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Effects of Mobile Phone Tele-Reminder on the Prevalence of Malaria and Antenatal Care Satisfaction among Pregnant Women Availing Antenatal Care at Phebe and Charles B. Dunbar Hospitals, Bong County, Monrovia-Liberia A Cluster-Randomized Controlled Trial

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ABSTRACT

Pregnant women with malaria and other associated infections have an increased risk of developing anemia later in pregnancy. This study aimed to determine the effect of mobile phone tele-reminder delivered through phone calls and SMS on the prevalence of malaria infection during pregnancy. The study recruited 150 pregnant women seeking antenatal care for the first time at the Phebe and Charles B. Dunbar hospitals in Bong County, Liberia. The antenatal care screening room (units of randomization) in both hospitals were randomized into six clusters. The 150 pregnant women were randomly assigned to an intervention group and a control group. A binary logistic regression using a generalized estimating equation model was run with a 95% Confidence Interval (CI). Malaria prevalence and antenatal care satisfaction were the primary outcome variables. The secondary outcome variable was the prevalence of anemia. Although there was a reduction in malaria infection in both groups, malaria prevalence between the intervention and control groups was not statistically significant (5 vs. 15%) (OR, 1.15; 95% CI, 0.71-1.85). Pregnant women in the intervention group were 4 times more likely to be very satisfied with ANC services compared with the control group (aOR, 4.01; 95%CI, 1.72-9.53). There was a positive trend toward anemia reduction among those in the intervention group. Integrating mobile phone technology in antenatal care services may help reduce the malaria infection rate and increase ANC satisfaction levels.

INTRODUCTION

Women who are pregnant remain at risk of malaria infection, particularly in low-income countries. The risk of malaria infection and severe infection is greater for pregnant women than for nonpregnant women. Anopheline mosquito bites transmit malaria, which is transmitted congenitally and through exposure to infected blood products (Lagerberg, 2008). In the genus Plasmodium, four species of protozoa cause malaria. Preterm delivery, low birth weight, stillbirth, congenital infection, and maternal death are some of the effects of malaria during pregnancy. Around 19% of infant LBWs are caused by malaria in malaria-endemic areas, and 6% of infant deaths are caused by LBWs caused by malaria. A lower mean hemoglobin level is associated with malaria among pregnant women (Ouédraogo *et al.*, 2013). In 2019, the World Health Organization found that malaria was endemic in 31 low-income countries. Women with malaria and other associated infections later in pregnancy are at an increased risk of low birth weight (Accrombessi *et al.*, 2019). Statistically significant associations are found between asymptomatic malaria in pregnant women and their hemoglobin levels (Feleke *et al.*, 2020).

Around 100,000 infants die every year in Sub-Saharan Africa due to malaria-related LBW (Guyatt & Snow,2004). At first antenatal booking, anemia is significantly associated with malaria parasitemia. The adverse birth outcomes in the United Republic of Tanzania-impacts and prevention of maternal risk factors showed that low birth weight and intrauterine fetal retardation are caused by malaria (Watson-Jones *et al.*, 2007).

WHO recommends a combination of insecticide-treated nets (ITNs) and either intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine for pregnant women. Despite relatively high rates of antenatal clinic attendance, coverage of intermittent preventive treatment and use of insecticide-treated nets by expectant women still falls far short of international targets.This is true even though coverage has increased in the majority of countries.

To determine whether the implementation of WHO's 2012 policy update for intermittent preventive treatment—which seeks to streamline the message and align preventive treatment with the focused antenatal care schedule—leads to improvements in coverage—should be evaluated, Van Eigk *et al.* (2013) recommend. Parasite resistance threatens the efficacy of IPTp with sulfadoxine-pyrimethamine in sub-Saharan Africa. Improved knowledge and education of women of childbearing age have a significant impact on malaria control during pregnancy (Iriemenam *et al.*, 2011). The use of insecticide-treated mosquito nets during pregnancy reduced the risk of malaria infection (Fana *et al.*, 2015; Apinjoh *et al.*, 2015).

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LITERATURE REVIEW

Malaria Situation in Liberia

The Liberian Health System remains one of the most fragile in the world. Ebola outbreaks in 2014-2016 and the recent Covid-19 pandemic are key factors driving the disruption of the health system in Liberia (Tarr-Attia *et al.*, 2018). Despite the adoption of WHO recommendations on ANC for a positive pregnancy experience in 2016, malaria infection during pregnancy has become so alarming in Liberia. Increasingly, pregnant women in Liberia are exposed to malaria, exposing Liberia's health system's weakness. Malaria, which is primarily a major public health problem of pregnant women, is preventable, treatable, and curable, in Liberia. Children and expectant mothers are especially vulnerable to malaria. To lessen the negative effects of malaria on a pregnant woman's health, the WHO advises using a three-pronged strategy: rapid diagnosis and treatment of infections that have been confirmed, use of long-lasting insecticidal nets (LLINs), and IPTp (WHO 2004). Pregnant women who are receiving routine prenatal care are given intermittent prevention of malaria in pregnancy (IPTp), an antimalarial medication. IPTp can help prevent cases of malaria, anemia, placental parasitemia, low birth weight, and neonatal mortality. The percentage of women receiving one or more IPTp doses has increased from 58% in 2009 to 90% in 2019–20, and the percentage of women receiving two or more doses has increased from 47% to 70%. In the period between 2011 and 2019, 40% of women received three or more IPTp doses (LDHS 2019). Plasmodium falciparum infections are anticipated to affect at least one in every eight women receiving their first antenatal care at private clinics in Monrovia outside of the wettest months, despite all the efforts the government is making to reduce the prevalence of malaria. Young primigravidae have a higher risk of contracting P. falciparum, claim Martnez-Pérez *et al.* (2018).

Use of Mobile Phones in Liberia's Health System

The most popular form of communication in Liberia now is through mobile phones. Even though the country's GSMs have increased their investment, the Liberia Health System has not yet integrated mobile phones into the delivery of healthcare services. A report from Digital Liberia 2021 states that there were 3.39 million mobile connections overall, with many people having multiple connections, up 19,000, or 0.6 percent, between January 2020 and January 2021. In the mobile sector, competition led to some of the lowest call prices in the country. Internet penetration was 14.9 percent in January 2021, equating to 761,000 internet users in the country. The number of internet users increased by 132,000, or 22 percent, between January 2020 and January 2021. About 84% of urban households and 50% of rural households own mobile phones (LDHS 2019-2020).

Use of Insecticide Treated Nets (ITNs) by Pregnant Women in Liberia

During the night before the conduct of the National Demographic and Health Survey in Liberia (2019-2020), 47% of pregnant women aged 15-49 slept under a mosquito net, while 78% of pregnant women in households with at least one mosquito net slept under a mosquito net. In 2019, 47% of pregnant women used ITNs, up from 33% in 2009. The proportion of pregnant women aged 15-49 who slept under an ITN the night before the survey is markedly lower in Greater Monrovia (34%) than in other urban areas (57%) and rural areas (48%) (Table 12.8).

Intermittent Preventive Treatment of Malaria in Pregnancy in (IPTp)

Pregnant women who want to prevent malaria are given an entire therapeutic course of antimalarial medication during routine prenatal care visits. This method is known as an intermittent preventive treatment of malaria in pregnancy (IPTp). IPTp aids in reducing the risk of neonatal mortality, low birth weight, maternal and fetal anemia, placental parasitemia, and episodes of malaria in pregnant women. In Liberia, sulfadoxine-pyrimethamine (SP), also known as Fansidar is the drug of choice for IPTp). Women who received one or more IPTp doses increased from 58% in 2009 to 90% in 2019–20, while those who received two or more doses rose from 47% to 70%. The proportion of females receiving three or more IPTp doses rose from 11% to 40% during the same time frame (LDHS 2019-2020).

Benefits of Mobile Phone Technology in Antenatal Care

In Africa, mobile phones are increasingly crucial for strengthening healthcare systems (Howitt 2012). According to Jareethum and others (2008), there is a higher satisfaction level of pregnant women who receive SMS via mobile phone during their antenatal service compared to the general antenatal care group. A more satisfactory level of patient satisfaction can be achieved when antenatal care consultations are improved to meet the desired needs of pregnant women in developing countries (Alhaqbani & Bawazir, 2022). Mobile phone tele-reminder likely increased counseling about IFAS, resulting in a higher level of adherence to IFA supplementation among pregnant women who participated in the intervention (Demis, Geda, Alemayehu, & Abebe, 2019. A significant association exists between frequencies of antenatal care (ANC) visits to the level of knowledge and the level of practice of mothers about preventing anemia in pregnancy (Ghimire & Pandey, 2013). In Nigeria, mobile phones also contribute to health promotion, prevention, and early identification of diseases, reducing maternal and child mortality (Odetola & Okanlawon, 2016). Using mobile phone applications in clinical settings increases the number of antenatal care visits and improves the quality of ANC services (Lund *et al.*, 2014). A study carried out in Bangladesh to outline the association and the use of mobile phones and essential maternal health care services showed pregnant women who utilized mobile phones utilized antenatal care services and professional delivery

services more than those who did not (Tang *et al.*, 2019). Additionally, with the use of mobile phone technology in healthcare settings, women felt more confident seeking medical care during pregnancy and childbirth and recognizing signs of illness in their newborns (Entsieh, Emmelin, & Pettersson, 2015).

Using a mobile phone application, Odetola & Okanlawon (2016) evaluated the effects of a nursing intervention on the uptake of antenatal care, tetanus toxoids, and malaria prevention among pregnant women in Nigeria. Mobile phone use by nurses during ANC was associated with increased attendance at antenatal clinics and IPT uptake. Women who received the SMS every week were more likely to attend eight ANC visits than those who did not (Osanyin *et al.*, 2022). Women who utilized mobile phones were more likely to use iron tablets and attend ANC in a randomized controlled trial conducted by Bangal *et al.* (2017). Despite not increasing the proportion of women receiving three doses of IPTp-SP, mobile phone intervention did increase the proportion of timely ANC visits (Ouédraogo *et al.*, 2022).

Using mobile phones to send short message services on focused antenatal care (FANC) positively affects the uptake of attentive antenatal care among pregnant women in middle and low-income countries (Wagnew *et al.*, 2018). Compared with the general antenatal care group, there is a higher satisfaction level of pregnant women who receive SMS via mobile phone during their antenatal service. Higher confidence and lower anxiety levels are seen in pregnant women who get SMS via mobile phone during the antenatal period (Jareethum *et al.*, 2008).

METHODOLOGY

Study Design

In two major referral hospitals, we conducted a three-month cluster randomized controlled trial with two arms. Phebe and Charles B. Dunbar hospitals, Bong County, Republic of Liberia, were the study sites between May 2022 and August 2022. Units of randomization were antenatal care screening rooms with midwives assigned to care for pregnant women. Group participants are randomly assigned to each treatment arm in a cluster randomized control trial rather than individuals. There were three ANC screening rooms in each hospital dedicated to pregnant women. Trained midwives provide all antenatal care in the screening rooms. This study considered each screen room as a cluster. There were two intervention groups in these two arms trials (control and experimental). As there was a possibility that pregnant women receiving antenatal care at Phebe Hospital might be close relatives of pregnant women receiving antenatal care at Charles B. Dunbar Hospital, we decided to conduct a cluster randomized controlled trial. There was a risk of contamination within and between clusters due to this relatedness. The cluster randomized control trial minimizes the risk of contamination. The administration of the Phebe Hospital provided ethical clearance for the study.

Clustering and Randomization

The randomization units were antenatal care screening rooms with licensed midwives. In cluster randomized controlled trials, the groups are randomized rather than the individual participants. In each of these hospitals, three screening rooms were dedicated solely to providing ANC to pregnant women. Each screening room was considered a cluster by the researcher in this study. There were three clusters at Phebe Hospital, referred to as 1, 2, and 3, while there were three clusters at Charles B. Dunbar Hospital, referred to as 4, 5, and 6. A team of midwives administered ANC to six clusters of pregnant women receiving ANC for the first time. In clinical research, randomization refers to assigning study participants to either a treatment or control group solely by chance (Figure 1). The six screening rooms (six clusters) were randomized into an intervention (clusters 1,4, & 6) and a control group (clusters 2,3, & 5).

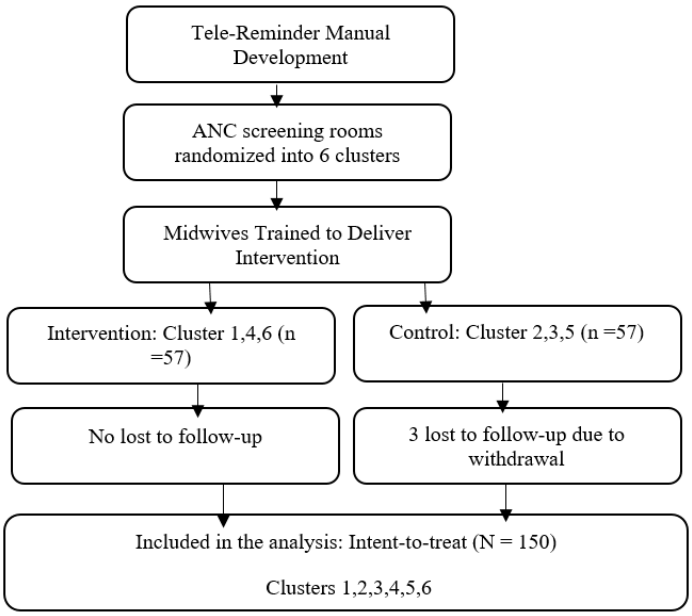

Figure 1: Operationalization of the Study

Setting

Phebe and Charles B. Dunbar hospitals were the research areas. The two hospitals which are situated in Bong County are key referral hospitals in Liberia. Bong County is a centrally located county with diverse ethnic groups. In 1964, Bong County was established. Dominant among the 12 ethnic groups in the county, is the Kpelleh-speaking people. Among the 15 counties in Liberia, Bong County ranks third in terms of area and population. Lofa and Gbarpolu counties border it on the north, Margibi and Montserrado counties on the west, Grand Bassa County on the south, and Nimba County on the east. In addition to rice production, the county is one of Liberia's food baskets. Cocoa, coffee, rubber, and palms are also grown in the county. Approximately 450,000 rural Liberians receive quality healthcare at Phebe Hospital. Lutheran Church in Liberia helped establish the hospital in 1921. The Liberian government founds the hospital.

Participants

Pregnant women availing antenatal care for the time in their current pregnancy were the participants in this study. Pregnant women who have had prior antenatal care at clinics, hospitals, or health centers, were not allowed to take part in this study. For this study, Phebe and Charles B. Dunbar hospitals were selected because of their high attendance at antenatal care, equipped medical and laboratory facilities, access to more than two screening rooms for pregnant women, and patient diversity.

Sample Size Calculation

The sample population consisted of all consenting pregnant women receiving their first ANC visit. Malaria is one of the leading causes of anemia among pregnant women in Liberia. In the Demography and Health Survey Report (2019), anemia is more prevalent among pregnant women (52%) compared to breastfeeding women (48%). As a result of this new intervention, malaria prevalence among pregnant women in Liberia is expected to be reduced, thereby eradicating anemia among them. Controlling malaria infection can reduce anemia prevalence among pregnant women by 25%. In a cluster randomized control trial, similarity among subjects within preexisting groups or clusters minimizes the variability of responses in a cluster sample, making it challenging to detect actual differences between groups. We used the intracluster correlation coefficients (ICC) to measure the degree of dependence within each cluster. We also adjusted for individual and cluster-level characteristics, and the adequate sample size was determined using the median ICC in primary healthcare research of 0.005 (Adams *et al*., 2004). The researcher's first step was to calculate the sample size required for individual randomized controlled trials. Next, the derived sample size from the individual randomized controlled trial was then adjusted for the design effect (DE). In this study, 150 pregnant women who were getting ANC for the first time were recruited. The study included 75 participants in each treatment arm. Three clusters were present in each treatment arm. A total of 25 participants were randomly assigned to each cluster.

Admission of Participants

Each hospital had three screening rooms dedicated exclusively to ANC services. A pregnant woman seeking ANC for the first time was directed to the registration room to obtain a valid hospital card and identification number. In subsequent hospital visits, the patient used the hospital card and identification number to access health care services. HIV/AIDS counseling follows the registration process, which aims to prevent mother-to-child transmission of HIV/AIDS. After counseling, the midwives assigned to those rooms took the patient's card to any of the screening rooms for further processing. A patient received healthcare from the screening room, where her card was transferred. Six clusters (screening rooms) were randomized, so three (3) clusters administered standard/routine interventions during the study period, while the remaining three administered intervention treatment. As mentioned in the selection criteria, the admission criteria were the same for both arms. The control and intervention groups were blinded. Certain information that might influence participants was kept from them. During the intervention, midwives were blinded.

Recruitment of Midwives

Six (6) licensed and trained midwives were hired to administer the intervention. Phebe and Charles B. Dunbar Hospitals employed these midwives full-time. In addition to the three midwives recruited from Phebe Hospital, three additional midwives were recruited from Charles B. Dunbar Hospital. The head midwives of both hospitals recommended and recruited the midwives. Among their responsibilities was administering all treatments to participants in both groups. Providers of the intervention treatment were guided by the teleconsultation manual designed for this study. Three midwives were randomly selected and charged with administering the intervention treatment throughout the study. The remaining three midwives provided the standard/routine treatment to the control group. The researcher provided a one-day training to the three midwives accountable for administering the intervention. Midwives in the intervention group were trained to use the tele-reminder manual to deliver an effective treatment. However, all the midwives were blinded. Neither the primary nor secondary outcomes variables were disclosed to them.

Data Collection

This study used several validated methods to collect accurate and insightful. All stages of this study were supervised by the researcher. For quality assurance, the researcher scrutinized every data report by the midwives. In both hospitals, midwives were hired to administer the interventions. Each participant at baseline, follow-up, and end line was tested for malaria and anemia

by trained laboratory technicians designated by the hospitals. A participant with a positive malaria smear was designated as having malaria. The participant with a hemoglobin level of less than 11g/dl was considered as having anemia. Those participants who had malaria and anemia at baseline were treated by doctors assigned at the hospitals before they could fully participate in the study. Data collection forms were designed to collect all the data. Filling out the form was facilitated by the midwives. The data collection form did not mention participants' names or personal identities, which might raise concerns about stigmatization. As part of the ANC satisfaction assessment, participants were asked how they felt about the hospital's treatment during the past three months.

Outcomes

The primary outcome was malaria prevalence and antenatal care satisfaction level. The secondary outcome variable measured was the prevalence of anemia.

Treatment in the Control Group

The control group received all routine and standard ANC services (Table 1). The participants in this group were followed up every month. A similar pattern of routine ANC services was followed in every subsequent follow-up. Every follow-up included measurements of primary outcome variables (malaria prevalence and ANC satisfaction) and the secondary outcome variable (anemia prevalence).

Table 1: Treatment in the Interventions and Control Clusters

Treatment Types	Control group (Routine Care)	Intervention Group (Routine + New treatment)	Reference
Diet Intervention	-Pregnant women were counseled about healthy eating and physical activity during pregnancy. -Using Visual aid containing the various food groups, pregnant women were counseled on the need to eat food from the different food groups daily to be kept healthy during pregnancy.	-Diet counseling focused on iron-rich foods (vegetables, fruits, and meat/fish products). -Participants were reminded biweekly to consume daily iron- and vitamin-rich foods from local markets and backyard gardens.	Sunuwar *et al*, (2019). Otoo & Adam (2016) WHO recommendations on ANC for a positive pregnancy experience (2016)
Iron and Folic acid supplements	Both hospitals routinely provided daily oral iron and folic acid supplementation to each participant	-Biweekly tele-reminders reminded participants to take iron and folate supplements. -IFA supplementation was emphasized in all	Gomes *et al.* (2021). WHO recommendations on ANC for a positive pregnancy experience (2016)
Malaria Prevention	A mosquito net was given to each participant to prevent malaria. In the second trimester of pregnancy, participants received intermittent preventive treatment with sulfadoxine-pyrimethamine (IPTp - SP). Based on hospital practice, dosing was determined	A biweekly tele-reminder emphasized the use of mosquito nets and the importance of adhering to IPTp-SP guidelines. A message (SMS) reminded them to use mosquito nets regularly and take the IPTp-SP.	Ngabo *et al.* (2012). WHO recommendations on ANC for a positive pregnancy experience (2016)
Hygiene Education	Participants were instructed to wash their hands with soap and water after using the latrine and touching contaminated surfaces. Participants were encouraged to keep their environment clean at all time	During follow-up visits, participants received handwashing soaps in addition to tele-reminders. Participants were reminded of the importance of washing their hands with soap and water after using the toilet, before cooking, and before eating Participants were also reminded biweekly to keep their environment clean	Sheth *et al.* (2010). WHO recommendations on ANC for a positive pregnancy experience (2016)
Prevention of intestinal parasites/ worm	Participants were treated with preventive anthelmintics according to hospital practice before undergoing their first ANC in the second trimester		WHO recommendations on ANC for a positive pregnancy experience (2016)

Treatment in the Intervention Group

Each participant in the intervention group received slightly different interventions than those administered to respondents in the control group. A mobile phone tele-reminder was delivered biweekly through phone calls and SMS to participants in the intervention group. During the mobile phone calls, Participants were counseled only on food groups with rich sources of iron (Table 1).

Development of Antenatal Care Tele-Reminder Messages

Health messages delivered to the study's participants are referred to in this study as "Core Antenatal Care Tele-Reminder Messages." There were three phases to the development of these core healthcare reminder messages (Table 2). In phase one, the researcher reviewed World Health Organization guidelines on antenatal care published in 2016. Healthcare messages supported by evidence-based practice were selected from the World Health Organization's antenatal care guidelines. During phase two of the development of core healthcare reminder messages. The researcher and the six midwives who administered the treatment (intervention and control) reviewed the components of the World Health Organization antenatal care guidelines incorporated into the local Liberian ANC guidelines (Figure 2).

Table 2: Core Health Messages Sent Via SMS

Types of Treatment	Core Health Messages Via SMS
Iron and Folate acid supplementation	"Increase your blood volume by taking one iron tablet a day."
Malaria Prevention	"Before you sleep, please hang the mosquito net over you."
Adherence to the ANC visit schedule	"Come to the hospital at the end of the month for treatment."
Hygiene Practices	"To prevent sickness, wash your hands frequently after using the toilet, before eating, and before cooking". Always keep your surrounding clean.

Phase two was intended to prevent giving health messages to the participants that the Ministry of Health of Liberia did not approve. In Phase Three, the six midwives pretested the critical health messages among ten mothers (pregnant women) who were not part of the study but received ANC services at Phebe Hospital.

Data Quality Control

CELL-DYN Emerald 22, an automated hematology analyzer designed for low-volume clinical settings, was used for hemoglobin testing. A blood Smear was conducted for malaria on all participants following all standard procedures followed by trained laboratory technicians at both hospitals. Licensed laboratory technicians collected blood samples for hematological (malaria smear) analysis. To ensure data quality control, a regular supervision visit was conducted to ensure that standard operating procedures were followed during blood sample collection. Blood specimens were transported in proper containers under the supervision and taken at the recommended time to the analyzer. Test materials were observed to avoid negative impacts on test results and to ensure they were properly stored and cleaned. For quality assurance purposes, laboratory technicians were treated blinded. All laboratory results were immediately entered into the laboratory request form of the participants.

Data Analysis Method

The primary outcome variables were malaria prevalence and ANC satisfaction. Participants with Positive malaria smears were considered as having malaria infection. The Chi-square test of independence (for categorical data) was used to assess the treatment effects on the outcome variables. A logistic regression analysis based on longitudinal data was used to determine the treatment effects on malaria infection and the level of antenatal care satisfaction. As facilities rather than individual pregnant women were randomized, a generalized estimating equation was used to account for within-cluster correlation coefficients.

RESULTS

Age and Pregnancy Profile of Participants

Participants range in age from 23 to 24 years old. There was no statistically significant difference between the ages of participants in the intervention group and the control group. Most participants were in their first trimester of pregnancy (Table 3).

Table 3: Age and Pregnancy Profile of Participants at Baseline

Variables	Intervention group n = 75	Control group n = 75	Independent Sample T-Test p-value
	Mean ±SD	Mean ±SD	
Age of participants	24.57 ± 6.280	23.45 ± 6.803	0.297
Age in months of pregnancy	3.15 ± 1.245	3.27 ± 1.044	0.513
Total pregnancy	2.11 ± 1.640	1.89 ± 1.956	0.470
Total living children	1.23 ± 1.341	1.16 ± 1.525	0.777
Age in the month of the last child	26.17 ± 28.974	20.75 ± 26.568	0.234

Table 4: Educational level and Marital status, Baseline

Variables and Category		Intervention group n = 75		Control group n =75		Fisher's Exact test p-value
		N	%	n	%	
Highest Education Attainment	Primary education	54	72	53	70	0.500
	Secondary education	21	28	22	29	
Marital status	Cohabiting	51	68	54	72	0.361
	Not married	24	32	21	28	

Participants have varying educational backgrounds. There were, however, a significant number of them who had at least a primary education. According to statistics (Table 4), there is no statistical difference between the groups regarding their educational attainment. The study also showed that more than half of the participants were cohabiting couples.

Comparing the Use of Insecticide-Treated Net and Intermittent Preventive Treatment (Iptp) at Baseline and End Line

In both groups, participants were asked if they took intermittent preventive treatment (IPTp). In terms of IPTp use before the study, there was no significant association between the two groups (p = 0.267). In Table 5, the Fisher's Exact test after the intervention showed no difference between the intervention group and the control group in terms of IPTp adherence (p = 0.221). At baseline, participants were also asked if they had used insecticide-treated nets the night before the study. There was no significant difference between the intervention and control groups regarding insecticide-treated net use the night before the study (p = 0.095). As a result of the intervention, there was a significant difference in IPTp usage between the intervention and treatment groups (p = 0.034).

Table 5: Intermittent Preventive Treatment (IPTp) Comparison at Baseline and end line

Used mosquito net in the past one night	Intervention group n = 75	Control group n = 75	Fisher's Exact Test p-value	Binary Logistic Regression
	n (%)	n (%)		Odds Ratio (95% CI)
Baseline	30 (40)	39 (52)	0.095	1.3 (0.46-3.76)
Endline	68(91)	59 (79)	0.034	
Intake of IPT				
Baseline	7(9)	4 (5)	0.267	2.6 (0.49-13.88)
Endline	73 (97)	70 (93)	0.221	

Comparing Malaria Prevalence at Baseline and After Treatment

In both intervention and control groups, the prevalence of malaria infection was high at baseline (Table 6); however, no significant difference was observed between the intervention and control groups. (43% vs. 45%; p = 0.869). As a result of treatment, the prevalence of malaria among pregnant women in the intervention group was lower than that among those in the control group (5% vs. 15%). However, the intervention group did not differ significantly from the control group (p = 0.050).

Table 6: Comparing Malaria Prevalence at Baseline and After Treatment

Malaria Prevalence	Intervention group n = 75	Control group n = 75	Fisher's Exact Test p-value
	n (%)	n (%)	
Baseline	32 (43)	34 (45)	0.869
Endline	4 (5)	11 (15)	0.050
McNemar Test P value	0.000	0.000	Unadjusted OR* (95%CI) 0.32 (0.09-1.08) Binary Logistic Regression

Treatment Effect on Antenatal Care Satisfaction

When adjusted for the age and education level of participants, most of the participants (95%) were very satisfied with ANC services in the intervention group and 86% in the control group (Table 7). Between pregnant women in the intervention group and those in the control group, the odds of being very satisfied with ANC services were significantly different (aOR, 4.01; 95%CI, 1.72-9.53). The study showed a significant difference between the intervention and control groups in terms of not wanting to quit antenatal care (Adjusted odds ratio "aOR," 2.17; 95%CI, 1.09-4.32). Pregnant women's satisfaction is a reflection of the patient's judgment of different domains of health care, including technical,

Table 7: Treatment Effect on Antenatal Care Satisfaction

Indicators	Intervention groups n (75)	Control group n = 75	Unadjusted OR*(95% CI)	Adjusted OR** (95% CI)	Logistic Regression p-value
	n (%)	n (%)			
Very satisfied	71(95)	64(86)	5.98 (4.15-8.61)	4.06 (1.72-9.53)	0.001
Had no desire to quit ANC	69 (92)	58 (78)	3.51 (2.49-4.96)	2.17 (1.09-4.32)	0.027

interpersonal, and organizational aspects. Satisfaction with varying elements of received antenatal care improves health outcomes, continuity of care, treatment adherence, and the relationship with the provider.

Effect of Treatment on Anemia Prevalence

The prevalence of anemia was a significant difference between Pregnant women in the intervention and control groups (4% vs. 13%; p = <0.039). The result also showed that pregnant women assigned to the intervention group had a significantly greater mean hemoglobin level after the two interventions, t (2.4) = 445, p<0.013; d = 0.23. The effect size of the analysis (d = 0.23) was found to be small (Table 8). These results indicate that pregnant women in the intervention group (M = 12.8, SD = 0.71) experienced a small increase in hemoglobin levels than did pregnant women in the control group (M =11.7, SD = 0.63).

Table 8: Impact of Treatment on anemia prevalence

Hemoglobin Level in g/dl	Intervention group	Control group	Independent Sample T-test p-value
	(Mean ± DS)	(Mean ± DS)	
Baseline	10.9 ± 0.94	10.8 ± 0.92	0.108
Endline	12.8 ± 0.71	11.7 ± 0.65	0.013
Paired T-test (p-value)	0.047	0.000	Cohen's d Test: 0.23
Anemia Prevalence	Intervention group n (%)	Controlgroup n (%)	Fisher's Exact Test (p-value)
Baseline	36 (48)	39 (52)	0.37
Endline	3 (4)	10 (13)	0.039
McNemar Test P value	0.000	0.000	Odds Ratio (Binary Logistic Regression): 3.7 (0.97- 14.00)

Anemia Prevalence among Participants with Malaria and History of Past Illnesses

Based on Table 9, 56% of intervention participants and 38% of control participants with malaria at baseline had anemia. Participants were asked at baseline whether they had experienced any illness in the past month. As a result, 25% of participants in the intervention group and 19% of participants in the control group who experienced illness in the past month had anemia at baseline.

Table 9: Anemia Prevalence Among Participants with Malaria and History of Past Illnesses at Baseline

Treatment Groups	Participants with malaria & anemia at baseline n = 66	Participants with a history of past illnesses with anemia at baseline n = 51
	n (%)	n (%)
Intervention Group	18 (56)	6 (25)
Control Group	13 (38)	5 (19)
Fisher's Exact Test p-value	0.217	0.412

DISCUSSION

There is no doubt that malaria during pregnancy can have devastating effects on mothers and their babies, and it is a leading cause of maternal and infant mortality. Pregnancy is most affected by malaria in sub-Saharan Africa, of which Liberia is a member. Preventive strategies for malaria in pregnancy in Liberia include intermittent preventive treatment (IPTp) with three or more doses of sulphadoxine-pyrimethamine (SP), using long-lasting insecticide-treated nets, and managing clinical malaria and anemia effectively. Pregnant women receive information about malaria causes and prevention during antenatal care visits. However, preventive measures may be overlooked if these educative messages are not consistently reinforced. There was a lower malaria prevalence in the intervention group than in the control group. However, the study found that pregnant women who received the mobile phone tele-reminder did not significantly differ in their odds of not contracting malaria compared to pregnant women who did not receive the intervention. However, despite this, the use of mobile phone tele-reminder as part of antenatal care was of great assistance in educating

pregnant women regarding the need for insecticide-treated nets and the causes of malaria infection. By using the mobile phone tele-reminder, midwives may be able to create a balance between myths and realities about malaria infection during pregnancy (Entsieh *et al*., 2015). In developing countries, such as Liberia, some of the challenges associated with accessing malaria information among pregnant women may be overcome by midwives by using their mobile phones to reinforce antenatal care counseling (Mbunge *et al*., 2011). These findings agree with Odetola and Okanlawon (2016) findings, who found that pregnant women were more likely to receive intermittent preventive treatment (IPT) when nurses used mobile phones to deliver ANC.

In a study by Lund *et al*. (2014), pregnant women who received the intervention had significantly higher levels of satisfaction with their antenatal care than those who did not. To reinforce the counseling messages given to participants at the hospital, midwives used SMS reminders and phone calls. As a result of such an integrated intervention approach, pregnant women seem motivated to seek antenatal care to give birth to a healthy baby. There is a possibility that midwives may be able to contribute to adherence to antenatal care in low-income countries if they deliver services using mobile phones. Despite still enjoying the comfort of home and family, pregnant women find that receiving healthcare through mobile phone technology is more encouraging and exciting than receiving healthcare in person. According to this study, pregnant women are more likely to seek care timely, suggesting that they are satisfied and anxiety free with the care they receive with the help of the mobile phone application (Jareethum *et al*., 2008). A more satisfactory level of patient satisfaction can be achieved when antenatal care consultations are improved to meet the desired needs of pregnant women in developing countries (Alhaqbani & Bawazir, 2022).

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Abbreviation

ANC: Antenatal Care,
g/dl: gram per deciliter
HIV: Human Immune Virus
IFA: Iron & Folic Acid
SMS: Short Message Services
WHO: World Health Organization

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