



RESEARCH ARTICLE

IMPROVING MALARIA PREVENTION IN IMMUNOCOMPROMISED GROUPS: A PUBLIC HEALTH IMPERATIVE IN AFRICA

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Abstract

Malaria continues to be a significant public health issue in Africa, disproportionately impacting at risk populations, particularly those with weakened immune systems like people living with HIV/AIDS, malnourished children, and individuals receiving immunosuppressive treatments. These groups have a higher susceptibility to malaria infections, suffer from more severe disease symptoms, and encounter worse treatment results due to weakened immune systems. Even with major progress in malaria management, current prevention methods frequently fail to meet the specific requirements of individuals with weakened immune systems. This examination investigates the pathophysiological relationship between malaria and immunosuppression, emphasizing how immune deficiencies increase vulnerability and severity of malaria infections. Existing malaria prevention strategies such as vector management, chemoprophylactic treatments, and health education are evaluated concerning their relevance and constraints in immunocompromised groups. Significant obstacles like fragmentation of health systems, socioeconomic limitations, and the rise of resistance to insecticides and medications are recognized as major issues that weaken prevention initiatives. To lessen the unequal malaria impact on immunocompromised populations, the review recommends integrated healthcare services, focused vector management, broadened preventive measures, and increased community involvement. Enhancing research and monitoring will guide customized, evidence backed policies. In the end, a thorough and cooperative public health strategy is crucial to protect the health of Africa's most at risk populations and enhance efforts toward eliminating malaria.

Keywords: HIV/AIDS, immunocompromised populations, malaria prevention, public health interventions, vector control strategies.

INTRODUCTION

Malaria remains one of the most serious infectious diseases worldwide, with sub-Saharan Africa responsible for the large majority of cases and fatalities. Although significant advancements have been made in lowering malaria cases and deaths in the last twenty years, the illness continues to be a serious public health concern^{1,2}. In 2023, more than 200 million cases and around 400,000 fatalities were reported, with young children and pregnant women being particularly impacted. Among these at risk groups, immunocompromised individuals such as those with HIV/AIDS, undernourished children, and those undergoing immunosuppressive treatments are at an even higher risk of malaria infection and its serious complications. Their weakened immune systems not

only heighten vulnerability to malaria but also hinder disease management and results³⁻⁵. The relationship between malaria and immunosuppression is complex and reciprocal. In individuals with HIV/AIDS, malaria infection can speed up the progression of HIV by stimulating immune activation and enhancing viral replication. On the other hand, immunosuppression due to HIV weakens the body's capacity to generate a potent immune response against Plasmodium parasites, resulting in elevated parasite levels, more common infections, and greater disease severity. Likewise, malnutrition a widespread issue in various regions of Africa weakens immune responses, making children more susceptible to malaria and delaying their recovery. In addition, individuals receiving chemotherapy or other immunosuppressive therapies also face

an increased risk of malaria due to reduced immune surveillance^{6,7}.

Malaria prevention methods in Africa have mainly targeted the overall population, placing considerable focus on vulnerable groups like pregnant women and young children. Key measures such as insecticide treated nets (ITNs), indoor residual spraying (IRS), intermittent preventive treatment (IPT), and timely case management have helped decrease malaria rates. Nevertheless, these interventions frequently do not adequately meet the specific needs of immunocompromised groups, whose risk factors, clinical manifestations, and reactions to preventive strategies can vary significantly from those of the broader population. This disparity highlights the necessity for customized approaches that consider the immunological and socioeconomic difficulties encountered by these populations⁸⁻¹⁰. Vector control continues to be the foundation of malaria prevention in Africa. ITNs and IRS have been extensively implemented, significantly decreasing malaria transmission in areas with sufficient coverage. However, the consistent and proper use of ITNs can be reduced among immunocompromised individuals because of issues like discomfort, family dynamics, or lack of awareness. Moreover, the resistance of mosquitoes to insecticides represents an increasing danger to the efficiency of these measures. Chemoprophylaxis, encompassing IPT and cotrimoxazole for individuals with HIV, provides extra protection; however, it is not universally available or consistently implemented among all immunocompromised groups^{11,12}.

Limitations within the health system further hinder the effectiveness of malaria prevention strategies in immunocompromised groups. Disjointed services frequently lead to overlooked chances for cohesive care, whereas a lack of diagnostic tools, antimalarial medications, and skilled healthcare personnel hampers prompt diagnosis and treatment. Socioeconomic obstacles, such as poverty, stigma, and inadequate health literacy, additionally impede the acceptance and consistency of interventions. These issues highlight the necessity for strong public health strategies that encourage comprehensive, patient focused care designed to meet the specific requirements of immuno-compromised patients^{12,13}. To enhance malaria prevention in immunocompromised populations, it is essential to increase knowledge of the pathophysiological relationships between malaria and immune impairment, evaluate the efficacy of current preventive strategies, and pinpoint deficiencies in existing practices. Enhancing surveillance systems and prioritizing research on these populations will guide evidence-based policies and program adjustments. Moreover, involving communities and caregivers through focused educational and empowerment programs can improve acceptance and ongoing utilization of prevention resources.

This narrative review aims to critically examine the challenges and current strategies for malaria prevention in immunocompromised populations in Africa, highlighting the pathophysiological basis of increased vulnerability, evaluating existing interventions, and

providing evidence based recommendations to enhance public health outcomes.

METHODS

This narrative review was conducted to synthesize and critically appraise existing evidence on malaria prevention among immunocompromised populations in Africa. A comprehensive, non-systematic literature search was undertaken using major biomedical databases, including PubMed, Scopus, Web of Science, and Google Scholar. The search strategy combined keywords and Medical Subject Headings related to malaria (e.g., malaria, *Plasmodium falciparum*), immunocompromised states (e.g., HIV/AIDS, pregnancy, malnutrition, immunosuppression, hematologic disorders), and prevention strategies (e.g., vector control, chemoprevention, vaccination, public health interventions), with a specific focus on African settings.

Peer reviewed original research articles, reviews, policy documents, and reports published in English were considered. Priority was given to studies conducted in sub-Saharan Africa or those with clear relevance to African epidemiology and health systems. Both clinical and population level studies were included to capture biological, epidemiological, and programmatic perspectives. No strict date limits were imposed; however, recent literature was emphasized to reflect contemporary challenges such as antimalarial drug resistance, insecticide resistance, and emerging prevention tools. Study selection was guided by relevance to immunocompromised populations and malaria prevention rather than formal quality scoring, consistent with the narrative review methodology. Evidence was thematically synthesized across key domains, including vulnerable population groups, limitations of existing prevention strategies, and emerging or enhanced interventions. Findings were interpreted within a public health framework that accounts for health system capacity, social determinants of health, and policy implications in Africa. This narrative approach was chosen to allow integration of diverse evidence sources and to provide a contextualized, policy relevant overview aimed at informing researchers, clinicians, and public health decision makers.

Pathophysiology and increased vulnerability in immunocompromised populations

Malaria begins when female *Anopheles* mosquitoes introduce *Plasmodium* sporozoites into the bloodstream while feeding on blood. These sporozoites quickly move to the liver, where they penetrate hepatocytes and undergo asexual multiplication, ultimately releasing thousands of merozoites into the circulation. The infection's blood stage, marked by the repetitive attack and damage of red blood cells (RBCs), accounts for the clinical symptoms of malaria. An effective immune response is crucial for managing parasite proliferation and minimizing disease intensity. In immunocompromised individuals, immune defenses are weakened, resulting in heightened parasite load and severe illness^{14,15}. In individuals with HIV/AIDS, the

loss of CD4⁺ T cells a vital part of adaptive immunity greatly hinders the capacity to manage Plasmodium infection. CD4⁺ T cells coordinate immune responses by stimulating macrophages, aiding B cell antibody synthesis, and enhancing cytotoxic T cell function. Their absence leads to impaired elimination of parasites, increased parasitemia, and extended infection duration. In addition, chronic immune activation caused by HIV worsens systemic inflammation, heightening the likelihood of complications like severe anemia and cerebral malaria. Clinical research has shown that individuals with HIV have a two- to threefold increased risk of experiencing clinical malaria and present more severe symptoms than those without HIV^{16,17}.

Malnutrition, especially protein energy malnutrition and deficiencies in micronutrients, weakens the host's immune response to malaria. Nutritional deficiencies hinder the generation and function of immune cells, decrease antibody responses, and modify cytokine profiles essential for efficient parasite elimination. Malnourished children exhibit reduced splenic activity and compromised phagocytosis, leading to elevated parasitemia and greater vulnerability to serious malaria issues, such as severe anemia and metabolic acidosis. The relationship between malnutrition and malaria forms a harmful cycle, with repeated malaria infections deteriorating nutritional status and continuing to promote immunosuppression¹⁸⁻²⁰. These treatments interfere with both innate and adaptive immune processes, affecting neutrophil activity, macrophage

function, and lymphocyte growth. As a result, these patients have reduced resistance to initial infections and impaired parasite elimination, making them more susceptible to severe and repeated malaria episodes. Additionally, immunosuppression may modify standard clinical manifestations, making diagnosis and prompt treatment more difficult^{21,22}.

The compromised immune reactions in immunocompromised individuals also influence the formation of naturally acquired immunity to malaria, which usually arises after multiple exposures in endemic regions. This immunity, facilitated by antibodies and memory T cells, decreases the occurrence and intensity of malaria episodes as time progresses. Nevertheless, individuals with compromised immune systems frequently struggle to establish or sustain effective immunity, leading to ongoing susceptibility during childhood and adulthood.

This absence of immunity requires increased and ongoing preventive actions to safeguard these groups^{23,24}. Additionally, malaria can worsen immunosuppression by provoking immune dysregulation. The parasite's capacity to avoid immune detection, adjust cytokine responses, and stimulate regulatory T cells leads to immune exhaustion. In individuals infected with HIV, episodes of malaria induce immune activation that enhances viral replication and speeds up disease advancement. This two-way relationship emphasizes the importance of combined management strategies that tackle both infections at the same time (Table 1)^{25,26}.

Table 1: Pathophysiology and increased vulnerability in immunocompromised populations.

Immunocompromised Group	Pathophysiological Mechanisms	Increased Vulnerability to Malaria
People living with HIV/AIDS	Depletion of CD4 ⁺ T cells, impaired antibody production, chronic immune activation	Higher parasite density, increased risk of severe disease, treatment failure, increased mortality
Pregnant women	Altered immune tolerance, hormonal modulation, placental sequestration of parasites	Maternal anemia, low birth weight, preterm delivery, severe malaria
Malnourished children	Impaired innate and adaptive immunity, micronutrient deficiencies	Frequent and severe malaria episodes, delayed recovery, higher mortality
Sickle cell disease / Hematologic disorders	Abnormal erythrocyte function, hemolysis, chronic inflammation	Increased susceptibility to complications, anemia, and severe malaria outcomes
Transplant recipients / Immunosuppressive therapy	Pharmacologic immune suppression, reduced cellular and humoral immunity	Atypical malaria presentations, higher risk of severe infection, drug interactions
Chronic diseases (CKD, diabetes, cancer)	Immune dysregulation, chronic inflammation, reduced pathogen clearance	Greater severity, prolonged infection, poor response to standard prevention

Current malaria prevention strategies in immunocompromised groups

Preventing malaria in immunocompromised groups in Africa necessitates a comprehensive strategy that combines vector management, chemoprophylaxis, and enhancements to health systems to lower infection rates and better clinical results. Existing strategies rely on general malaria control methods but need to be modified to address the unique requirements of immunocompromised persons, whose susceptibility and treatment reactions differ from those of the general populace^{27,28}. Vector control remains fundamental to malaria prevention and mainly consists of using insecticide treated nets (ITNs) and indoor residual

spraying (IRS). ITNs are extensively provided in numerous African nations via mass campaigns and regular health services, and their utilization has been proven to greatly decrease malaria morbidity and mortality. Nonetheless, consistent and proper use among immunocompromised people is occasionally inadequate because of issues like discomfort, perceived low risk, or socio-economic obstacles. IRS, which entails the application of long lasting insecticides on indoor walls and ceilings, supplements ITNs by focusing on mosquitoes that rest indoors. Although IRS coverage differs by area, it continues to be an essential instrument in areas with high transmission rates,

especially where insecticide resistance is carefully tracked and controlled^{29,30}.

Chemoprophylaxis is another important approach designed specifically for immunocompromised populations. For individuals with HIV/AIDS, daily cotrimoxazole prophylaxis is commonly advised and has shown effectiveness in lowering malaria occurrence by as much as 50%. Cotrimoxazole offers antibacterial and antimalarial properties and is frequently included in standard HIV treatment. Furthermore, intermittent preventive treatment (IPT), which consists of providing complete therapeutic doses of antimalarial medications at set intervals regardless of infection status, has been effectively utilized in pregnant women (IPTp) and in infants (IPTi). Extending IPT to additional immunocompromised populations, including children with HIV or individuals receiving immunosuppressive treatments, is currently a focus of research and policy discussions^{31,32}. Timely diagnosis and efficient case management continue to be essential elements of malaria control in immunocompromised groups. Rapid diagnostic tests (RDTs) and microscopy facilitate prompt identification of infection, allowing for early intervention to avert serious illness. Therapeutic protocols should consider drug-drug interactions, particularly in individuals receiving antiretroviral therapy (ART) or immunosuppressive drugs, to prevent negative outcomes and ensure effectiveness. Artemisinin based combination therapies (ACTs) are now the primary treatment for uncomplicated malaria in numerous African nations and have shown effectiveness even in patients with compromised immunity³³⁻³⁵. Health education and community involvement are crucial for improving the adoption and long term use of preventive measures among those with weakened immune systems. Customized communication that tackles particular issues and cultural values can enhance adherence to ITN usage, chemoprophylaxis, and prompt healthcare seeking behavior. Engaging caregivers, support networks, and community health personnel creates encouraging settings that bolster preventive practices^{36,37}.

Challenges and barriers to effective malaria prevention

Although notable advancements in malaria control have been made throughout Africa, various challenges and obstacles impede the successful prevention of malaria in immunocompromised groups. These challenges encompass biological, socioeconomic, healthcare, and environmental areas, hindering attempts to safeguard these at-risk populations and highlighting the necessity for thorough, context-relevant interventions^{38,39}. A major biological challenge is the increasing resistance of *Anopheles* mosquitoes to widely utilized insecticides. Resistance to pyrethroids the primary category of insecticides employed in insecticide treated nets (ITNs) and indoor residual spraying (IRS) has been extensively recorded throughout Africa, diminishing the effectiveness of vector control strategies. This resistance undermines the effectiveness of ITNs and IRS in stopping mosquito bites, consequently raising the risk of malaria

transmission, especially in heavily affected areas. Moreover, *Plasmodium* parasites have gained resistance to various antimalarial medications, such as sulfadoxine-pyrimethamine utilized in intermittent preventive treatment (IPT), which restricts preventive choices for immunocompromised individuals⁴⁰.

Socioeconomic elements also create considerable obstacles to malaria prevention in those with weakened immune systems. Poverty limits the availability of preventive resources like ITNs and chemoprophylactic drugs, particularly for underserved communities. Limited literacy rates and insufficient health education hinder comprehension of malaria transmission and the significance of regular preventive measures. The stigma linked to immunocompromising conditions such as HIV/AIDS may deter those affected from seeking treatment or revealing their health status, leading to lost chances for specific prevention and treatment strategies^{41,42}. Limitations within the health system pose another significant obstacle. In numerous African nations, fragmented and poorly funded healthcare systems hinder the provision of integrated services that merge malaria prevention with treatment for immunocompromised conditions. Disruptions in the supply chain result in shortages of critical items like ITNs, antimalarial medications, and diagnostic tests, hindering continuous intervention coverage. Moreover, inadequate training and heavy workloads of healthcare professionals diminish the quality of counseling and follow-up care, especially for intricate cases that need personalized management⁴³⁻⁴⁵.

Diagnostic difficulties add to the complexity of malaria prevention and treatment in immunocompromised patients. Unusual clinical manifestations and co-infections can hinder malaria diagnosis, postponing timely treatment and heightening the risk of complications. While rapid diagnostic tests (RDTs) have enhanced malaria detection, their sensitivity might be diminished in individuals with low parasite densities or in those undergoing prophylaxis. Many settings lack advanced diagnostic tools, which restricts precise identification and monitoring of malaria infections, particularly in immunocompromised individuals with complicated clinical presentations^{46,47}. Factors related to the environment and behavior also impact efforts to prevent malaria. Seasonal shifts in mosquito populations and human movement influence exposure risk and the effectiveness of interventions. Cultural customs, sleeping habits, and family dynamics can affect ITN usage, as misunderstandings about malaria and its prevention continue in certain communities. These elements require health promotion initiatives that are culturally aware and community involvement to encourage acceptance and compliance with preventive strategies⁴⁸⁻⁵⁰. The convergence of various vulnerabilities like HIV infection, malnutrition, and poverty leads to increased risks that standard prevention methods might not sufficiently tackle. The interdependent link between malaria and immunosuppression adds complexity to clinical management and prevention strategies. In the absence of coordinated, multisectoral strategies that tackle these interconnected challenges, immunocompromised

groups will persist in experiencing a disproportionate share of malaria related illness and death⁵⁰.

Tackling the unequal impact of malaria on immunocompromised groups in Africa requires a holistic and customized strategy that combines biomedical, social, and systemic measures. To improve malaria prevention and health results in these at risk populations, the following suggestions are made. Initially, it is crucial to enhance vector control strategies. The creation and use of advanced insecticide treated nets that include various insecticides or synergists can reduce the effects of insecticide resistance. Increasing the reach of indoor residual spraying (IRS) with alternating insecticides and incorporating new methods like spatial repellents and larval source management may further diminish mosquito numbers. Facilitating fair access to these interventions via complimentary or subsidized distribution aimed at immunocompromised individuals will improve protection.

Secondly, it is crucial to optimize chemoprophylaxis protocols specifically designed for immunocompromised populations. For individuals with HIV/AIDS, ensuring the continuation of extensive cotrimoxazole prophylaxis and assessing the possibilities of alternative or supplementary antimalarial prophylactics should be emphasized. There is an urgent need for research on safe and effective intermittent preventive treatment (IPT) protocols for other immunocompromised groups, including malnourished children or individuals receiving immunosuppressive therapies. Policymakers need to revise guidelines to align with new evidence and guarantee adherence to implementation. Enhancing diagnostic capabilities and case management is essential. Increasing the access to sensitive, point-of-care diagnostic tools that can identify low-level parasitemia and mixed infections will enhance early detection, particularly in immunocompromised patients showing unusual symptoms. Educating healthcare providers on malaria management in immuno-suppressed patients, covering drug interactions and possible complications, will improve clinical results.

Fourth, integrating malaria prevention into existing health programs, particularly HIV care and nutrition services, will create synergistic benefits. Co-locating malaria interventions with antiretroviral therapy (ART) clinics and malnutrition programs ensures consistent access and monitoring. Health information systems should incorporate data on immunocompromised populations to enable targeted surveillance and resource allocation. Fifth, addressing socio-economic and behavioral determinants of malaria prevention is crucial. Community based health education campaigns tailored to cultural contexts and literacy levels can improve understanding of malaria risks and the importance of preventive measures. Engaging community leaders, caregivers, and support groups will foster trust and adherence. Additionally, efforts to reduce stigma associated with immunocompromising conditions will encourage timely healthcare seeking and sustained intervention uptake. Lastly, investing in health system strengthening and research is

fundamental. Governments and partners should bolster supply chain management to prevent stockouts of preventive commodities and medicines. Expanding training programs for healthcare providers and increasing funding for malaria research focused on immunocompromised populations will accelerate innovation. Collaborative partnerships across sectors and countries can facilitate knowledge sharing and the implementation of best practices.

CONCLUSIONS

Malaria continues to be a significant public health issue in Africa, especially among vulnerable populations with weakened immune systems who are more likely to contract infections and experience severe illness. The intricate pathophysiology behind their increased susceptibility caused by weakened immune responses and additional issues like HIV/AIDS and malnutrition requires customized prevention approaches distinct from those applied to the general population. Existing measures, such as vector management, chemoprophylaxis, and swift diagnosis, have helped decrease the malaria burden; however, issues like insecticide and drug resistance, constraints within health systems, and socio-economic obstacles persist in hindering their complete effectiveness. Tackling these obstacles necessitates a thorough, cohesive strategy that enhances current prevention methods while developing new approaches tailored to the specific requirements of immunocompromised individuals. Incorporating malaria prevention into standard care for immunosuppressive conditions, fostering community involvement to boost adherence, and providing focused health education are essential elements of this strategy. Additionally, investing in health system capabilities and continuous research to improve prevention, diagnostics, and treatment strategies will be essential for enhancing malaria control among populations.

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AUTHOR'S CONTRIBUTION

Obeagu EI: conceived the idea, writing the manuscript, critical review. **Kenedy K:** literature survey, formal analysis, data processing. Final manuscript was checked and approved by both authors.

DATA AVAILABILITY

The empirical data used to support the study's conclusions are available upon request from the corresponding author.

CONFLICT OF INTEREST

Regarding this project, there are no conflicts of interest.

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