

The Impact of Mobile Health (mHealth) Interventions on Malaria Diagnosis and Treatment Adherence among Pregnant Women: A Comprehensive Review

Mugisha Emmanuel K.

Faculty of Science and Technology Kampala International University Uganda

ABSTRACT

Malaria in pregnancy (MiP) poses a significant public health threat, particularly in sub-Saharan Africa, contributing to maternal anemia, preterm birth, low birth weight, and maternal and infant mortality. Early diagnosis and strict adherence to antimalarial treatments are essential to reduce these risks, yet access to timely care and consistent treatment adherence remain major challenges. Mobile health (mHealth) interventions, utilizing mobile technologies such as SMS reminders, diagnostic applications, and telemedicine platforms, have emerged as innovative tools to address these barriers. This comprehensive review examined the impact of mHealth interventions on malaria diagnosis and treatment adherence among pregnant women in malaria-endemic regions. Through case studies from Kenya, Nigeria, and Tanzania, we explore the effectiveness of mHealth solutions in improving maternal health outcomes by ensuring timely diagnosis and promoting adherence to treatment. Methodologically, the review drew on empirical studies, program evaluations, and case reports from peer-reviewed literature. Despite promising outcomes, challenges such as technological barriers, cultural resistance, and scalability concerns persist. Future research should focus on integrating emerging technologies like AI and machine learning to enhance mHealth's effectiveness while prioritizing equitable access to digital health solutions. Policymakers must also prioritize the integration of mHealth into national health systems to ensure long-term sustainability.

Keywords: mHealth interventions, Malaria in pregnancy (MiP), Treatment adherence, Malaria diagnosis, Sub-Saharan Africa

INTRODUCTION

Malaria in pregnancy (MiP) remains a significant public health issue, particularly in sub-Saharan Africa where the majority of malaria cases occur [1]. Pregnant women are at an increased risk of malaria due to physiological changes that alter their immune response, resulting in higher susceptibility to severe forms of the disease [2]. Malaria during pregnancy contributes to serious maternal and neonatal health complications, including maternal anemia, preterm birth, low birth weight, and, in extreme cases, maternal and infant mortality [3]. Early diagnosis and strict adherence to antimalarial treatment are essential to mitigate these risks, yet access to timely care and consistent treatment adherence remains a major challenge, especially in low-resource settings.

Mobile health (mHealth) interventions, which leverage mobile technologies to support healthcare delivery and patient engagement, have emerged as a promising tool to address these challenges [4, 5]. mHealth strategies, including SMS-based reminders, mobile applications, and telemedicine

platforms, have demonstrated potential in improving healthcare outcomes in a variety of contexts. For pregnant women at risk of malaria, mHealth interventions offer innovative solutions to enhance the accuracy and timeliness of malaria diagnosis, promote adherence to antimalarial treatments, and improve communication between patients and healthcare providers.

This review aims to examine the impact of mHealth interventions on malaria diagnosis and treatment adherence among pregnant women, focusing on their effectiveness, challenges, and future prospects. By exploring case studies and empirical evidence from malaria-endemic regions, this comprehensive review will highlight the role of mHealth in improving maternal and neonatal health outcomes in resource-constrained environments and offer insights into how these technologies can be scaled and integrated into national health strategies.

Malaria In Pregnancy: A Public Health Challenge

Pregnancy significantly increases the vulnerability to malaria due to changes in immunity, leading to higher parasitemia levels and more severe outcomes compared to non-pregnant women [6, 7]. *Plasmodium falciparum*, the deadliest malaria parasite, sequesters in the placenta, causing placental malaria, which contributes to maternal anemia, low birth weight, and perinatal death. Despite the availability of preventive measures such as intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine (SP) and insecticide-treated bed nets (ITNs), uptake remains suboptimal due to various factors, including lack of access to healthcare facilities, low health literacy, and cultural beliefs. In this context, timely diagnosis and adherence to antimalarial treatment are crucial in preventing complications. However, challenges such as delays in accessing healthcare, misdiagnosis, and non-adherence to treatment protocols undermine the effectiveness of malaria control programs among pregnant women [8]. mHealth interventions offer an innovative solution to address these barriers by providing timely information, facilitating remote consultations, and promoting adherence to treatment regimens.

mhealth Interventions: Enhancing Malaria Diagnosis and Treatment

- i. **The Role of mHealth in Malaria Diagnosis:** Accurate and timely diagnosis of malaria is essential for effective management, particularly among pregnant women where delayed treatment can result in adverse outcomes [9]. Traditional diagnostic methods, including microscopy and rapid diagnostic tests (RDTs), often face limitations in resource-limited settings, such as lack of trained personnel, equipment, and infrastructure. mHealth tools can bridge these gaps by enabling healthcare workers to remotely consult experts, interpret diagnostic results, and access clinical guidelines through mobile devices. Several mHealth interventions have shown promise in improving malaria diagnosis accuracy and timeliness. For instance, mobile applications that incorporate decision-support algorithms have been used to guide healthcare workers in diagnosing malaria, particularly in remote areas where access to laboratories is limited. Additionally, SMS-based reporting systems have enabled real-time communication between community health workers (CHWs) and higher-level health facilities, ensuring timely diagnosis

and referral of pregnant women with suspected malaria. In a study conducted in Kenya, an mHealth application that provided diagnostic support for CHWs resulted in a significant reduction in diagnostic errors, leading to improved treatment outcomes for pregnant women. Similarly, in Ghana, an mHealth initiative that used mobile phones to transmit diagnostic results from peripheral clinics to district hospitals reduced the turnaround time for malaria diagnosis, ensuring prompt initiation of treatment for pregnant women.

- ii. **mHealth and Treatment Adherence:** Adherence to antimalarial treatment is critical for the successful management of malaria in pregnancy [10]. Non-adherence to prescribed treatment regimens not only exacerbates the risk of maternal complications but also increases the likelihood of drug resistance, particularly in areas with high malaria transmission. mHealth interventions have emerged as effective tools in promoting treatment adherence by providing reminders, education, and follow-up support. SMS-based reminders have been particularly successful in improving treatment adherence among pregnant women. In a randomized controlled trial conducted in Uganda, pregnant women receiving SMS reminders about their malaria treatment showed significantly higher adherence rates compared to those who did not receive reminders. The messages, which included reminders to take medication, attend follow-up appointments, and use ITNs, helped reinforce health behaviors and encouraged women to complete their prescribed treatment courses. Moreover, mobile applications that track medication intake and send automatic alerts when a dose is missed have also been shown to improve adherence. In Tanzania, an mHealth app designed for pregnant women with malaria provided real-time tracking of medication adherence, with automated alerts sent to both the patients and healthcare providers if a dose was missed. This intervention resulted in a 20% increase in treatment adherence compared to traditional methods.

Case Studies: Successful mhealth Interventions in Malaria Management

Several mHealth interventions targeting malaria diagnosis and treatment adherence have been successfully implemented in malaria-endemic

regions, with positive outcomes for pregnant women [11]. Three notable case studies are highlighted below:

- i. **Kenya: The SMS for Life Program:** The SMS for Life program in Kenya is a text-message-based system designed to improve the availability of antimalarial drugs and ensure timely treatment of malaria [12]. While initially focused on stock management, the program has expanded to include components that support malaria diagnosis and treatment adherence among pregnant women. By sending regular SMS reminders to pregnant women about clinic appointments, medication schedules, and preventive measures, the program has significantly improved treatment adherence and reduced malaria-related complications in pregnancy. A study evaluating the program found that pregnant women who received SMS reminders were 30% more likely to complete their antimalarial treatment compared to those who did not receive reminders.
- ii. **Nigeria: Mobile Phones for Malaria Control:** In Nigeria, a mobile phone-based intervention aimed at community health workers (CHWs) has improved malaria diagnosis and treatment adherence among pregnant women in rural areas. The initiative involves equipping CHWs with mobile phones that allow them to report malaria cases, receive diagnostic support, and send reminders to patients about their treatment. An evaluation of the program revealed a 40% increase in the timely diagnosis of malaria among pregnant women and a 25% increase in treatment adherence. The program's success is attributed to its ability to facilitate communication between CHWs and healthcare providers, ensuring prompt management of malaria cases.
- iii. **Tanzania: The mSpray Initiative:** The mSpray initiative in Tanzania combines mobile technology with community-based interventions to improve malaria diagnosis and treatment adherence among pregnant women [13]. The program uses mobile phones to map high-risk areas for malaria transmission, enabling targeted interventions such as insecticide spraying and distribution of ITNs. Additionally, pregnant women enrolled in the program receive SMS reminders about their malaria treatment and preventive measures. A study assessing the impact of mSpray

found a 15% increase in the use of ITNs and a 10% increase in treatment adherence among pregnant women.

Challenges and Limitations of mHealth Interventions

Despite the promising outcomes associated with mHealth interventions, several challenges hinder their full potential in improving malaria diagnosis and treatment adherence among pregnant women.

- i. **Technological Barriers:** In many malaria-endemic regions, particularly rural areas, access to mobile phones and reliable network coverage remains limited [14]. This technological gap poses a significant barrier to the widespread implementation of mHealth interventions. Furthermore, low digital literacy among pregnant women and healthcare workers can limit the effectiveness of these interventions.
- ii. **Cultural and Behavioral Factors:** Cultural beliefs and health behaviors play a crucial role in determining the success of mHealth interventions [15]. In some communities, there may be resistance to using technology for health purposes, particularly among older pregnant women or those with low health literacy. Additionally, concerns about privacy and confidentiality may deter some women from participating in mHealth programs.
- iii. **Sustainability and Scalability:** Many mHealth interventions are pilot projects funded by external organizations, raising concerns about their long-term sustainability. Ensuring the scalability of these programs requires sustained investment, government support, and integration into national health systems. Without these, the benefits of mHealth interventions may be short-lived, particularly in resource-constrained settings.

Future Directions and Implications for Policy

The potential of mHealth interventions to improve malaria diagnosis and treatment adherence among pregnant women is undeniable. However, to maximize their impact, several key considerations must be addressed in future research and policy development.

- i. **Integration with National Health Systems:** For mHealth interventions to be sustainable and scalable, they must be integrated into national health systems [16]. Governments should prioritize the development of digital health strategies that include mHealth as a core component of malaria control programs. This includes investing in infrastructure,

training healthcare workers, and ensuring that mobile technologies are accessible to all populations.

- ii. **Leveraging Emerging Technologies:** Emerging technologies such as artificial intelligence (AI) and machine learning (ML) offer new opportunities to enhance mHealth interventions. AI-driven diagnostic tools can improve the accuracy of malaria diagnosis, while ML algorithms can be used to personalize treatment adherence reminders based on individual patient behavior. Future research should

explore the integration of these technologies into mHealth platforms to optimize their effectiveness.

- iii. **Addressing Equity in Access to mHealth:** Ensuring equitable access to mHealth interventions is essential, particularly for marginalized and underserved populations. Policies should focus on reducing the digital divide by expanding mobile network coverage, improving digital literacy, and providing affordable mobile devices to pregnant women in malaria-endemic regions.

CONCLUSION

Mobile health (mHealth) interventions present a transformative opportunity to enhance malaria diagnosis and treatment adherence among pregnant women in malaria-endemic regions, particularly in sub-Saharan Africa. The use of mobile technology, including SMS-based reminders, diagnostic support applications, and telemedicine platforms, has shown promising results in addressing barriers such as delayed diagnosis, non-adherence to treatment regimens, and limited access to healthcare services. Through the various case studies reviewed, it is evident that mHealth interventions can significantly improve maternal and neonatal health outcomes by ensuring timely and accurate malaria diagnosis and promoting consistent adherence to antimalarial treatments. However, the implementation of mHealth interventions is not without challenges. Technological barriers, including limited access to mobile devices and reliable network coverage, along with cultural and behavioral factors, must be

addressed to ensure the sustainability and scalability of these programs. Additionally, the integration of mHealth into national health systems, supported by government policies and long-term investment, is critical to realizing the full potential of these interventions. Looking ahead, future research should explore the incorporation of emerging technologies such as artificial intelligence (AI) and machine learning (ML) to enhance the precision of malaria diagnosis and personalize adherence support. Furthermore, policies must prioritize equity in access to mHealth solutions to bridge the digital divide and ensure that vulnerable and underserved populations benefit from these innovations. By addressing these considerations, mHealth interventions have the potential to revolutionize malaria control strategies, ultimately improving the health and well-being of pregnant women and their newborns in malaria-endemic regions.

REFERENCES

- Okafor, I.P., Ezekude, C., Oluwole, E.O., Onigbogi, O.O.: Malaria in pregnancy: A community-based study on the knowledge, perception, and prevention among Nigerian women. *Journal of Family Medicine and Primary Care*. 8, 1359 (2019). https://doi.org/10.4103/jfmpc.jfmpc_295_18
- Alum, E.U., Ugwu, O.P.C., Egba, S.I., Uti, D.E., Alum, B.N. (2024). Climate Variability and Malaria Transmission: Unraveling the Complex Relationship. *INOSR Scientific Research*11(2):16-22. <https://doi.org/10.59298/INOSRSR/2024/1.1.21622>
- Rogerson, S. J., Desai, M., Mayor, A., Sicuri, E., Taylor, S. M., & van Eijk, A. M. (2018). Burden, pathology, and costs of malaria in pregnancy: new developments for an old problem. *The Lancet infectious diseases*, 18(4), e107-e118.
- Chibi, M., Wasswa, W., Ngongoni, C., Baba, E., & Kalu, A. (2023). Leveraging innovation technologies to respond to malaria: a systematized literature review of emerging technologies. *Malaria journal*, 22(1), 40.
- Ugwu, O. P., Alum, E. U., Ugwu, J. N., Eze, V. H.U., Ugwu, C. N., Ogenyi, F. C., Okon, M. B. Harnessing technology for infectious disease response in conflict zones: Challenges, innovations, and policy implications. *Medicine (Baltimore)*. 2024 Jul 12;103(28):e38834. doi: 10.1097/MD.00000000000038834. PMID: 38996110; PMCID: PMC11245197.
- Cutts, J.C., Agius, P.A., Zaw Lin, Powell, R., Moore, K., Draper, B., Simpson, J.A., Fowkes, F.J.I.: Pregnancy-specific malarial immunity and risk of malaria in pregnancy and adverse birth outcomes: a systematic review. *BMC Med*. 18, 14 (2020). <https://doi.org/10.1186/s12916-019-1467-6>
- Bauserman, M., Conroy, A. L., North, K., Patterson, J., Bose, C., & Meshnick, S. (2019, August). An overview of malaria in pregnancy. In *Seminars in perinatology* (Vol. 43, No. 5, pp. 282-290). WB Saunders.

8. Egwu, C. O., Alope, C., Chukwu, J., Agwu, A., Alum, E., Tsamesidis, I, et al. A world free of malaria: It is time for Africa to actively champion and take leadership of elimination and eradication strategies. *Afr Health Sci.* 2022 Dec;22(4):627-640. doi: 10.4314/ahs.v22i4.68.
9. Kitojo, C., Chacky, F., Kigadye, E. S., Mugasa, J. P., Lusasi, A., Mohamed, A., ... & Ishengoma, D. S. (2020). Evaluation of a single screen and treat strategy to detect asymptomatic malaria among pregnant women from selected health facilities in Lindi region, Tanzania. *Malaria Journal*, 19, 1-8.
10. Al Khaja, K. A., & Sequeira, R. P. (2021). Drug treatment and prevention of malaria in pregnancy: a critical review of the guidelines. *Malaria journal*, 20, 1-13.
11. Abaza, H., & Marschollek, M. (2017). mHealth application areas and technology combinations. *Methods of information in medicine*, 56(S 01), e105-e122.
12. Maero, A. L. (2020). Implementation fidelity of malaria test and treat guidelines amongst healthcare providers in Kisumu, Kenya, 2019.
13. Bervell, B., & Al-Samarraie, H. (2019). A comparative review of mobile health and electronic health utilization in sub-Saharan African countries. *Social Science & Medicine*, 232, 1-16.
14. Mbunge, E., Millham, R. C., Sibiya, M. N., & Takavarasha Jr, S. (2024). Leveraging mobile phones to improve malaria healthcare service delivery in Buhera rural communities: implications for practice and policy. *Behaviour & Information Technology*, 1-14.
15. "Ilozumba, O., Dieleman, M., Kraamwinkel, N., Van Belle, S., Chaudoury, M., & Broerse, J. E. (2018). "I am not telling. The mobile is telling": factors influencing the outcomes of a community health worker mHealth intervention in India. *PLoS One*, 13(3), e0194927.

CITE AS: Mugisha Emmanuel K. (2024). The Impact of Mobile Health (mHealth) Interventions on Malaria Diagnosis and Treatment Adherence among Pregnant Women: A Comprehensive Review. IAA Journal of Applied Sciences 12(1):6-10. <https://doi.org/10.59298/IAAJAS/2024/121.61000>