The Effects of Using Mobile Telephone Communication to Provide Maternal Health Provision on Antenatal Care Attendance Among Expectant Mothers in Kyotera and Rakai Districts, Uganda.

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Abstract:
Sustainable Development Goal (SDG) 3 targets to improve the health and wellbeing of all people across the globe with the integration of information and communication technologies in the delivery of health services. The 2014 National ICT policy of Uganda encourages the adoption of ICTs to improve and extend healthcare and health information systems to remote and underserved areas and vulnerable populations. Despite the estimated 69% mobile telephone subscription among women across Uganda[1], the use of the handy mobile telephone ICT options among expectant mothers in the acquisition of maternal health services remains wanting. The districts of Kyotera and Rakai have an adult mobile telephone subscription of 55.4%[2]. However, the subscribers largely use the telephones for business and sexual relationship[3]. The poor usage of mobile telephone communication in the acquisition of vital maternal health information results into the poor ANC attendance and utilization of services among expectant mothers in the districts of Kyotera and Rakai estimated at a mere 30% below the national ANC utilization target of 47.5% [4].
This article thus, describes an investigation into the effectiveness of providing maternal health information and reminders for scheduled ANC visits using mobile telephones on the antenatal care attendance among expectant mothers in the districts of Rakai and Kyotera in Uganda.

Methodology: A total of 28 health facilities were randomly sampled and allocated into the intervention and control arms at a ratio of 1:1. Overall, 2143 expectant mothers receiving antenatal care from the 28 health facilities were enrolled through systematic sampling. Mothers in the intervention arm received mobile telephone voice and text messages reminders for scheduled ANC visits while expectant mothers in the control group did not get any reminders for scheduled ANC visit and maternal health information through the mobile telephone communication platform. Expectant mothers in both groups provided baseline data and end of term data that was collected after an intervention period of 12months.

Results: Provision of maternal health information and reminders for scheduled ANC visits to expectant mother using mobile telephones caused statistically signification differences in ANC attendance during pregnancy with a recorded *OR=1.72* and *p<0.005*. In the intervention group, 75.3% of the expectant mothers attained the 8 ANC visits recommended by the MoH compared to the mere 34.2% recorded in the control group.

Conclusion: Using mobile telephone communication to avail maternal health information and reminders for scheduled ANC visit is an effective method of enhancing ANC attendance and utilization of services among expectant mothers.

Keywords: *Mobile Telecommunication, AnteNatal Care; Utilization, Maternal Mortality, Uganda.*

Abbreviations: ANC-Ante Natal Care, SDG-Sustainable Development Goals,AHSPR-Annual Health Sector Performance Report, GSMA- Global System for Mobile Communications Association, ICT- Information and Communication Technology

1.0 Introduction:

Sustainable Development Goal (SDG) 3 targets to improve the health and well being of all people across the globe with the deployment of information and communication technologies in the delivery of health services. Maternal health has been prioritized in the global agenda and the 2030 target is to reduce the maternal mortality ratio to 70/100000 live births with incorporation of ICT support systems in the delivery of health services[5]. The Ugandan National ICT policy of 2014 encourages the adoption of ICTs to improve and extend healthcare and health information systems to remote and under served areas and vulnerable populations, ***recognizing women's roles as health providers in their families and communities.*** Despite the estimated 69% mobile telephone subscription among women across Uganda[1], the use of the handy mobile telephone ICT options among expectant mothers in the acquisition of maternal health services has remained very low. Reviewed studies indicated that a mere 17% of mobile telephone subscribers use phones for acquisition of medical information which culminates into a mere 42% ANC attendance and utilization of services across the country[6]. Whereas the districts of Kyotera and Rakai have an adult mobile telephone subscription of 55.4%[2], the subscribers largely use the telephones for business and sexual relationship[3]. The implies that the available technologies have not diffused to support the critical role of availing maternal health information to the expectant mothers. The poor usage of mobile telephone communication in the acquisition of vital maternal health information results into the poor ANC attendance and utilization of services among expectant mothers in the districts of Kyotera and Rakai estimated at a mere 30% which is far below the national ANC attendance and utilization target of 47.5%[4]. In light of the shortfall in the usage of mobile telephone communication in the acquisitions of maternal health information, the study focused on examining the effects of mobile telephone communication on ANC attendance and the utilization of services among expectant mothers in Kyotera and Rakai Districts, Uganda.

1.1 Main Objective: Examining the effects of mobile telephone communication use in provision maternal health information on ANC attendance and utilization of services among expectant mothers in Kyotera and Rakai Districts, Uganda.

2.0 Study Design

The study deployed an experimental research design to assess the effect mobile telephone communication in availing maternal health information and reminders for scheduled ANC visits on the utilization of ANC services during pregnancy in the districts of Kyotera and Rakai Uganda. A Cluster Randomized Controlled Trial (CRCT) design comprised of both quantitative and qualitative approaches was used as a gold standard in conducting impact evaluation research in order to maximize comparability between the intervention and control groups, and hence give a strong evidence of a causal relationship between the intervention and the outcome [7–9]

The 28 health centres formulated the units of randomization; a total of 2143 expectant mothers obtaining ANC services from the selected health centres were recruited into the study by systematic sampling.

Therefore, the selected health centres (clusters) were randomly assigned to either the intervention or control arm of the study leading 14 health centres in the intervention and 14 health centres in the control arm.

A single blinded approach was implemented to prevent systematic biases arising from prior knowledge of group allocations among the participants and research aim outcomes as per RCT study standards [8]. Information regarding research hypotheses and randomization of health Centres into the different study arms research assistants, was concealed from expectant mothers and cluster team leaders to avoid biases at the different levels of research.

The study used the Intent to Treat (ITT) approach for analysis to minimize biases and establish the actual effect of mobile telephone communication use in availing maternal health information and reminders for scheduled ANC visits. In the ITT, every expectant mother allocated to the intervention group was considered to be part of the trial. The study made use of the pre-test-post-test control group approach [8]. In this approach, baseline characteristics regarding mobile telephone communication and utilization of ANC services were collected from expectant mothers from both arms of the study to allow for a discrete evaluation of the pre-to-post changes.

The study made assumptions that; the mobile telephone communication networks were stable to support the apt implementation of the intervention and that at every recommended visit the expectant mothers obtained the required doses of ANC and

Qualitative data was collected through focus group discussions with expectant mothers, health workers, community leaders and VHT's. Additional qualitative data was obtained from in-depth interviews of key informants in the community such as district health officers, district chairpersons and leaders of VHT's and midwives.

Study variables
Independent Variable: Mobile Telephone Communication Use
a) Ownership
b) Knowlede and Usage including receipt of reminders
c) Voice/Text Messages

Dependent Variable: Utilization of Antenatal Care Services
a) Utilization of ANC services
   Examination ANC Services
   Testing ANC Services
   Treatment ANC Services

2.1 Study Setting
The study was be conducted in Kyotera and Rakai Districts found in the central region of Uganda [10]. Kyotera District lies approximately 44km, by road, south west of Masaka District. It is also 29km, by road, northeast of Rakai District. The coordinates for Kyotera District are 0037'54.0" S,31032'36.0E. The district headquarters are located at Kasaali (Vote: 621). Similarly, Rakai district is located in South Western Uganda. It is west of Lake Victoria, lying between longitude 310E, 32oE and latitude0oS. The southern boundaries of Rakai are part of the international boundary between Uganda and Tanzania. It is bordered by Masaka District in the East, Kalangala District in the South-East, Isingiro District in the West and Lyantonde District in the North. The district headquarters are located in Rakai Town which is a tarmac road distance of approximately 190km from Kampala the Capital City of Uganda, it has a total area of 7908.7 sq/km with a total population of 518,008 people comprising of 253,054 males and 264,954 females [2]. Out of the 264,954 females, 158,972 females are above 15 years of age with an estimate fertility rate of 6.2% [2]. The study therefore, had teenage mothers. tudy participants will be teenage mothers. The districts have 2 government hospitals, 01 health center IV, 22 health center III's, 43 health center II and 49 not for profit health centers spread across the 20 sub-counties in Rakai District [10]. It is important to note that the population statistics and health facilities recorded are as per the population census of 2014 when Kyotera District was an integral part of Rakai District.

Study Population: 2143 expectant mothers aged 15 to 49 years residing in the districts of Kyotera and Rakai in Uganda were recruited.

Inclusion and Exclusion Criteria for Expectant Mothers

The study focused on expectant mothers in the districts of Kyotera and Rakai in Uganda. An expectant mother qualified for inclusion in the study if the pregnancy was less than 10 weeks, she or a member of the household she hailed from owned a mobile phone and showed willingness to participate. The Village Health Teams (VHT's) identified the potential trial participants. Participants who met the eligibility criteria were required to sign a consent form after obtaining the details of the study from the VHT's. These were be randomized into either the intervention or control arms of the study depending on facility they obtained ANC services from. Participants in both arms were followed for one year to establish the level of ANC attendance in light of predisposing, enabling and need factors. Expectant mothers who fell short of the described criteria were excluded from the study.

2.2 Sample Size Calculation and Determination

The sample size was calculated based on the formula in equation 1used for computing the number of individuals per arm assuming cluster level analysis for parallel RCT designs with dichotomous outcomes [11].

The specific formula is provided in Equation 1.

$$\boldsymbol{m} = \frac{\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2 [P_1(1-P1) + P_2(1-P_2)]}{\Delta^2} \dots \dots \dots \dots \dots \dots Equation\ 1$$

Where;

m=Desired sample size per group;

P1=the probability of an event happening in the control group which is the standard ANC service in Kyotera and Rakai Districts. Reports provide an annual estimate of 5,589 pregnancies in Kyotera and Rakai Districts and an estimate 1,659 expectant mothers utilizing ANC services within Kyotera and Rakai Districts [4]. This translates into an approximate ANC utilization of 30% among expectant mothers in Kyotera and Rakai Districts. Thus P1=0.3

P2=The probability of an event happening in the treatment group. The MoH targeted to increase the level of consumption of ANC to 47.5% with different interventions such as sensitization [12]. Thus P2=0.475.

Δ= Represents the clinically important difference in the treatment proportions, P1-P2=-0.175

α=is the type one error (rejecting the null hypothesis when it is actually true). The study deployed a two-sided t-test that requires smaller sample sizes and set α to 0.05

β=type two error (the probability of rejecting the null hypothesis when it is false). This is given by the power of the study. Conventionally, the power is set at 0.80, for higher the power, the more sample is required.

z= the standard normal deviate for a one or two sided x;

First Step:

Feeding the stated quantities into equation 1 yields the following;

Formula for determining the number of subjects per group for dichotomous outcomes for a two-sided significance level α and power 1-β we have;

$$m = \frac{(1.96 + 0.842)^2[0.3\,(1 - 0.3) + 0.47(1 - 0.47)]}{(0.3 - 0.47)^2} \ldots\ldots\ldots\ldots Equation\ 1$$

m=287 participants per study arm (Sample size before adjusting for the design effect)

Second Step:

In order to adjust for the clustering effect, the sample size for binary outcomes will be inflated by the Design Effect (DE) to obtain an adjusted sample size[13].

The adjusted cluster size will thus be:

$$\boldsymbol{m} = \frac{\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2[P_1(1 - P1) + P_2(1 - P_2)]}{\Delta^2}$$
$$\times (1 + (n - 1)\rho) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation\ 2$$

The design effect is computed as; DE=1+(n-1)ρ

Where ***n*** is the number of individuals per cluster and ***ρ*** the Intra-Cluster Correlation Coefficient (ICC).

ICC is the ratio of the between-cluster variance to the total variance of an outcome variance and quantifies the correlation between the outcomes of any two individuals within the same cluster [8].

Since there were no previously published study findings in Uganda documenting the ICC, an ICC of 0.01 was adopted since it is within the recommended inter-quartile range ICC (0.011-0.094) for previously undocumented ICC. Researchers recommend a minimum cluster size of 50 subjects per cluster to cater for secondary outcomes, therefore, a fixed cluster size of 80 expectant mothers was considered for this study [8].

Therefore, the design effect was computed as;

DE=1+ (287-1) *0.01

DE=3.86

When the quantities are fed into equation 2, the adjusted sample size that the study was to engage was; $m = \frac{(Z_{1-\alpha/2}+Z_{1-\beta})^2[P_1(1-P1)+P_2(1-P_2)]}{\Delta^2} \times DE \ldots\ldots\ldots\ldots Equation\ 2$

$$m = \frac{(1.96 + 0.842)^2[0.3\,(1 - 0.3) + 0.47(1 - 0.47)]}{(0.3 - 0.47)^2} \times 3.86 \ldots\ldots\ldots\ldots\ldots.. Equation\ 3$$

m=287×3.86=1108 (Sample size per arm after adjusting for the design effect)

m=1108 per study arm

Multiply by the two arms the total number of expectant mothers to be engaged in both arms will be **2216**.

Therefore, a sample size of 2216 with 1108 expectant mothers per arm was sufficient to detect a clinically important difference of 38.6% between groups in the mobile telephone communication intervention, using a two sided test of 80% power (β) and 5% of significance level (α) with 95% confidence interval.

Obtaining the Number of Clusters

The minimum number of units required to attain a 5% level of significance would be four per arm assuming normality for the cluster level responses and the use of non-parametric test, Mann–Whitney U-test [7-9]. Therefore, the least number of expectant mothers a cluster was to have were four.

Furthermore, researchers aver that with three units per arm, it is within the bounds of chance that the outcomes in the three treatment arms are all greater than the outcomes in the three control arms, but with four per arm, this is unlikely to happen by chance more than 1 in 20 times [8]. Therefore, the minimum number of clusters is four per arm (eight in total) for an unmatched design or six matched pairs for a matched design.

To determine number of clusters needed (n_cluster)

n_cluster   = Total number of participants in the two groups (/ fixed cluster size)

 = 2216 / 80

=27.7clusters~28 clusters

Therefore, the study had a total of 28 clusters, 14 clusters being randomized to the intervention arm and 14 randomized into the control group.

2.3 Sampling Techniques

Sampling of participants for quantitative data collection

The study applied the multi-stage sampling technique to select the study participants. With the multi stage sampling method, the study ably divided the population of expectant mothers into groups/clusters at different stages to ease data collection, management and interpretation. The districts of Kyotera and Rakai were purposively sampled due to the attendance and utilization of ANC services estimated at only 30%; which is below the desired national consumption of 47.5% [12]. The gap in the attendance and utilization of ANC services arises from the poor use of mobile telephone communication to obtain vital maternal health information in the districts of Kyotera and Rakai[3]. Kyotera and Rakai Districts have a total of 112 registered medical facilities spread across the three counties of Kakuuto, Kooki and Kyotera [10]. In order to ensure that any baseline differences in group characteristics were purely a result of chance rather than systematic bias, the cluster was the unit of randomization in the study.

Cluster Sampling: Clusters of expectant mothers obtaining ANC services from selected health Centres who were representative of the target population were identified and included in the sample [15]. Each health facility was a cluster and it was the sampling unit. The sampling frame comprised of all registered health facilities. Lists of registered health facilities were obtained from the district health officers in the two districts. The facilities were ranked based on the

number of expectant mothers attending ANC at the different facilities. The 28 clusters (health Centres) with the highest ANC attendance were prioritized in the study.

Random Sampling: After obtaining the 28 health centers from the register of health Centres, each health centre was allocated unique identification number that was written on small pieces of paper and placed in a box. The random numbers were written in such a way that 14 health centers were to be allocated to the intervention arm (7 Kyotera and 7 Rakai district) and 14 allocated to the control arm (7 Kyotera and 7 Rakai district). This was done to ensure that the allocation into the study arms was balanced across the two districts.

Other factors that were considered for inclusion of a health facility into the study included;
  a) Willingness to participate in the study expressed by the administrator or in charge of the facility and the midwife.
  b) Availability of ANC services.
  c) Geographical location of the health centre randomly sampled

Systematic Sampling: Systematic sampling was used to select the 2216 expectant mothers from the 28clusters. A random expectant mother was selected at the start and every ith mother who met the eligibility criteria was recruited into the study up to 80 expectant mothers per health facility. The sampling framework is displayed in Figure 1.
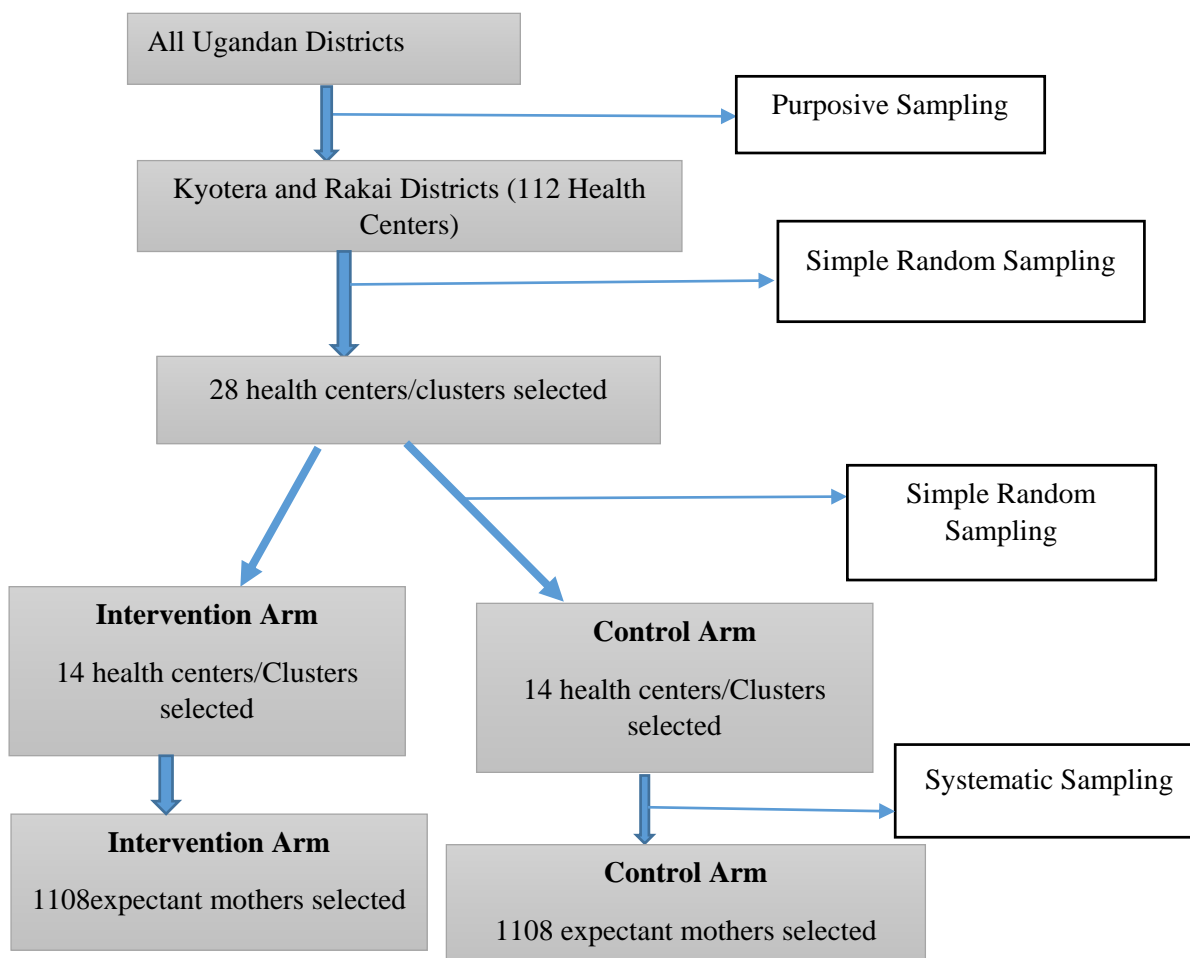
Figure 1: Sampling Framework for the Study   Data Source: Primary Source, 2022

2.4 Recruitment of the Expectant Mothers:

The research assistants engaged the in charges at the different health Centres to understand the ANC schedules and conduct a review of registers. After reviewing the registers, engagement was sought with the VHTs to conduct a community mobilization for the study participants. The engagement of VHTs to mobilize expectant mothers in the villages, raised awareness of potential study participants who reported to the selected health facilities for recruitment into the study. On reporting to health centres, expectant mothers were received by the research assistants enforce a random start. Thereafter, the research assistant discussed the study objectives with every ith expectant mother for recruitment into the study.

After explaining the study objectives to the potential study participant, the research assistant would administer the consent form and willingness to participate in the study was affirmed by appending a signature or thumb print. On receiving a signed consent form, the expectant mother provided baseline information to the research assistant obtained through completing the interviewer administered expectant mother questionnaire. Completion of the baseline data collection tool led to the allocation of the unique identification number to the expectant mother that was used to follow up the mother during the study.

Where VHTs identified an expectant mother in the village who is eligible for recruitment and had not come to the health facility, the VHT would guide the research assistant to the potential participant. When the expectant mother signed a consent form, then they were recruited into the study.

2.5 Description of the Intervention

Message Contents

In the intervention arm, mobile telephone phone-based text and voice messages sent to expectant mothers and VHT's hailing from villages served by health Centres in the intervention comprised of information about the usefulness of maternal health services' such as ANC, PNC and institutional delivery; and reminders of the next scheduled ANC appointment.

Particularly, every two weeks a text messages were sent to expectant mothers in the intervention arm. Text messages were followed up with a monthly voice call to cater for mothers who could not read. The text messages were developed in Engish and translated into Luganda based on the findings in the baseline where expectant mothers indicated that preferred languages of coomunications.

Scheduling of Expectant Mothers and Message Content

The international guidelines on maternal health supports the notion that the first ANC visit should be as early as possible in pregnancy, preferably in the first trimester; that is; within the first 12 weeks [16]. In a normal pregnancy, a minimum of eight ANC visits is recommended [16]. Furthermore, the Ugandan maternal health guidelines developed by the Ministry of Health provide for a minimum of 8 ANC visits during pregnancy [17]. Therefore, provision of maternal health and reminders for scheduled ANC visits was done on a monthly basis with one voice call and two text messages happening on a fortnightly basis. Therefore, an expectant mother randomized into the intervention group received a total of 18 text messages and nine voice calls during the study period.

An expectant mother was deemed to have received the intervention if they received atleast nine text messages and atleast five voice calls.

2.6 Description of the Control Group

In the control group, expectant mothers received existing maternal health information that informed them about the advantages of maternal health care service use at the respective health centers. The expectant mothers verbally obtained information from the midwives at the health centers, informing them about the available services and giving appointments for scheduled ANC visit.

Whereas expectant mothers had mobile telephone, no mobile text/ voice message were sent to expectant mothers in this group . Base line data was collected by research assistants and VHT's from the expectant mothers who meet the eligibility criteria across the 19 Sub-Counties of Kyotera and Rakai Districts. The data collected focused on the key components identified in the designed data collection instruments.

In the event that an expectant mother moved to another location that was not within the study area before the end of the study period, they would be recorded as drop-outs irrespective of the study arm. The status of delivery was tracked by VHT's and research assistants in view of the fact that mothers have different gestation periods.

Following up Expectant Mothers

Intervention Arm
Health Centers randomized into the intervention arm and mothers enrolled into the study in these health Centres were followed up by the VHTs only a monthly basis. This was in addition to the fortnightly maternal health messages (voice and text) reminders that were sent to mobile telephones.

The VHTs put emphasis on encouraging women who have received messages to go and receive ANC at the health facility as reminded. The VHT were required to report those who had missed any ANC visits, had any complications and those who changed location.

A midterm review of ANC registers at the health Centres was conducted by research assistants to establish the number of times an expectant mother had attended and utilized ANC services.

Similarly, at the time of delivery, a mother was required to complete an interviewer administered exit interview that enriched the study with details of the 9months. This was done by the research assistants. Where the delivery happened outside the health facility, the research assistant was guided by the VHT to the home of the study participant to have the exit interview form completed.

Control Arm
Expectant mothers in the control armwere monitored by VHTs and were reminded that ANC services are available at the nearby health facility with no additional information. The VHTs were similarly be required to report those who had missed any ANC visit, had any complications and those who had changed location.

A midterm review of ANC registers at the health Centres was nducted by the research assistants to establish the number of times a study participant had attended and utilized ANC services.

Similarly, at the time of delivery, a mother was required to complete an interviewer administered exit interview that enriched the study with details of the 9months. This was done by the research assistants. Where the delivery happened outside the health facility, the research assistant was guided by the VHT to the home of the study participant to have the exit interview form completed.

Data Collection Methods: Quantitative data was collected using the survey method at three intervals during the 12months. Expectant mothers provided baseline data at the commencement of the study, at 6months data was collected from ANC registers and at 12 months an interviewer administered questionnaire was completed by expectant mothers. Qualitative data was collected to enrich quantitative findings mainly using in-depth key informant interviews and focus group discussions once for the 12months period.

Data Collection Tools: Quantitative data was collected using the interviewer-administered questionnaire. On the other hand, qualitative data was collected using the Key Informant Interview guide and discussions using the Focus Group Discussion guides.

Participants: The study respondents to the interviewer administered questionnaires, key informant interviews and focus group discussions were categorized as shown in Table 1.

Table 1: Sampling Frame Showing Categorization of Participants

Category of Participants	Target Population	Sample Size	Sampling Technique
Quantitative Sample Frame			
Health Centres	112	28	Simple Random
Expectant mothers	5589	2*1108=2216	Systematic Sampling
VHTs	117	28	Simple Random
Qualitative Sample Frame			
District Health Officers	200	5-25	Stratified sampling
Nurses	112	5-25	Purposive
Midwives/In charge HC	112	5-25	Purposive
District & Community Leaders	70	5-25	Purposive
Husbands to mothers	800	5-25	Convenience
VHT's	150	5-25	Convenience/SRS
Total	1444	<=50	

Source: Primary Data 2021

Table 1 summarizes the different targeted study respondents at different levels and the means of sampling that were used to arrive at the desired sample size in each category.

Validation of Data Collection Instruments: The study data collection instruments were tested for face and content validity. This validation of instruments was to ensure that the tools accurately measure what they aimed to measure, regardless of the respondent. A valid data collection tool supports the collection of better quality data with high comparability and increased data credibility.

2.7 Data Analysis

Quantitative data analysis
Analysis was done using aggregate cluster-level analysis; Regression analysis using individual expectant mother data with robust standard errors; Random-effects (Res) models using individual expectant mother data and; population averaged models using individual patient data with regression coefficients estimated using generalized estimating equations (GEEs). During the study, data exploration was done to visualize the general features of the data then the key analyses conducted using SPSS at both cluster and individual level.

Descriptive Statistics
Summary statistics for the categorical ANC attendance and utilization outcome were generated in form of means, proportions, frequencies and percentages depending on the nature of the data.

Measures of central tendency for both clusters and individuals such as frequencies, mean, medians and standard deviations formulated the descriptive statistics that were generated to describe the characteristics of the study population on sex, age, socio-economic, education level, distance from the health center and transport costs among others.

Inferential Statistics with Associations Inclination
The Chi-Square test and Pearson's correlation product moment were generated from the data to determine the association between mobile telephone use and ANC attendance among expectant mothers in Kyotera and Rakai Districts.

The paired t-test will be used to test whether the mean difference of the ANC utilization between the intervention and control groups is zero or not.

Inferential Statistics with Effect Inclination
On the other hand of inferential statistics, a general logistic regression model were fitted to the data to the assess the impact of the intervention that is; mobile telephone communication use and ANC attendance and utilization of services. In order to identify independent factors that influence ANC attendances among expectant mothers in Kyotera and Rakai Districts, a multiple logistic regression model was fitted to data.

A path analysis was conducted to examine the comparative strength of direct and indirect relationships among variables using the Structural Equation Modelling (SEM). With the use of SEM the study was able to measure and analyze the relationships of observed and latent variables

Qualitative Data Analysis

Content Analysis
The data obtained from FGD and key- informant interviews regarding the attitudes and perceptions of expectant mothers about the ANC attendance in Kyotera and Rakai Districts required coding and categorization into themes. Therefore, content analysis formulated the basis for the engagement of other qualitative analysis methods.

Thematic Analysis
The study deployed a thematic analysis to display and classify data from the two study arms based on similarities and differences [18]. The use of thematic analysis provided an opportunity to understand the criticality of any issues regarding ANC attendance among expectant mothers [19].

Studies emphasize that apart from counting explicit phrases and words, the thematic analysis pays due attention to ascertaining and describing both explicit and implicit proposal therein [20].

3.0 Results and Discussion

Social Demographic Characteristics Of Expectant Mothers

The entire study had a total of 2143 expectant mothers with 1060 mothers randomized into the intervention arm while 1083 mothers randomized into the control arm. Out of the 2143, 245 were less than 18years (12.0%), 1394 (68.5%) were aged 19- 29 years, 373(18.3%) were aged 30-40 years and 22(1.1%) were aged 41 years and above. A total of 1608(75.4%) of the expectant mothers were married, 160(7.5%) were single, 13(0.6%) were divorced, 18(0.8%) were separated, 8(0.4%) were widows while 325 (15.2%) were cohabiting. As far as the education level of expectant mothers was concerned, 269(12.7%) had not gone to school at all, 1145(53.9%) were primary leavers, 534(25.1%) had attained secondary education, 126(5.9%) had attained tertiary education while 51(2.4%) were university graduates.
With regard to religious affiliations of expectant mothers, 1055(49.3%) were Catholics, 558(26.1%) were Anglicans, 93(4.3%) were Moslems, 276(12.9%) were SDAs while 159 (7.4%) were classified among other religious affiliations.

Chi-square test for demographic characteristics at baseline

Age of expectant mothers: Majority of expectant mothers were aged between 19 and 29 years with 720(69.9%) in the intervention arm and 674(67.1%) in the control arm. No statistically significant differences were observed around age (χ^2=4.572, p=0.206). This means that the expectant mother age grouped were balanced across the two groups with particular age group being to high or too low compared to another in both the intervention and control groups.

Marital Status: Majority of the expectant mothers were married with 74.7% randomized in the intervention and 76.1% randomized into the control group with insignificant variation between the two groups (χ^2= 2.348, p=0.799). This suggests that the randomization was balanced in that both groups comprised of mothers of different marital status at the same level. Thus, no group had the married only or nay other categorization only.

Education Level: With regard to education, most expectant mothers had attained primary education. In the intervention group, 54.4% had attained primary education while 53.3% had attained primary education in the control arm. The allocation with respect to education level did not show any statistically significant difference among the two groups (χ^2= 3.788, p= 0.58). This means that the education levels were balanced across the two groups with no group have only one education level. All levels were represented in the two groups with comparable proportions of expectant mothers.

Religious Affiliation: Majority of the expectant mothers in Kyotera and Rakai Districts were Catholics with 50.5% of the mothers randomized into the intervention group being Catholics and 48.1% of expectant mothers randomized into the control group being Catholics.
There was no statistically significant difference observed with regard to religious affiliations (χ^2= 3.614, p= 0.461). Impliedly, all religious denominations were represented in comparable proportions without any skewness towards a certain denomination across the two groups.

Interpretation and Discussion of the Demographic Characteristics on the Attendance and Utilization of ANC Services by Expectant Mothers in Kyotera and Rakai Districts.

The findings in Table 3.1 indicate that there was no statistically significant difference in the demographic characteristics of the expectant mothers in the intervention group compared to

mothers randomized into the control group. Specifically, the expectant mother age group recorded a $\chi2= 4.572, p=0.206$ which is greater than 0.05, marital status recorded a $\chi2=$ 2.348, p=0.799, education level recorded a $\chi2= 3.788, p=0.588$ and $\chi2= 3.614$, $p=0.461$. The results of social demographics generally depict homogeneity across the two groups which implies that the randomization of the health centres was properly conducted. All expectant mothers had comparable age groups, education levels and with an even distribution across the religious affiliations and marital status. There were observably no inclinations in numbers across the two groups with respect to social demographic characteristic meaning that no group had categorization that was much bigger than another.

The baseline findings with regard to social demographic characteristics are in resonance with an argument affirming that when there is no observed imbalance in the baseline variables across the study arms, it is assumed that the outcome of the study was due to the intervention[21]. Furthermore, baseline findings are in consonance with the CONSORT 2010 guidelines which assert the need for proper participant selection for avoidance of baseline differences to facilitate comparison and data utilization[6].

Therefore, the expectant mothers were drawn from the same population in the districts of Kyotera and Rakai implying that the reported results from the study that occurred in the intervention were not by chance but attributed to the mobile telephone communication intervention provided in the selected health centres. Given the homogeneity observes across the study groups, the study provided maternal health information and reminders for scheduled ANC visit using mobile telephone communication and the specific interventions are provided in section 3.2 below.

Provision of ANC Information and Reminders for Scheduled ANC Visits to Expectant Mothers Using Mobile Telephone Communication

The study provided ANC information to all expectant mothers that were randomised into the intervention arm. The information included; dates of ANC clinics at the health centre, available ANC services at the Health Centre, advantages of going for ANC, reminders of the next schedule visits.

The intervention provided a minimum of 18 text message to all mothers randomized. Two message were sent every month, that is, every two weeks a message was sent. The text messages were followed by a monthly voice call to take care of the expectant mothers who could not read the text messages.

An expectant mother was considered to have received reminders for scheduled ANC visits and maternal health information if at least 9 text messages were received and at least 5 voice calls were made to the expectant mothers. As a result of providing ANC information and reminders, expectant mothers went to the health centre and obtained the following service; Maternal Health Education, Physical Examination, Gynaecological Examination, Blood Tests, Urinalysis, Ultrasound, Malaria Test &Treatment, Nutritional Supplements, Tetanus Vaccine, HIV/STD Tests and PMTCT.

Expectant mothers recruited into the study provided perceptions about the mobile telephone communication reminders for scheduled ANC visits and receipt on maternal health information and some are provided below.

> *The use of mobile telephone communication to give us maternal health information is welcome because sometimes the VHT is away so we do not get the information on time. (FGD1, 2022)*

> *It is good that the messages to be shared are in local languages, the information will be easily understood because English is not easy for many of us. (FGD1, 2022)*

Baseline Findings Regarding Receipt of Maternal Health Information and ANC Visit Reminders by Expectant Mothers Using Mobile Telephone Communication

The study established that before the intervention, majority of the mothers that is 98.9 % in the intervention group and and 99.2% in the control group did not receive mobile telephone messages and voice calls for maternal health information and reminders for scheduled ANC visits. The receipt of ANC reminders and maternal health information using mobile telephone communication by either text message or voice calls did not have statistically significant differences at baseline with χ^2=1.695, p=0.193 and χ^2=0.725, p=0.395 for text messages and voice calls respectively. This means that expectant mothers in the districts of Kyotera and Rakai did not receive maternal health information on their mobile telephone irrespective of the group an expectant mother was randomized into. A mere 1.4% and 0.8 % who reported to have received reminders informed the study that reminders were done by either husbands or relatives. This confirmed that no prior study had provided such an intervention to the expectant mothers in the districts of Kyotera and Rakai.

Based on the qualitative findings which envisaged sharing of maternal health information as an practical alternative in the event that the VHT was away to deliver information and the absence of a similar intervention in the past as evidenced by the 98.9 % and 99.2% expectant mothers in the intervention and control group respectively who did not receive such reminders in the past, the study implemented the intervention.

Endline Findings Regarding Receipt of Maternal Health Information and ANC Visit Reminders by Expectant Mothers Using Mobile Telephone Communication.

At the end of the intervention, majority of expectant mothers randomized into the intervention arm reported to have received the minimum number of text and voice messages being 77.10% and 98.10% for text messages and voice calls respectively. On the other hand, the study established that 97.3% and 82.13% of expectant mothers randomized into the control arm did not receive either a text message or voice call respectively as reminders for scheduled ANC visits and maternal health information. This implies that text messages providing maternal health information and reminders for scheduled ANC visit were sent to the correct group of expectant mothers who had been randomized into the intervention group.

The receipt of ANC reminders and maternal health information using mobile telephone communication by either text message or voice calls recorded significant differences at the end of the intervention with χ^2= 1445.023, p<0.0001 and χ^2=1524.633, p<0.0001 for text messages and voice calls respectively. This means that mothers randomized into the intervention group indeed received the desired maternal health information using the mobile telephone communication platform which was not the case with expectant mothers randomized into the control group. The intervention created a significant difference in terms of number of text messages and voice calls received across the two study groups. The difference in difference for the two groups was 94.3% for text messages and 95.2% for voice calls meaning that expectant mothers in the intervention group received maternal health text messages to a tune of 94.3% compared to the counterparts in the control group and 95.2% more voice calls compared to the counterparts in the control group. Expectant mothers provided perceptions after the intervention and indicated that;

> *Mobile telephone communication messages were very useful especially in rainy season where going to the garden takes most of my day. It easy to forget the appointment, when I got the message the day before I remembered and planted my maize after visiting the health centre. (FGD2,2022)*

The voice call saved me transport costs because the midwife had lost someone and I had to go the following day. The caller advised me to go on Wednesday instead of Tuesday which really saved me. (FGD2,2022)

3.3 ANC Attendance and Utilization of ANC Services Among Expectant Mothers in Kyotera and Rakai Districts

Maternal health guidelines in Uganda provide that an expectant mother should attend at least eight ANC visits[17]. During the 8 visits, the mother should be exposed to 8 maternal health education sessions, 8 physical examinations, at least 2 blood tests with an intention to establishing the HIV status of the expectant mother, at least 3 preventive malarial doses, nutritional supplements given at each of the eight visits, at least 2 tetanus vaccine eight for an expectant mother. Therefore, the expectant mother was considered to have attended ANC if she attained the eight recommended visits and utilized ANC services if she attended received the minimum prescribed doses for each service.

Baseline Findings Regarding Mobile Telephone Communication and Utilization of ANC Services Among Expectant Mothers in Kyotera and Rakai Districts

Findings indicated that the proportion of expectant mothers who attended ANC visits for more than eight times did not vary significantly across the two groups with 51.4% in the intervention arm and 55.3% in the control arm (χ^2= 3.39, p= 0.495). This means that the attendance of ANC visits at baseline did not have variations across the groups. Expectant mothers randomized into the intervention arm and those randomized into the control arm did not attain the MoH recommended number of eight visits during pregnancy. Therefore, the variations observed in the number of ANC visits attended among the expectant mothers in the intervention group at the end of the study were attributed to the mobile telephone communication text and voice calls provided to mothers randomized in the intervention arm.

Furthermore, the consumption of all other ANC services did not depict significant variations between the intervention and control arms where maternal health education recorded χ^2= 2.819, p=0.589. This suggested that the number of maternal education sessions that expectant mothers randomized into the intervention arm and those randomized into the control group did not have variations and in both groups, it was below the minimum eight sessions an expectant mother should be exposed to during pregnancy.

Additionally, blood tests for expectant mothers recorded χ^2= 5.290, p=0.259 which was not statistically significant. This means that expectant mothers randomized into the intervention group and those randomized into the control group had the same number of blod tests with 55.7% in the intervention group having no blood tests done and 54.0% having no blood tests node in the control group.The tetanus vaccination among expectant mothers recorded a χ^2= 7.735 and a p=0.102 which were not statistically significant meaning that mothers in both groups of the study received the same number of dozes for the tetanus vaccination. Preventive malarial treatments as one of the ANC services also recorded a non-statistically significant of χ^2= 3.614, p=0.46. This suggested that mothers in both groups of the study received the same number of dozes for preventive malarial treatments with no big variations observed to point to biases in the randomization process.

Consequently, the variations observed in the utilization of crucial ANC services such as Maternal Health Education, Physical Examination, Gynaecological Examination, Blood Tests, Urinalysis, Ultrasound, Malaria Test &Treatment, Nutritional Supplements, Tetanus Vaccine, HIV/STD Tests and PMTCT among the expectant mothers in the intervention group at the end of the study were attributed to the mobile telephone communication reminders provided during the 9 months. Persons in charge of health centres provided an overall picture of ANC utilization and key informants indicated that;

> *Expectant mothers in this area do not like coming for ANC early, they come at the later stages of pregnancy making it difficult to identify danger signs early and even learn the basics about maternal health that we teach during the maternal health education sessions.* (KI03,2022).

This means that expectant mothers in the districts of Kyotera and Rakai are not accustomed to attending ANC during the early stages of pregnancy and thus exposed to risks of late identification of danger signs of pregnancy.

Given that baseline findings were not different across the two groups, the study assessed the effectiveness of mobile telephone communication use on the attendance and utilization of ANC services.

3.4 The Effect of Using Mobile Telephone Communication to Provide Maternal Health Information on the Utilization of ANC Services Among Expectant Mothers

End line Findings Regarding Mobile Telephone Communication and Utilization of ANC Services Among Expectant Mothers in Kyotera and Rakai Districts

At the end of the study intervention, 75.3% of the expectant mothers had attended at least 8 ANC visits in the intervention group compared to the 51.4% observed at the baseline in the same arm. This means that there was considerable increment in the number of expectant mothers who achieved the MoH recommended 8 ANC visits. Notably, expectant mothers in the control group who attended at least 8 ANC visits dropped from 55.3% at baseline to 34.3% at the end of the study. This means that mothers randomized into the control group who attended the recommended MoH 8 ANC visits further dropped from the baseline observations. Therefore, more expectant mothers in the intervention group obtained the vital ANC services compared to expectant mothers in the control group. Statistically significant differences were observed between the two groups with regard to the number of ANC visits attended with $\chi^2 = 321.107$, p<0.000. This suggested that there was a big variation in the attainment of the MoH recommended 8 ANC visits between expectant mothers randomized into the intervention group and those randomized into the control group. This further suggested that expectant mothers randomized into the intervention group received ANC right from the early stages of pregnancy and attained the 8 ANC visits as recommended by MoH and thus obtained more maternal health education and other ANC services compared to the expectant mothers randomized into the control group since it was a mere 34.3%.

When key informants were asked about ANC utilization at the end of the study intervention, it was pointed out that;

> *The mobile telephone communication reminders were very good because expectant mothers managed to come to the health centre early an in big numbers every month though it was overwhelming since we are very few health workers at the health centre.* *(KI04, 2022)*

This suggested that expectant mothers turned up for ANC visits during the early stages of pregnancy despite the number the number of health workers at the health centres being low. Furthermore, the consumption of ANC services depicted statistically significant variations between the intervention and control arms where maternal health education recorded a $\chi^2 = 666.734$, p<0.000. This means that expectant mothers in the intervention group attended ANC visits at the early stages of pregnancy recommended 8 maternal health education sessions when compared to the expectant mothers in the control group. This provided an opportunity for expectant mothers to attain a more information on maternal and child care during the eight maternal health education when compared to mothers in the control group.

Blood tests for expectant mothers recorded statistically significant differences recorded at a a $\chi^2 = 14.631$, p<0.001. This suggested that expectant mothers in the intervention group attained the recommended 2 blood tests compared to the expectant mothers in the control group. This further meant that expectant mothers in the intervention group had an opportunity to start on the prevention of mother to child due to the early interaction with the health the healthcare system. The results of tetanus vaccination also showed statistically significant differences with a recorded a $\chi^2 = 47.965$, p<0.000. This suggested that the number of expectant mothers in the intervention group who received tetanus vaccinations was more than the number of expectant mothers who received the tetanus vaccination in the control group. This further means that more expectant mothers in the intervention group had immunity for tetanus compared to mothers in the control group. Results for preventive malarial treatments showed a a $\chi^2 = 40.704$, p< 0.000, this suggested that mothers in the intervention group received more preventive doses for malaria compared to the expectant mothers in the control group. Therefore, fewer numbers of expectant mothers in the intervention group had a risk of getting malaria during the study period because of the low utilization of ANC services.

Study findings in showed that the percentage of expectant mothers who attended 8 ANC visit was 75.3% in the intervention group and 34.3% in the control group. The findings are coherent with the Zanzibar study where results showed that mobile telephone communication use increases ANC attendance [22] despite the fact that percentages observed in Zanzibar were 44% and 31% for the intervention and control group respectively.

Qualitative findings indicated that:

> *The monthly reminders and the subsequent interface with the midwife enabled me take good care of myself and resulted into a successful delivery of a healthy baby boy compared to the previous birth where I was referred to Kalisizo Hospital. (KI05, 2022)*

This suggests that late interactions with the healthcare system during pregnancy may result into referrals since the health centre has not had enough time to monitor the expectant mothers over the nine months.

The study further fitted a multiple logistic regression model to the data where an outcome of 8 or more visits was coded at 1 and zero otherwise. Table 3.1 clearly indicates expectant mothers who received at least eight text messages were more likely to attend the recommended 8 ANC visits (OR=1.72555, p<0.05) compared to mothers who did not receive the text messages and the difference was statistically significant. This meant that expectant mothers who received text messages with maternal health information and reminders for scheduled ANC visits had 1.73 chances more of attending ANC compared to expectant mothers in the control group. Therefore, expectant mothers in the intervention group had 1.73 more chances of receiving all services in provided at ANC visits including blood tests, preventive malarial treatment, tetanus.

The findings rhyme with the qualitative findings which asserted that:

> *I missed the call and did not have airtime to call back but when I read the message on my mobile telephone, I went to the health facility and received my routine check-up for the pregnancy. Messages are better because I was able to find it even after some hours and picked the information (FGD, 2022)*

Study findings indicated that merely owning a telephone without receiving maternal health information and reminder did not improve the ANC attendance and the no statistically

significant difference between expectant mothers who owned a mobile telephone and those who did not own a mobile Telephone (p>0.05). This meant that the number of ANC visits did not differ by simply owning a telephone across the groups. Therefore, an expectant should not only own a phone but also receive relevant matter health information and reminders for scheduled ANC visits if ANC attendance is to be improve.

Table 3.1: Logistic Regression Showing the Relationship Between Mobile Telecommunication Use and the Utilization of ANC Services

ANC Outcome	Odds Ratio	Std.Err	Z	P>/z/ Value	-	[95% Interval]	Conf.
Own a Phone -Yes	*0.76252*	0.133811	-1.55	0.122		0.54060	1.075536
Send/Receive Messages-Yes	*1.72555*	*0.324982*	*2.90*	*0.004*		1.19294	2.495977
Make Voice Calls-Yes	0.480541	0.205126	*-1.72*	*0.086*		0.208152	1.109379

** Significance at 5% level. Data Source: Primary Data,2022

Hypothesis Testing

Ho: Use of mobile telephone communication does not affect utilization of antenatal care services among pregnant women in the districts of Kyotera and Rakai - Uganda

H$_1$: Use of mobile telephone communication affects the utilization of antenatal care services among pregnant women in the districts of Kyotera and Rakai - Uganda

The null hypothesis in a multiple logistic regression assumes that all coefficients are zero and none of the predictors has a statistically significant relationship with the response variable which was ANC attendance of at least 8visits in the current study. On the other hand, the alternative hypothesis states that not every coefficient is simultaneously equal to zero.

From table 3.1 phone ownership had a coefficient of 0.763 with p>0.05, receiving of voice messages had a coefficient of 1.73 with a p<0.05 while receiving of voice calls had a coefficient of 0.48 with ap>0.05. As observed, in table 3.1, all the coefficients are not equal to zero.

The study therefore, rejected the null hypothesis which stated that use of mobile telephone communication does not affect utilization of antenatal care services among pregnant women in the districts of Kyotera and Rakai – Uganda and accepted the alternative hypothesis which stated that *use of mobile telephone communication affects the utilization of antenatal care services among pregnant women in the districts of Kyotera and Rakai – Uganda*.

Discussion on the Effect of Mobile Telephone Communication Use On The Utilization Of ANC Services Among Expectant Mothers in Kyotera And Rakai Districts:

The study established that the utilization of ANC services was higher (75.3%) in the intervention group where the expectant mothers received maternal health information and reminders for scheduled ANC Visits compared to the control group where it was a mere 34.3%. There was an observable statistically significant difference in the utilization of ANC services between expectant mothers randomized into the intervention group and those randomized into the control group with χ 2= 321.107, p<0.000. This meant that more expectant mothers in the intervention group met the 8 ANC visits recommended by the MoH compared to the expectant

mothers in the control group. The current study findings agree with the findings where the attendance of the recommended 4 ANC visit was observed at 75% in the intervention group compared to a mere 13% recorded in the control group[22].

Similar studies indicated that use of mobile telephone communication applications during pregnancy help in reminding mothers to attend antenatal/postnatal visits, enhance spouse support and involvement and facilitate communication with health care providers among other things[24].

It is important to note is that whereas some studies provided only text messages[23] to the expectant mothers, the current study provided both text and voice messages for expectant mothers randomized into the intervention arm to take care of the rural women who may not have been able to read the text message. At the end of this study, 75.3% and 34.3% of expectant mothers had attended the recommended 8 ANC visits as observed in Table 5.3.

Whereas texts messages were the only option in some studies[23], results obtained provided closely related results of 75% for the intervention group and 13% for the control group despite the variance in the number of visits focused on as 4 ANC Visits.

On the other hand, when expectant mothers were provided an enhanced mobile telephone communication application with videos providing illustrations on the usefulness of maternal health care[24].

Based on the closely related studies discussed above, the current study affirms that use of mobile telephone communication enhances the utilization of ANC services among expectant mothers irrespective of the minimum number of visits recommended by the MoH. The provision of maternal health information using text messages preferably in local languages yields better results since the messages can be retrieved and referenced at any point in time as seen in the qualitative findings (FDG2,2022).

Summary of Key findings
Study findings indicated that there were no statistically significant variations in the baseline variables for expectant mothers randomized in either group of the study which suggested that the randomization of health centres into the two study groups was properly conducted and suggested homogeneity of the study population in the districts of Kyotera and Rakai in Uganda.

Merely owning a mobile telephone by an expectant mother does not guarantee increase in the utilization of ANC services unless the mobile telephone owned by the mother receives maternal health information and reminders for scheduled ANC visits

Voice calls made to expectant mothers to provide maternal health information may not enhance the utilization of ANC services.

Mobile telephone communication usage most especially text message enhances the utilization of ANC services among expectant mother.

Conclusion:
Based on the study findings discussed above, mobile telephone communication use enhanced the utilization of ANC services among expectant mothers in the districts of Kyotera and Rakai Uganda. It is however, important to interrogate factors that may lead to the use of mobile telephone communication among expectant mothers. Therefore, chapter six discusses the factors that motivate of impede the utilization of mobile telephone communication among expectant mothers.

Recommendation:

The Ministry of Health works closely with mobile telephone communication companies to avail vital maternal health information to the expectant mothers.

The use of text messages in local languages in the deliver of the messages is paramount to ease understanding of the contents and access after several days.

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