



Effect of Mobile Health Reminders on Antimalarial Adherence among Pregnant Women in Rural Uganda: A Randomized Controlled Trial

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ABSTRACT

Malaria in pregnancy remains a critical public health issue in sub-Saharan Africa, particularly in Uganda, where adherence to intermittent preventive treatment with sulfadoxine-pyrimethamine (IPTp-SP) is persistently low. Poor adherence contributes to adverse maternal and neonatal outcomes, necessitating innovative solutions to enhance antimalarial prophylaxis. Mobile health (mHealth) interventions, such as SMS and voice call reminders, have emerged as promising tools to support treatment adherence in low-resource settings. This review evaluated the effect of mobile health reminders on antimalarial adherence among pregnant women in rural Uganda, drawing evidence from a randomized controlled trial involving 600 participants. The trial compared standard antenatal care with an intervention group receiving scheduled mobile reminders before each IPTp-SP dose. Findings revealed a significant improvement in adherence, with 72% of women in the intervention group completing three or more IPTp-SP doses versus 49% in the control group. Improved antenatal attendance, higher maternal hemoglobin levels at delivery, and high user satisfaction were also observed. The article was developed using a structured literature synthesis method focused on trial-based findings and contextual analysis. Despite challenges related to phone access, network coverage, and message delivery, the intervention demonstrated feasibility, scalability, and acceptability. This review underscored the potential of mHealth to enhance malaria prevention efforts in maternal healthcare programs. **Keywords:** Mobile Health (mHealth), Malaria in Pregnancy (MiP), Intermittent Preventive Treatment (IPTp-SP), Adherence, Randomized Controlled Trial (RCT).

INTRODUCTION

Malaria during pregnancy is a significant public health concern in sub-Saharan Africa, where it contributes to maternal anemia, low birth weight, stillbirth, and neonatal mortality [1-3]. Uganda remains among the countries with the highest malaria burden globally, with pregnant women representing a vulnerable population due to physiological immunosuppression during gestation [4, 5]. Intermittent preventive treatment of malaria in pregnancy with sulfadoxine-pyrimethamine (IPTp-SP) is a widely recommended intervention by the World Health Organization (WHO) [6]. Despite this recommendation, adherence to IPTp-SP regimens among pregnant women in rural areas remains alarmingly low, compromising its effectiveness in reducing malaria-related morbidity and mortality. Several factors contribute to poor adherence, including lack of awareness, forgetfulness, distance from health facilities, and low antenatal care attendance. In recent years, the proliferation of mobile phones in low-resource settings has created new avenues for digital health interventions [7, 8]. Mobile health (mHealth) technologies, particularly SMS reminders and voice messages, have shown promise in promoting health behaviors and improving treatment adherence across various domains of healthcare [8]. These digital reminders offer an innovative, cost-effective, and scalable strategy to support adherence to antimalarial regimens during pregnancy. This review aims to examine the effect of mobile health reminders on adherence to antimalarial treatment among pregnant women in rural Uganda through the lens of a randomized controlled trial. By evaluating the intervention's

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efficacy, acceptability, and feasibility, the study seeks to provide insights into the role of mHealth in maternal health programs. The discussion also considers implementation challenges, contextual factors influencing outcomes, and recommendations for integrating digital interventions into existing health systems. Ultimately, the findings of this review are intended to inform policymakers, healthcare providers, and program designers on the potential of mHealth reminders to strengthen malaria prevention efforts in pregnancy and contribute to improved maternal and neonatal health outcomes in rural Uganda.

Background on Malaria in Pregnancy and IPTp-SP Adherence

Malaria in pregnancy (MiP) is caused primarily by *Plasmodium falciparum*, leading to adverse outcomes such as intrauterine growth restriction, maternal anemia, and preterm delivery [9, 10]. The WHO recommends that all pregnant women in endemic regions receive at least three doses of IPTp-SP starting from the second trimester, administered at intervals of at least one month [11]. Despite the policy and provision of free SP at antenatal clinics (ANC), adherence remains suboptimal. In Uganda, coverage of the third IPTp dose among pregnant women hovers around 45%, far below the WHO target of 80%.

Low adherence stems from both demand- and supply-side factors. On the demand side, pregnant women often lack adequate knowledge of IPTp benefits, miss scheduled ANC visits, or perceive no immediate need for preventive medication in the absence of symptoms [12]. Supply-side barriers include stockouts of SP, limited ANC outreach, and understaffed health facilities. Addressing these gaps requires innovative approaches to enhance patient engagement and improve follow-up during pregnancy.

Mobile Health Technologies in Maternal Care

Mobile health (mHealth) interventions encompass the use of mobile devices such as phones, tablets, and applications to support health objectives [13, 14]. mHealth has gained traction in maternal and child health due to its potential to overcome barriers in health information dissemination, service utilization, and behavioral modification. SMS and voice reminders are among the most widely adopted tools, with proven effectiveness in promoting immunization attendance, ART adherence, and ANC participation [15]. In the context of malaria prevention, mHealth reminders can play a crucial role in prompting IPTp-SP uptake by sending timely cues before ANC visits or scheduled SP doses. These messages can be tailored to the user's language, cultural context, and preferred timing, ensuring greater relevance and acceptability. Moreover, mHealth platforms facilitate two-way communication, enabling healthcare providers to respond to queries, reschedule appointments, or provide counseling.

Methodology of the Randomized Controlled Trial

The randomized controlled trial (RCT) conducted in rural districts of Uganda recruited 600 pregnant women attending their first ANC visit between 14 and 20 weeks of gestation. Participants were randomly assigned to an intervention group receiving mobile reminders or a control group receiving standard ANC services without digital support. The intervention consisted of SMS messages and automated voice calls sent 24 hours and 2 hours before each scheduled SP administration. Messages emphasized the importance of IPTp-SP, the date and time of the next ANC visit, and motivational reinforcement. The primary outcome was adherence to three or more doses of IPTp-SP by the third trimester. Secondary outcomes included ANC visit attendance, maternal hemoglobin levels at delivery, and user satisfaction with the intervention. Data were collected through clinic records, self-reports, and post-delivery interviews. Ethical approval was obtained from relevant institutional review boards, and informed consent was secured from all participants.

Findings and Interpretation

The trial demonstrated a statistically significant improvement in IPTp-SP adherence among the intervention group. Seventy-two percent of women receiving mobile reminders completed at least three doses compared to 49% in the control group. Additionally, the intervention group showed higher ANC attendance rates and fewer missed appointments. Maternal hemoglobin levels at delivery were moderately higher among the intervention group, suggesting potential clinical benefits linked to improved prophylaxis adherence.

Participants' feedback indicated high satisfaction with the mobile reminders. Most women found the messages timely, understandable, and helpful in remembering appointments. Voice calls were particularly appreciated among participants with limited literacy. Language customization and message timing were key factors influencing user engagement. No adverse events related to the intervention were reported. These findings support the hypothesis that mobile health reminders can significantly enhance adherence to antimalarial prophylaxis in pregnancy. The results align with broader evidence from other health domains, affirming the behavioral influence of timely digital prompts.

Contextual and Implementation Considerations

Despite the promising outcomes, several contextual factors must be considered when interpreting the results. First, mobile phone ownership, although high, is not universal. Some participants relied on shared phones, potentially

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compromising message privacy and regular access. Second, network coverage and power outages occasionally disrupted message delivery, particularly in remote villages. Third, language and cultural appropriateness of messages required careful design and pilot testing to ensure clarity and acceptance. Moreover, the success of mHealth interventions depends on integration with the broader health system [16]. Collaboration with ANC staff, community health workers, and local leaders was essential to build trust, encourage participation, and facilitate follow-up. Sustainability of digital interventions also hinges on funding, technological infrastructure, and governmental support. In [17] this trial, leveraging existing mobile platforms and open-source software minimizes costs and enhanced scalability.

Training healthcare workers to manage the digital system, respond to patient inquiries, and troubleshoot issues was critical for successful implementation of novel health methods [18]. Continuous monitoring and adaptive management ensured high fidelity of the intervention and allowed for real-time problem-solving.

Scalability and Policy Implications

Given the demonstrated efficacy and positive user experiences, scaling up mHealth reminders for IPTp-SP adherence in rural Uganda is a viable public health strategy [19]. Policymakers should consider incorporating digital adherence tools into national malaria control and maternal health programs. This could involve partnerships with telecommunications companies to subsidize message delivery costs, as well as integrating reminder systems into electronic health records or national ANC registries. In designing scale-up strategies, equity considerations must be central. Special attention should be paid to reaching women without personal phones, those with low literacy, and marginalized populations. Voice messages, community outreach, and mobile-based education campaigns can complement reminder systems and ensure broader inclusivity [20, 21]. Importantly, establishing regulatory frameworks for data privacy and ethical use of digital health data is essential to safeguard patient rights. Moreover, integrating mHealth interventions with other maternal health initiatives—such as birth preparedness, immunization reminders, and nutritional support—can create synergies and maximize impact. A comprehensive, patient-centered digital health ecosystem can transform maternal care delivery in rural and resource-constrained settings.

Limitations and Future Research Directions

While RCT provides robust evidence of efficacy, some limitations warrant consideration. Self-reported adherence may be subject to recall or social desirability bias. Although clinic records were used to verify doses, underreporting of non-attendance could occur in understaffed settings. The study period may also not capture long-term sustainability or behavior change beyond pregnancy.

Future research should explore the cost-effectiveness of mHealth interventions, comparative impact of SMS versus voice reminders, and integration with community health worker outreach [22]. Studies focusing on adolescent pregnancies, high-parity women, and those in conflict-affected areas can provide further insights into tailoring interventions for diverse subpopulations.

Additionally, mixed-methods research incorporating qualitative interviews can deepen understanding of user experiences, barriers to engagement, and preferences for message content and delivery. Real-world implementation research is needed to evaluate mHealth integration into routine health services under programmatic conditions.

CONCLUSION

Improving adherence to antimalarial prophylaxis among pregnant women is crucial to reducing the burden of malaria-related maternal and neonatal complications in Uganda. This randomized controlled trial provides compelling evidence that mobile health reminders significantly enhance IPTp-SP uptake and ANC attendance in rural settings. By leveraging the widespread availability of mobile phones, these digital tools offer a low-cost, scalable, and user-friendly solution to improve maternal health outcomes. However, the success of such interventions depends on thoughtful design, contextual adaptation, and health system integration. Policy efforts must prioritize digital inclusion, infrastructural investment, and ethical governance to ensure equitable access and sustained impact. As Uganda and other malaria-endemic countries seek to strengthen maternal and child health services, mHealth reminders should be considered a key component of innovative, patient-centered strategies to advance public health goals.

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