Saikia PK, Veer V (2014) Socio-Economic Determinants for Malaria Transmission Risk in An Endemic Primary Health Centre in Assam, India. Infect Dis Poverty 3: 19.
- 33. Sherrard-Smith E, Ngufor C, Sanou A, Guelbeogo MW, N'Guessan R, et al. (2022) Inferring the Epidemiological Benefit of Indoor Vector Control Interventions Against Malaria from Mosquito Data. Nat Commun 13(1): 3862.
- 34. Perkins DJ, Were T, Davenport GC, Kempaiah P, Hittner JB,

et al. (2011) Severe Malarial Anemia: Innate Immunity and Pathogenesis. Int J Biol Sci 7(9): 1427-1442.

- 35. Obeagu EI, Opoku D, Obeagu GU (2023) Burden of Nutritional Anaemia in Africa: A Review. Int J Adv Res Biol Sci 10(2): 160-163.
- 36. Obeagu EI, Babar Q, Obeagu GU (2021) Megaloblastic Anaemia A Review. Int J Curr Res Med Sci 7(5): 17-24.
- Obeagu EI, Obeagu GU, Ukibe NR, Oyebadejo SA (2024) Anemia, Iron, and HIV: Decoding the Interconnected Pathways: A Review. Medicine 103(2): e36937.
- Obeagu EI, Obeagu GU (2024) Malaria's Silent Partner: Anemia in Children. Elite Journal of Public Health 2(1): 1-7.
- Obeagu EI, Mohamod AH (2023) An Update on Iron Deficiency Anaemia among Children with Congenital Heart Disease. Int J Curr Res Chem Pharm Sci 10(4): 45-48.
- 40. Moxon CA, Grau GE, Craig AG (2011) Malaria: Modification of the Red Blood Cell and Consequences in the Human Host. Br J Haematol 154(6): 670-679.
- 41. Obeagu EI, Ogunnaya FU, Obeagu GU (2024) Integrated Approaches for Improving Pediatric Health: Addressing Anemia in Malaria Cases. International Journal of Innovative and Applied Research 12(1): 27-34.
- 42. Obeagu EI, Obeagu GU (2024) Overcoming Hurdles: Anemia Management in Malaria-Affected Childhood. Elite Journal of Laboratory Medicine 2(1): 59-69.
- 43. Raiten DJ, Neufeld LM, De-Regil LM, Pasricha SR, Darnton-Hill I, et al. (2016) Integration to Implementation and the Micronutrient Forum: A Coordinated Approach for Global Nutrition. Case Study Application: Safety and Effectiveness of Iron Interventions. Adv Nutr 7(1): 135-148.
- 44. McCann RS, Kabaghe AN, Moraga P, Gowelo S, Mburu MM, et al. (2021) The Effect of Community-Driven Larval Source Management and House Improvement on Malaria Transmission when added to the Standard Malaria Control Strategies in Malawi: A Cluster-Randomized Controlled Trial. Malaria Journal 20(1): 232.