Can SMS reminders improve utilization of malaria prevention strategies among pregnant women in Busia County?

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ABSTRACT

Despite extensive efforts to promote Insecticide-Treated Nets (ITNs) and Intermittent Preventive Treatment in Pregnancy (IPTp), utilization rates among pregnant women remain suboptimal. Leveraging Kenya's extensive mobile networks, this study evaluated whether SMS text-message reminders could improve and sustain the use of these malaria prevention strategies. A parallel-group randomized trial was conducted from September 2023 to February 2024, enrolling 156 pregnant women aged 15–49 years from Busia County, Kenya. Participants were block randomized into an intervention group, receiving SMS reminders on ITN and IPTp use for 5 months, or a control group with no text messages. The primary outcomes were ITN utilization and adherence to IPTp dosing as per Kenyan guidelines. McNemar's test assessed changes in paired proportions pre- and post-intervention. At baseline, ITN utilization was high, with 95% in the control and 88% in the intervention group, with no significant changes observed post-intervention. However, IPTp adherence significantly increased in both groups (control: $\chi^2 = 37.1$, $p < 0.001$; intervention: $\chi^2 = 45.0$, $p < 0.001$). High ITN use at baseline, likely due to robust community health worker (CHW) outreach, may have limited the SMS intervention's impact on ITN utilization. However, significant increases in IPTp adherence were observed in both groups, suggesting that CHW outreach was effective, with SMS reminders possibly reinforcing IPTp adherence in the intervention group. These findings highlight the potential of combining CHW outreach with SMS reminders to enhance malaria prevention, particularly for IPTp adherence, in high-risk areas.

Keywords: *Community health workers; Insecticide-treated nets, Intermittent preventive treatment in pregnancy,Malaria prevention, Maternal health, Pregnant women, SMS reminders.*

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Highlights of this paper

- This study evaluated the impact of SMS text-message reminders on the utilization of ITNs and IPTp among pregnant women in Busia County, Kenya.
- While high baseline ITN use limited the intervention's additional impact, significant increases in IPTp adherence were observed in both groups, highlighting the role of CHW outreach and SMS reinforcement.
- These findings suggest that combining SMS reminders with routine CHW efforts can enhance malaria prevention strategies, particularly for interventions requiring sustained adherence.

1. INTRODUCTION

Malaria remains a significant public health threat in sub-Saharan Africa, responsible for 95% of the 600,000 malaria deaths globally in 2020 (World Health Organization, 2023). Due to its high morbidity and mortality, malaria remains one of the most serious public health problems in Africa (Schantz-Dunn & Nour, 2009). Malaria in pregnancy is a preventable cause of severe outcomes in pregnancy (Guyatt & Snow, 2004; Menéndez, D'Alessandro, & Kuile, 2007) including low birth weight, maternal anaemia, infant mortality, and stillbirth, affecting an estimated 819,000 infants and causing 10,000 maternal deaths in 2020 alone (WHO, 2021). These outcomes are particularly prevalent in low- and middle-income countries (Bakken & Iversen, 2021). In Kenya, where three-quarters of the population are at risk, malaria accounted for 13% to 15% of outpatient consultations in 2020 (DNMP & ICF, 2021; Mkubwa, Kagura, Chirwa, Ibisomi, & Kinyanjui, 2022). Busia County, in a malaria-endemic region, has a particularly high prevalence (27%) compared to the national average of 8% (DNMP & ICF, 2021). The World Health Organization (WHO) recommends several interventions to mitigate malaria in pregnancy (MiP), including early diagnosis, use of insecticide-treated nets (ITNs), and intermittent preventive treatment in pregnancy (IPTp) (WHO, 2021). Insecticide-treated nets (ITNs) reduce mosquito bites, while intermittent preventive treatment in pregnancy (IPTp) offers protection against malaria regardless of infection status—both critical for mitigating risks such as placental malaria, low birth weight, and stillbirths (Gamble, Ekwaru, & ter Kuile, 2006; Wangdi et al., 2018). Malaria prevention with ITNs and IPTp has seen a tremendous scale-up in sub-Saharan Africa in recent years with huge reduction in malaria burden observed (Tizifa et al., 2018). However in Kenya, despite increased availability, utilization remains suboptimal, with only 49% of pregnant women receiving the recommended IPTp doses and 73% sleeping under ITNs (DNMP & ICF, 2021). To address these gaps, accessible and cost-effective interventions such as short message service (SMS) are needed to improve adherence in resource-limited setting (Ben-Zeev et al., 2015; Chung et al., 2015; Garofalo et al., 2016; Gatwood et al., 2016; Rohman, Maruswezki, & Boyce Cam, 2015).

SMS has become a focus of researchers in the health care field and is recommended for use by leading organizations in various health care fields (American Medical Association, 2016; World Health Organization, 2012). Even though mobile health reminder research has in the past mostly aimed at outcomes for instance adherence to medication and attendance to appointments (Berrouiguet et al., 2016; Kannisto et al., 2014; Okuboyejo & Eyesan, 2014) SMS reminders can be useful in behavior change (Schwebel & Larimer, 2018).

This study evaluates the impact of SMS text message reminders on ITN and IPTp utilization among pregnant women in Busia County, a malaria-endemic region. A parallel group-controlled trial, conducted from September 2023 to February 2024, assessed the effectiveness of this intervention in enhancing malaria prevention strategy adherence. This paper focuses on one key objective: to evaluate the post-intervention effects of SMS text message reminders on promoting ITN and IPTp utilization for malaria prevention among pregnant women in Busia County.

2. MATERIALS AND METHODS

2.1. Study Design

A parallel group-randomized controlled trial (GRT) was done in Busia County, Kenya to assess the effect of SMS reminders on malaria prevention interventions among pregnant women. The study participants were pregnant women who were identified by the research team together with the Community Health Workers. The participants were assigned into either the intervention group or the control group by the principal investigator via block randomization. The primary outcome of interest was the use of malaria prevention measures including IPTp and ITNs among the two groups of women before and after the intervention.

2.2. Study Site and Population

Busia County is one of the malaria endemic areas in the Lake Victoria basin and has malaria incidence of 27% as compared to the national average of 8% (Bashir, Nyakoe, & Van Der Sande, 2019). The climate in Busia County is tropical and it has two rainy seasons per year which promotes the breeding of mosquitoes and hence sustained malaria transmission throughout the year. These geographic and environmental factors contribute to the significant morbidity and mortality associated with malaria in the region.

The study population consisted of pregnant women aged 15-49 years from all sub-counties in Busia County. Eligible participants were those who gave informed consent, were in their second or third trimester of pregnancy, and had access to a mobile phone, either their own or a family member's, which could receive SMS messages. Pregnant women were excluded if they had experienced complications in previous pregnancies, had long-term illnesses, or exhibited any danger signs during pregnancy, such as vaginal bleeding, convulsions/fits, severe headaches with blurred vision, fever and weakness, severe abdominal pain, or rapid or difficulty in breathing.

2.3. Data Collection Procedures

The baseline data collection was conducted across all seven sub-counties from September to October 2023, followed by the post-intervention phase from January to February 2024. The data was gathered using structured questionnaires administered via Microsoft® Office Forms on Android devices. Participants were asked about their usage of ITNs the previous night, as well as the frequency of their consumption of Sulfadoxine-Pyrimethamine/Fansidar (SP) for IPTp. IPTp adherence was assessed by cross-referencing gestational age with SP doses taken, as per Ministry of Health (MOH) guidelines (MOH, 2016).

2.4. SMS Intervention

The SMS intervention utilized SMSLeopard (https://app.smsleopard.com) to automatically send text-message reminders to study participants in Busia County. This one-way communication system was selected for its ability to engage respondents directly. The SMS content was developed based on the Kenya National Guideline for Malaria Prevention (MOH, 2016) and refined through pretesting. Messages were tailored in both English and Kiswahili to ensure clarity and cultural relevance. Participants provided consent and their mobile numbers for message delivery at baseline. In the intervention arm, three unique messages focused on malaria prevention were sent weekly on Monday, Wednesday, and Friday for 20 weeks, during weeks 13 to 40 of gestation, the critical period for receiving at least three doses of intermittent preventive treatment in pregnancy (IPTp). The messages that were sent are listed in Table 1.

Table 1. Malaria prevention messages sent to intervention arm 1.

Malaria prevention using IPTp messages.
• SMS1: IPTp is recommended in areas of high malaria transmission, Busia is a high malaria zone. • SMS2: A minimum of 3 doses is required at an interval of 4 weeks (1 month) after 13 weeks of pregnancy. • SMS3: SP as IPTp is safe up to 40 weeks of pregnancy and even one dose is beneficial for women presenting late in pregnancy. • SMS4: Attend all ANC visits as scheduled.
Malaria prevention using ITNs messages.
• SMS5: Malaria is caused by mosquitoes. • SMS6: Nets prevent malaria. • SMS7: Sleep under an ITN every night. • SMS8: Seek prompt diagnosis and correct treatment of all fevers within 24 hours of the onset of symptoms including fever, chills, and body aches. • SMS9: Be tested before receiving any treatment for malaria. • SMS10: Adhere to dosing instructions and complete all prescribed medicines.

To increase the chances that the respondent will read the messages, each message was complemented with a short proverb, in Kiswahili, which is unrelated to malaria prevention but designed to be motivating, interesting, entertaining, or merely attention-getting.

2.5. Data Analysis

Data were analyzed in STATA 15, with internal consistency checks conducted prior to analysis. Descriptive statistics, including proportions and frequencies, provided an overview of the dataset, while cluster-adjusted Pearson's chi-square or Fisher's Exact tests were used to compare categorical variables. The McNemar's test assessed paired proportions for ITN and IPTp utilization before and after the intervention, evaluating statistically significant changes in utilization within the same sample of pregnant women. Statistical significance was set at $p < 0.05$, with findings presented in tables and charts.

2.6. Ethical Considerations

The study protocol received ethical approval from KEMRI's Scientific and Ethics Review Unit (SERU No. 4622). The Busia County Department of Health provided additional approval after they were briefed about the study. All respondents provided informed consent prior to enrolment. Research assistants informed participants about the study's purpose, potential risks, and their rights to participate or withdraw, ensuring confidentiality and providing the researcher's contact information.

3. RESULTS

3.1. Response Rate

This study achieved a high response rate at baseline, exceeding the target sample size with 156 participants enrolled resulting in a 101% response rate from a screened pool of 158 pregnant women. Two participants were excluded due to presenting pregnancy danger signs therefore 156 pregnant women were interviewed at baseline and considered eligible for follow-up (Figure 1).

Out of 156 participants, 77(49%) from three clusters (Matayos, Nambale and Samia) were assigned to the control group, and 79(51%) from four clusters (Bunyala, Butula, Teso North and Teso South) were assigned to the intervention group. During the follow-up, 62(81%) participants from the control group were interviewed, with 15(19%) lost to follow-up (eight were unavailable after three visits, and seven had relocated outside the study area).

In the intervention group, 68(86%) participants were interviewed, while 11(14%) were lost to follow-up (five were unavailable after three visits, and six had moved away from the study area). In total, 26 participants (17%) were lost to follow-up, with 19% lost from the intervention group and 12% from the control group. The initial sample size calculation anticipated a 20% loss between baseline and the follow-up survey. Therefore, the overall loss of 17% fell within the expected threshold.

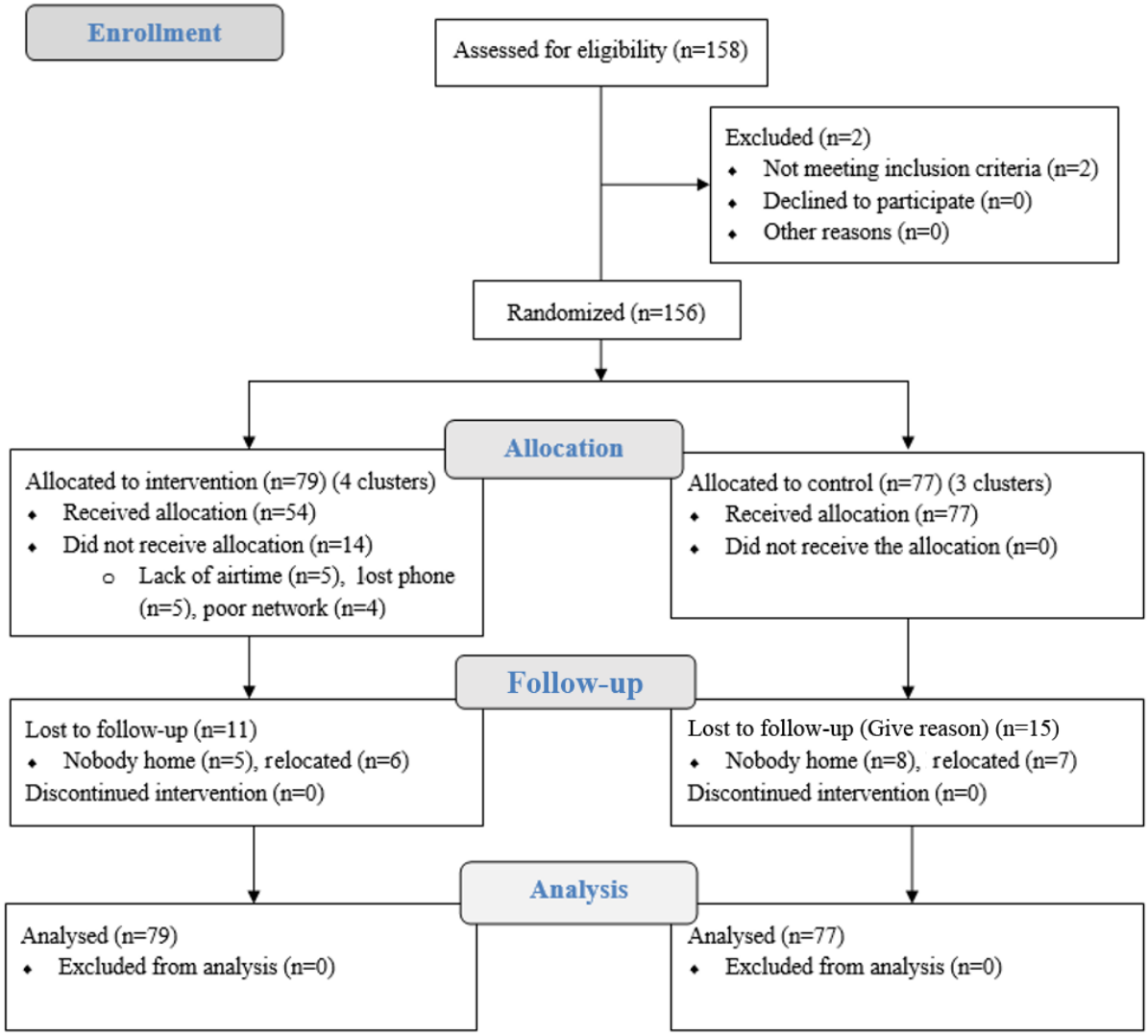

Figure 1. Study flow diagram.

3.2. Characteristics of the Respondents

Table 2 summarizes the socio-demographic and socio-economic characteristics of the study population. Most participants, 111(71%) individuals, were within the 18-22 years 57(37%) and 23-27 54(35%) years age groups. Nearly half 71(46%) had a primary education level, while the same proportion attained secondary education. Only a small 14(9%) fraction possessed a tertiary education. Marital status showed a high 139(89%) proportion of married women. Household socioeconomic status varied across a five-point scale, indicating diverse economic backgrounds. Regarding occupation, unemployment was prevalent 83(53%), followed by farming 30(19%), with participants with some employment being most likely self-employed traders 27(17%). Parity data revealed that over a third 51(33%) of participants had no children, almost half 72(46%) had 1-2 children, and only a fifth 33(21%) had three or more children. The majority 117(75%) of participants were Protestants, with the remaining being Catholics.

Table 2. Baseline characteristics of the study population.

Characteristic	Total (N=156) n (%)
Age group in years	
18-22	57(36.5)
23-27	54(34.6)
28 +	45(28.8)
Highest education level attained	
Primary	71(45.5)
Secondary	71(45.5)
Tertiary	14(9.0)
Marital status	
Unmarried	17(10.9)
Married	139(89.1)
Household socio-economic status	
Poorest	32(20.5)
Very poor	31(19.9)
Poor	31(19.9)
Less poor	31(19.9)
Least poor	31(19.9)
Occupation	
Farmer	30(19.2)
Some employment: Salaried	10(6.4)
Some employment: Casual worker	6(3.8)
Some employment: Trade/Self-employed	27(17.3)
Unemployed	83(53.3)
Number of children	
None	51(32.7)
1-2	72(46.2)
3+	33(21.2)
Religious affiliation	
Roman catholic	39(25.0)
Protestant/Other Christian	117(75.0)

3.3. Post-Intervention Effects of SMS Text Message Reminders on Utilization of ITNs and IPTp

3.3.1. Change in Proportion of ITN Use Pre- and Post-Intervention

Among the control group, 54 pregnant women (95%) reported bed net use both pre- and post-intervention (Table 3). In the intervention group, 50 pregnant women (88%) reported consistent bed net use across these periods.

McNemar's test found no statistically significant difference in bed net use pre- and post-intervention within the control group ($\chi^2 = 0.33$, $p = 0.564$) or the intervention group ($\chi^2 = 1.29$, $p = 0.256$).

Table 3. Change in proportion of ITN utilization pre- and post-intervention.

	Controls		Proportion with factors			McNemar's ($\chi 2$)	p-value
	Exposed	**Unexposed**	**Cases**	**Controls**	**Difference (95%CI)**		
Cases							
Self-reported ITN use last night among controls							
Exposed	54	2					
Unexposed	1	0	0.98	0.96	0.02 (-0.06, 0.09)	0.33	0.564
Self-reported ITN use last night among the inervention							
Exposed	50	2					
Unexposed	5	0	0.91	0.96	-0.05 (-0.16, 0.05)	1.29	0.256

3.3.2. Change in Proportion of IPTp Use Pre- and Post-Intervention

Among the control group, eleven participants (18%) reported intermittent preventive treatment in pregnancy (IPTp) use both pre- and post-intervention (Table 4). In the intervention group, 3 pregnant women (4%) reported consistent IPTp use across these periods.

McNemar's test found statistically significant difference in IPTp use pre- and post-intervention within the control group ($\chi^2 = 37.1$, $p < 0.001$) and the intervention group ($\chi^2 = 45.0$, $p < 0.001$).

Table 4. Change in proportion of IPTp utilization pre- and post-intervention.

	Controls		Proportion with factors			McNemar's (χ^2)	p-value
	Exposed	Unexposed	Cases	Controls	Difference (95%CI)		
Cases							
Self-reported IPTp use among controls							
Exposed	11	1					
Unexposed	40	10	0.19	0.82	-0.63 (-0.77, -0.48)	37.1	< 0.001
Self-reported IPTp use among the intervention							
Exposed	3	0					
Unexposed	45	20	0.04	0.71	-0.66 (- 0.79, -0.53)	45	< 0.001

4. DISCUSSION

4.1. Effects of SMS Text Message Reminders on ITN Use

The study found no significant changes in ITN use between SMS-exposed and unexposed groups, likely due to the high baseline utilization (over 95%) that was sustained throughout the study. This high level of ITN use can be attributed to a robust community health worker (CHW) system, which has been well-supported by local government and health partners to promote malaria prevention. Previous studies highlight CHWs' effectiveness in enhancing ITN use and malaria prevention education (Yaya, Uthman, Amouzou, & Bishwajit, 2018).

The ITN usage rates observed in this study were considerably higher than those reported in the 2021 Malaria Indicator Survey, where 73% of pregnant women in Kenya used an ITN the night before (DNMP & ICF, 2021). This emphasizes the effectiveness of initiatives led by community health workers (CHWs) in promoting ITN utilization.

4.2. Effects of SMS Text Message Reminders on IPTp Use

Significant increases in IPTp use were observed in both study groups post-intervention, with the gap between the groups narrowing. While CHWs played a critical role by providing health education and encouraging IPTp uptake, the intervention group's targeted SMS reminders likely reinforced these efforts, contributing to higher IPTp adherence.

These findings are consistent with evidence from studies, such as one in Guinea, which demonstrated that SMS reminders improved antenatal visit attendance and IPTp adherence (Flueckiger et al., 2019). The combined use of digital health tools and CHW support offers a promising approach to improving maternal and child health outcomes in malaria-endemic areas by addressing gaps in preventive care.

4.3. Study Limitations

Several limitations must be acknowledged, including the shared influence of CHWs in both groups, which may confound intervention effects, and the inability to evaluate the impact of SMS frequency independently.

Additionally, reliance on self-reported data introduces potential recall bias, and the study's regional scope may limit broader applicability. Addressing systemic factors affecting IPTp and ITN access was beyond the study's focus. Future research should explore larger, more diverse populations, extend follow-up periods, and design interventions that account for CHW influence to provide stronger evidence of SMS intervention effectiveness.

5. CONCLUSIONS

This study evaluated the impact of SMS reminders on ITN and IPTp utilization among pregnant women in Busia County, Kenya, a high-risk malaria area. The findings underscore the potential of integrating SMS interventions with CHW strategies to enhance malaria prevention and improve maternal health outcomes in resource-limited settings.

High ITN utilization at both baseline and follow-up, likely due to strong CHW-led outreach efforts, may have limited the potential impact of SMS reminders in further increasing ITN use. IPTp utilization increased substantially in both groups, with similar improvements, suggesting that CHW outreach was effective across both groups. However, SMS reminders in the intervention group may have reinforced these efforts, supporting IPTp adherence.

These findings suggest that integrating CHW outreach with digital interventions, such as SMS reminders, may enhance malaria prevention efforts in high-risk regions, especially for interventions like IPTp that require adherence over time.

List of Abbreviations

ANC	Anti Natal Clinic.
CHW	Community Health Worker.
CI	Confidence Interval.
GRT	Group Randomized Trial.
ITN	Insecticide Treated Nets.
JKUAT	Jomo Kenyatta University of Agriculture and Technology.
KDHS	Kenya Demographic and Health Survey.
KEMRI	Kenya Medical Research Institute.
LBW	Low Birth Weight.
LG	Living Goods.
MIS	Malaria Indicator Survey.
NACOSTI	National Commission for Science, Technology, and Innovation.
RR	Relative Risk.
SERU	Scientific and Ethics Review Unit.
SMS	Short Messaging Services.
SP	Sulfadoxine Pyrimethamine.
WHO	World Health Organization.

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