

The extent of exposure to mobile health initiatives in promoting timely initiation of antenatal care among pregnant women living with HIV in Kamuli district. A cross-sectional study.

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Abstract:

Background:

Timely initiation of antenatal care (ANC) is essential for improving maternal and neonatal outcomes, particularly among pregnant women living with HIV (PWLHIV). This study assessed the extent of exposure to mHealth initiatives in promoting timely ANC initiation among PWLHIV in Kamuli District, Uganda.

Methodology:

A cross-sectional phenomenological qualitative study was conducted in Kamuli District among pregnant women living with HIV and health workers implementing mHealth interventions. Purposive sampling was used to select 15 pregnant women and 5 key informants. Data were collected using in-depth interviews and key informant interviews. Interviews were audio-recorded, transcribed verbatim, and thematically analyzed using Atlas.ti version 13. Ethical approval and informed consent were obtained before data collection.

Results:

The majority were farmers/peasants (35%), housewives (30%), and small business owners (25%). Most respondents were Catholic (30%), while 40% had attained primary education. Exposure to mHealth initiatives was moderate but unequal. Awareness mainly came through health workers, radio programs, and peers. Participants reported receiving ANC appointment reminders, medication alerts, and HIV-related education through mobile phones, which encouraged earlier ANC attendance. Health worker recommendations increased trust and willingness to use mHealth services. However, barriers included poor network connectivity, limited phone ownership, low digital literacy, privacy concerns, and inconsistent or excessive messaging. Women in remote rural areas were less exposed than those living near health facilities.

Conclusion:

Exposure to mHealth initiatives positively contributes to the timely initiation of ANC among PWLHIV in Kamuli District by improving reminders, awareness, and access to HIV-related maternal health information. However, access remains uneven due to technological and social barriers.

Recommendation:

Government and partners should strengthen rural network coverage, increase community sensitization, train health workers in digital support, ensure confidentiality, and design simple SMS-based interventions tailored to women with low literacy levels.

Keywords: Mobile health (mHealth), timely ANC initiation, pregnant women living with HIV, PMTCT, maternal health, digital health, Kamuli District.

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Background.

Antenatal care is critical in reducing maternal and neonatal mortality and morbidity. According to the WHO (2024), optimal ANC involves regular check-ups to monitor maternal and fetal health, provide essential nutrition and vaccination, and educate pregnant women on healthy practices. However, many women in low- and middle-income countries (LMICs) face barriers such as limited access to healthcare services, long distances to healthcare facilities, inadequate health literacy, and financial

constraints. mHealth initiatives can overcome some of these barriers by providing remote monitoring, health education, and direct communication with healthcare professionals. The coverage of mHealth initiatives is therefore crucial in delivering quality ANC services. The exposure of PWLHIV to mHealth initiatives varies significantly across regions due to differences in mobile phone penetration, health infrastructure, and digital literacy. In sub-Saharan Africa, mHealth interventions have been widely implemented, but their reach remains limited due to factors such as poor

network coverage and the affordability of mobile devices (Chib et al., 2020).

A study in Kenya found that while 85% of women owned mobile phones, only 40% were actively using mHealth services due to limited awareness and concerns about confidentiality (Odeny et al., 2019). Similarly, research in Uganda by Kizito et al. (2022) revealed that only 37% of PWLHIV had received SMS reminders for ANC, despite government efforts to integrate digital health solutions into maternal care. For instance, a study evaluating an SMS-based mHealth intervention aimed at enhancing adherence to antiretroviral (ARV) prophylaxis and early infant diagnosis (EID) among mother–infant pairs found that 73.3% of infants underwent HIV PCR testing at 10 weeks. This high rate suggests that mHealth interventions may positively influence timely ANC attendance and subsequent infant testing, although the study did not find a statistically significant difference compared to district rates during the same period (Dube-Pule et al., 2021).

In Uganda, the MatHealth App was developed to support maternal and child health among pregnant women, including those living with HIV. A study assessing its impact revealed that women using the MatHealth App had higher odds of knowing the recommended gestation period for starting ANC and the recommended number of ANC visits compared to those receiving routine care. Additionally, all women in the MatHealth App group exclusively breastfed their babies and brought them for HIV testing at six weeks, indicating improved adherence to recommended practices (Musiimenta et al., 2022). Despite the potential benefits, exposure to mHealth initiatives among pregnant women living with HIV varies. Factors influencing exposure include mobile phone ownership, literacy levels, and the availability of tailored interventions. A study conducted in Johannesburg, South Africa, found high mobile phone ownership among pregnant, HIV-infected women attending ANC; however, internet and email usage were low, suggesting that SMS-based interventions might be more effective in such contexts (Noholoza et al., 2023).

Assessing the coverage of mHealth initiatives is crucial to understanding their impact on population health. Coverage refers to the proportion of the target population that is reached by the intervention (WHO, 2010). Factors influencing coverage include the availability of infrastructure (such as mobile networks), affordability of mobile devices and data, and the acceptability and accessibility of the mHealth intervention itself. Studies have shown varying levels of mHealth coverage in different settings, with challenges related to equity and access often observed (Mbuagbaw et al., 2019). Furthermore, utilization, which refers to the actual use of the mHealth service by those who have access, is another important factor to consider. Even with high coverage, low utilization can limit the impact of mHealth interventions. While existing

literature highlights the potential of mHealth in improving ANC services for PWLWH, there are still research gaps, particularly regarding the coverage and utilization of these interventions in specific contexts like Kamuli district. In this section, literature has been reviewed on the coverage and utilization of mHealth initiatives globally. In Uganda, several mHealth initiatives have been introduced to enhance maternal health outcomes, particularly among women living with HIV. Programs such as m4RH (mobile for reproductive health) and U-report have contributed to increased ANC attendance and PMTCT service uptake (Kibuuka et al., 2021). However, in Kamuli District, where healthcare access remains a challenge, the role of mHealth in ANC initiation among HIV-positive mothers has not been extensively studied. Understanding how mobile interventions can be tailored to this region is crucial for improving maternal health outcomes. This study assessed the extent of exposure to mHealth initiatives in promoting timely ANC initiation among PWLHIV in Kamuli District, Uganda.

Methodology.

Study Design.

This study adopted a cross-sectional phenomenological qualitative design, which was deemed appropriate due to the research's central aim: to explore and understand the lived experiences, feelings, and perspectives of pregnant women living with HIV regarding the use of mobile health (mHealth) services in accessing antenatal care (ANC).

Study Area.

The study was conducted in the Kamuli District. Kamuli District is a district in the Eastern Region of Uganda. The town of Kamuli is the site of the district headquarters. Kamuli District is bordered by Buyende District to the north, Luuka District to the east, Jinja District to the south, and Kayunga District to the west. The district headquarters at Kamuli are approximately 74 kilometres (46 mi), by road, north of Jinja, the largest city in the Busoga sub-region.

Study Population.

Population refers to an aggregate of people or things that a researcher has in mind from which one can obtain information and draw conclusions (Franken and Wallen, 2016). A population targeted for a specific study shares a number of common features. In this study, the target population was pregnant women living with HIV in Kamuli district. In addition, the health workers who were implementing the mHealth initiatives were also included in the study.

Study Unit

The study unit was pregnant women living with HIV in Kamuli district, particularly those receiving care from health facilities implementing the mobile health initiative.

Inclusion

Page | 3 The study only included pregnant women living with HIV in Kamuli district who had been on treatment while pregnant.

Exclusion.

Those who are critically ill and mentally unsound were not included.

Sample Size Determination.

In this study, 10-15 pregnant women living with HIV were selected, and 5 key informants were selected. The sample size was reached by considering the accepted benchmark of 20 participants required to reach data saturation in a phenomenological study (Judith Green & Nicki Thorogood, 2014).

Sampling Technique.

A purposive sampling method was used for the selection of participants from the target population. The target population was the pregnant women living with HIV in Kamuli district attending health services at health facilities implementing mobile health initiatives that met the criteria, and were invited to participate in the study. The inclusion criteria include patients who have used mobile health initiatives, 15 years or older, able to communicate, and willing to participate in the study. The health workers for key informants were also purposively selected based on the fact that they are implementing mhealth care initiatives and working with pregnant women living with HIV.

Variables.

Dependent variable

The dependent variable was mobile health initiatives in the timely initiation of antenatal care among pregnant women living with HIV.

Independent variables.

The independent variable was the extent of exposure to mobile health initiatives in the timely initiation of antenatal care among pregnant women living with HIV.

Data Collection Methods

The study utilized an interview guide to gather information from the elderly persons and key informants within pertinent institutions. The guide contains structured questions that generated discussion on the sexual reproductive health rights among the elders. This tool allows the researcher to

read respondents' body language and other non-verbal communication (Creswell & Clark, 2017). It also allows the researcher to probe the respondents for deeper insights into the themes under investigation (Malunda & Atwebembeire, 2021).

An in-depth interview guide, which is the primary qualitative data collection tool in phenomenology, was used. Twenty IDIs were conducted at convenient times with patients who had visited the facility for their treatment. The interview took approximately 45-60 minutes, which was recorded. The interview was conducted by researchers with the support of the research assistants. Consent was sought from participants who met the criteria and were willing to be part of the study. Strict supervision throughout the process of data collection was emphasized by the principal investigator to facilitate the collection of quality data with minimal errors. In addition, the study also conducted key informant interviews with health workers implementing mobile health initiatives.

Data Collection Tools and Methods.

An in-depth interview guide, which is the primary qualitative data collection tool in phenomenology, was used. IDIs were conducted at convenient times after participants had visited the facility for healthcare services. In-depth interviews were conducted by the principal investigator with the question, "Please, can you tell me from your own perspective, what has been the role of mobile health initiatives in the timely initiation of antenatal care among mothers living with HIV?" The participants who met all the criteria were approached after their clinic appointment and were then invited to participate in the study. Strict supervision throughout the process of data collection was emphasized by the principal investigator to facilitate the collection of quality data with minimal errors. Considering consistency, all the filled tools were rechecked on a daily basis after data collection, and pre-coding of the questionnaires containing closed-ended questions was done.

Data Entry, Analysis, and Presentation

The audiotaped interviews were transcribed verbatim. The transcripts were read all over again, and grammatical errors were edited before being imported into Atlas.13 software for analysis. A thematic analysis was used employing both deductive and inductive analysis. The interviews were transcribed verbatim by the principal researcher. Each interview was coded with a defined coding frame to ensure confidentiality and limit bias. Data analysis was done using the three steps identified by Speziale and Carpenter (2017). The first step was the naive reading of each text to gain an impression and formulate ideas for further analysis. The second step was structural analysis to identify meaningful statements through revealing the structure and internal dependent relations that constitute the static state of the text.

The third step was the understanding of the interpreted whole from reflection on the naive reading and structural analysis. From each transcript, the significant statements pertaining directly to the role of mobile health initiatives in the timely initiation of antenatal care among mothers living with HIV were identified. Meanings were then formulated from the significant statements. The formulated meanings were then clustered together into themes, allowing for the emergence of themes common to all the participants' transcripts. The result was then integrated into an in-depth, exhaustive description of the phenomenon.

This was done by each transcript being opened in the Atlas.13 software and line-by-line reading and coding of all the statements were done. The coding was reviewed, where some codes were rearranged, and others merged to develop themes. A code book was developed, and afterwards, major themes were identified, and the table of themes was exported into Word for further interpretation of the data. Also, each code was exported back into Word for easy reading and selection of the best quotes, which were presented in the results section of the work.

Quality Controls

Two (2) Research Assistants qualified at least up to Diploma level and with experience in data collection and management, and with a health-related background, will be employed to manage the data collection process. The Research Assistants were trained in data collection and given an orientation on the use of the tools.

Five pregnant women living with HIV were used to pre-test the data collection tools. These were conducted in Luuka district, which is in a neighboring district outside the study area but with similar characteristics, and shall enable the researcher to identify the gaps in the tool and thereafter improve on it before using it for data collection.

Furthermore, Quality control measures for qualitative data to ensure the validity and reliability of the interview guide are described below:

Credibility

The researcher assessed response accuracy and truthfulness, validating alignment with participants' perspectives. Selected individuals with diverse backgrounds ensured a faithful representation of opinions, thereby bolstering the credibility and authenticity of the collected data.

Dependability

The study rigorously maintained findings' stability across diverse conditions. Meticulous documentation of participant responses clarified themes, and transparent data management processes boosted research outcome transferability.

Reflexivity

This involves meticulous documentation of the research process. In this study, reflexivity was maintained by accurately recording participant comments and personal reflections, strictly following the interview guide to mitigate potential biases. Trained research assistants were employed to reduce the researcher's influence in this process.

Top of Form

Transferability

The study assessed the applicability of its findings beyond the study setting by providing a comprehensive and precise description supported by diverse data. By incorporating a broad range of information, the study aims to ensure the robustness and relevance of its conclusions in diverse contexts.

Ethical Consideration.

This study was approved by the university research ethics committee at Umu, from which the researcher obtained an introductory letter to use in the field. An official letter that explains the objectives, rationale, and expected outcomes of the study was written to Kamuli district and all health facilities implementing mobile health initiatives from the University. The principal investigator communicated with the hospital administration and obtained written consent from individuals who participated in the study. Permission will be sought from the HIV and ANC clinics to study pregnant women living with HIV who receive health services from them. The respondents were assured that the information they passed on was to be kept confidential and that it was used in such a way that it could not be traced back to a particular response. Confidentiality was maintained at all levels. The research team was required to show respect to the respondents, especially respecting the opinion of the respondents, including the right to terminate the interview whenever they felt uncomfortable continuing, and questioning style, especially for very personal and sensitive questions.

The respondents were also assured of maximum respect during the entire process of data collection.

Lastly, a consent form was provided to the respondents for signing after an elaborate explanation of the subject matter in the research study. The privacy of the participants was duly respected as they were not compelled to respond to questions that they were not comfortable with. The identities of the participants were made anonymous, and the collected data cannot be traced to any of them. In addition, the right to decide whether or not to participate in the study was explained. In Addition, the researcher informed the respondents that they were free to choose not to answer particular questions that they felt they should not answer. While relevant ethical considerations such as informed consent and confidentiality were observed, the study also

acknowledges potential sources of bias. These include researcher bias during data interpretation, social desirability bias, where participants may have responded that they believed to be favorable, and recall bias, given the reliance on self-reported experiences. Measures such as reflexive journaling, triangulation of responses, and member checking were used to minimize these biases and enhance the credibility of the findings.

Informed Consent:

Written informed consent was obtained from all participants before their inclusion in the study. Participants were informed about the purpose of the study, procedures involved, potential risks and benefits, and their right to withdraw at any time without penalty.

Results.

Demographic characteristics of the respondent

Table 1: Demographic characteristics of the respondent.

Variables	Frequency (n)	Percentage (%)
Age Group (Years)		
18-24	5	25
25-30	8	40
31-35	4	20
36+	3	15
Occupation		
Farmer/Peasant	7	35
Small business owner	5	25
Housewife	6	30
Health worker	2	10
Religion		
Catholic	6	30
Protestant	5	25
Muslim	3	15
Pentecostal/Born-again	4	20
Other	2	10
Highest Qualification		
None	3	15
Primary	8	40
Secondary	6	30
Tertiary	3	15

The large number of participants in this survey is aged between 25 and 30 years (40%), with the most common occupation being a farmer/peasant (35%). In terms of

religion, most identify as Catholic (30%). For education, the largest group has attained primary education (40%).

Emerging themes

Table 2: Codebooks Roles of Mobile Health Initiatives in Timely Initiation of Antenatal Care Among Mothers Living with HIV/AIDS in Kamuli District

Theme	Definition
The extent to which pregnant women living with HIV are exposed to mHealth initiatives	
Awareness of mHealth Programs	The knowledge that pregnant women living with HIV have about mobile health initiatives promoting timely ANC visits.
Exposure to mHealth Services	The extent to which pregnant women living with HIV interact with and utilize mHealth programs for ANC.
Healthcare Provider Influence	The role of healthcare workers in introducing, recommending, and supporting mHealth services for ANC.

Frequency of mHealth Messages	How often pregnant women receive ANC-related reminders and educational messages via mobile health platforms.
Reliability of mHealth Information	The consistency, accuracy, and trustworthiness of ANC messages delivered through mobile health services.
Access to HIV-Related Information	The role of mHealth in providing education and guidance on managing HIV during pregnancy.
Trust in Digital Health Services	The confidence and willingness of pregnant women to rely on mHealth platforms for maternal healthcare decisions.
Digital Literacy and Ease of Use	The ability of pregnant women to understand, navigate, and effectively use mobile health platforms for ANC support.

Themes under this objective include Awareness of mHealth Programs, which refers to the knowledge women have about mobile health services promoting timely ANC visits, and Exposure to mHealth Services, which examines how often women interact with these programs. Healthcare Provider Influence highlights the role of healthcare workers in recommending mHealth services, while Frequency of mHealth Messages looks at how often ANC-related reminders are sent to users. Additionally, Reliability of mHealth Information emphasizes the trustworthiness of the information received, and Access to HIV-Related Information shows how mHealth supports education on managing HIV during pregnancy. Digital Literacy and Ease of Use and Trust in Digital Health Services examine women's ability to navigate and trust mobile health platforms.

The extent to which pregnant women living with HIV are exposed to mHealth initiatives

Awareness of mHealth Programs

Awareness of mHealth programs plays a critical role in their adoption and effectiveness, particularly in regions with limited healthcare infrastructure. The more individuals know about the services offered, such as health tips, medication reminders, or access to remote consultations, the more likely they are to use them. Respondents shared that they often became aware of mHealth services through word of mouth or media, but a lack of targeted outreach means some individuals remain unaware of the available resources. Inadequate awareness can prevent people from benefiting from these programs, even if they would improve their health outcomes.

".....I had never heard about mHealth programs until my friend told me about them. She said it helped her keep track of her health during pregnancy, but I didn't know who to trust for more information. Sometimes, I wonder if there's something more out there to help me, but it's hard to know where to start....." A 28-year-old pregnant woman living with HIV, Kamuli District

".... I only learned about the mobile health service when I saw a billboard in town. I didn't know these programs could help with reminders for doctor visits and medication. But I

still don't understand everything they offer....." A 35-year-old pregnant woman, Kamuli District

".....The first time I heard about mHealth was on the community radio. They were talking about how it helps pregnant women with HIV remember their appointments. But they didn't explain how to register, and I didn't know who to ask. Without clear information, many of us remain unaware. I think a lot of women in our village would benefit from these mHealth services, but many don't know they exist. If more people were explaining how it works, it might be easier for us to adopt..." A 24-year-old pregnant woman living with HIV, Kamuli District

".....I had no idea that I could receive medication or next ANC visit reminders through my phone until a friend mentioned it. Once I signed up, it made a huge difference in remembering my prescriptions..." 24-year-old pregnant woman living with HIV, Kamuli District.

"We primarily use community health workers and health center staff to inform women about these mHealth services. During ANC visits, we tell the women about the program and help them sign up. For women in the community, we rely a lot on word of mouth and radio programs, but sometimes that's not enough, and many are still unaware of these services." Health Worker, 40 years old, Kamuli

"Awareness largely depends on the level of community outreach. Some women engage better because they hear about the program from a trusted community health worker, while others, especially in more remote areas, remain unaware because we don't have the resources to reach them. Education about the services, as well as access to mobile phones and data, plays a big role in how well these initiatives succeed."

Health Worker, 32 years old, Kamuli.

Exposure to mHealth Services

Exposure to mHealth services influences individuals' likelihood to use them. While some people have limited exposure, others, particularly those in urban areas, are more likely to encounter and access mHealth platforms. Frequent exposure helps build familiarity and trust. However, the experience of respondents revealed that many people in rural or underserved areas have little or no access to these

services, making it difficult for them to adopt digital health interventions, even when they are aware of their existence.

".....I first came across mHealth services during a health talk at the local clinic. They gave us a brochure, but I didn't understand much. The nurse was explaining, but the signal on my phone was bad, and it made it hard to understand how to use it..." A 30-year-old pregnant woman living with HIV, Kamuli District

"I live in a village where network coverage is poor. Even if I wanted to access mHealth services, my phone won't connect, and I can't always get the information I need." A 29-year-old pregnant woman, Kamuli District

".....Sometimes, I hear about the benefits of mHealth services from other women in the village, but there's never been a clear way for me to learn more. It's frustrating not knowing how to get involved." A 32-year-old pregnant woman living with HIV, Kamuli District

"I live in a remote area, and it took a long time before I saw anyone using mobile health services. Even now, it's not something that many people in my community use, even though it could really help..." A 36-year-old pregnant woman living with HIV, Kamuli District

The health workers had similar views.

"My role involves coordinating the mHealth programs within the district, making sure that the initiatives we have are properly implemented. I oversee the communication between the health centers and the mobile health service providers, ensuring that pregnant women living with HIV receive timely health reminders, educational messages, and consultations. It's a team effort, but the real impact is seen when these women are consistently engaged with the services." Health Worker, 37 years old, Kamuli

"I have been involved with mHealth initiatives for about three years now. Initially, it was just a pilot project focused on maternal health, but over time, we've expanded it to include specific interventions for women living with HIV. The more I've been involved, the more I realize how important these programs are for reaching women who otherwise might not have access to timely health information." Health Worker, 45 years old, Kamuli

Healthcare Provider Influence

Healthcare providers can influence a patient's decision to adopt mHealth services. Trust in medical professionals often extends to the digital health services they recommend, and many patients are more likely to use mHealth services if suggested by their healthcare provider. However, some healthcare workers remain skeptical about these services, leading to a lack of recommendations, which affects patient uptake.

".....When I went for my last antenatal visit, the nurse told me about an app that could help me track my medication. I trusted her advice, and I decided to try it, even though I was

worried about using my phone for health..." A 27-year-old pregnant woman living with HIV, Kamuli District

".... I asked my doctor about these mHealth services, but he didn't seem sure about them. He said they might be helpful, but didn't give me a reason to start using them..." A 33-year-old pregnant woman, Kamuli District

".....My midwife recommended that I use the health service on my phone. She said it would remind me about the medication, and it makes me feel more confident in my pregnancy..." A 31-year-old pregnant woman living with HIV, Kamuli District

".....The nurse encouraged me to use a health app to track my blood pressure, and since then, I've been more consistent in managing my health....." A 45-year-old pregnant woman, Kamuli District

Frequency of mHealth Messages

The frequency of mHealth messages can impact user engagement. If messages are too frequent, they might overwhelm or annoy users, causing them to ignore or unsubscribe from services. On the other hand, infrequent messages might lead to disengagement and missed opportunities for health intervention. Respondents indicated that a balanced approach, with periodic and personalized messages, was most effective in keeping them engaged without feeling bombarded.

".....At first, I was happy getting health messages, but now they come too often, and I ignore them. They should send fewer but more useful ones..." A 45-year-old pregnant woman, Kamuli District

"Sometimes, I don't see the messages because they come so rarely. I wish they could remind me more often, especially about my next clinic visit..." A 3-year-old pregnant woman, Kamuli District

".....Too many messages feel like a disturbance, but too few and I forget important things. They need to find a balance." A 31-year-old pregnant woman, Kamuli District

".....I appreciate getting reminders about my checkups, but too many messages make me feel overwhelmed. I prefer a few thoughtful, timely ones instead..." A 4-year-old pregnant woman, Kamuli District

Reliability of mHealth Information

The reliability of information provided through mHealth services is crucial for user trust and continued usage. Many respondents expressed concerns about the accuracy of health advice or medication information delivered through mobile apps. Without solid evidence and endorsements from trusted medical authorities, users can hesitate to trust digital health interventions fully.

".....One message told me to take my medicine in the morning, but the doctor had said at night. I got confused and had to go back to the clinic to confirm." A 29-year-old pregnant woman, Kamuli District

".....I trust the information when it comes from the hospital, but sometimes I worry that these phone services may give wrong advice....." A 25-year-old pregnant woman, Kamuli District

".....There are times when the messages are helpful, but other times, they seem general. I wish they were more specific to my condition..." A 32-year-old pregnant woman, Kamuli District

".....I used an app for advice on managing my diabetes, but I had doubts about the information provided. It didn't seem reliable, so I stopped using it....." A 22-year-old pregnant woman, Kamuli District

Access to HIV-Related Information

Access to HIV-related information is essential for individuals in high-risk groups to make informed decisions about prevention, treatment, and care. mHealth services can provide valuable resources, but many respondents expressed challenges in accessing this information due to limited availability, lack of privacy, or unclear messaging. For people living with HIV or those at risk, easy access to reliable and up-to-date information can empower them to manage their health better.

".....I don't want to ask about HIV information in public, so if I can get messages on my phone, that would be good. But sometimes, I don't receive anything, and I have to risk asking at the clinic....." A 31-year-old pregnant woman, Kamuli District

".....There was a time I wanted to know if I could breastfeed safely, but I didn't know where to get the right information. If these phone services were better, they would really help women like me..." A 29-year-old pregnant woman, Kamuli District

".....The problem is that some of the messages are too general. I need specific answers for my situation, but they just send common advice that doesn't always apply to me..." A 34-year-old pregnant woman, Kamuli District

Trust in Digital Health Services

Trust in digital health services is essential for their widespread acceptance and use. Many respondents reported skepticism about privacy, data security, and the ability of digital platforms to provide quality healthcare services. Without trust, people are less likely to engage with these services, even if they could benefit from them.

".....I'm cautious about sharing my health data on an app. I worry that it could be misused, so I've only used services recommended by my doctor." A 33-year-old pregnant woman, Kamuli District

".....I don't know if my health information is safe. What if someone else reads my messages? That is why I fear using these services..." A 30-year-old pregnant woman, Kamuli District

".....I still prefer talking to a real doctor. A phone message cannot check my body the way a nurse does..." A 23-year-old pregnant woman, Kamuli District

".....At first, I thought it was a scam. I asked my friend, and she said she also receives the messages. That's when I started trusting them. If these services were officially linked to our hospitals, I would trust them more. Right now, I am not sure who is behind the messages."

".....I worry about who else sees my information. What if someone at the hospital shares my details?" A 31-year-old pregnant woman, Kamuli District, "The messages help, but I still prefer talking to a real doctor. Sometimes I need to ask questions, and a message can't answer me..." A 27-year-old pregnant woman, Kamuli District

Digital Literacy and Ease of Use

Digital literacy is a key factor influencing the successful use of mHealth programs. For many people, especially older adults or those with lower education levels, navigating health apps can be a barrier to effective use. Apps that are easy to use and require minimal digital skills are more likely to be embraced by a broader population.

".....I don't know how to use smartphones, so even if this service is available, I wouldn't know where to start. If they made it simple for people like me, I would try it....." A 35-year-old pregnant woman, Kamuli District

"When I tried to register for a health service, they sent a code that I didn't know how to enter. I had to ask my son for help, but I don't want him to know about my condition." A 31-year-old pregnant woman, Kamuli District

".....I can read simple messages, but if they send too many instructions, I get confused. They should make the messages short and easy to understand." A 28-year-old pregnant woman, Kamuli District.

Discussion of results.

The extent to which pregnant women living with HIV are exposed to mHealth initiatives that promote timely initiation of ANC visits among pregnant women living with HIV.

The study found that awareness of mHealth programs is one of the main factors in their adoption and effectiveness, particularly in rural areas like Kamuli District. This is probably because many individuals are first introduced to mHealth services through word of mouth or media, but targeted outreach remains limited, leading to gaps in awareness. This is in line with studies by Nair et al. (2020), which highlighted that awareness and education are crucial in ensuring the successful uptake of digital health initiatives, especially in underserved communities. Similarly, Soni et al. (2018) observed that people in rural areas often have limited access to information about available health services, which delays the adoption of health innovations. However, studies conducted in more urbanized or high-

literacy settings have found that awareness alone does not necessarily lead to adoption, suggesting that factors like perceived usefulness and trust in technology also play critical roles (Desai et al., 2019). This difference could be because urban populations may already be saturated with health information but remain skeptical or selective about which services to adopt. This implies that while awareness is a foundational step, mHealth programs should also focus on building trust and demonstrating value to ensure effective uptake.

The present study found that exposure to mHealth services also affects the likelihood of their adoption, with urban areas showing greater exposure than rural ones. Many respondents from Kamuli, especially those in remote villages, reported minimal exposure to these services, making it difficult to integrate them into their health routines. This is probably because urban areas have better infrastructure, including internet connectivity, which supports greater engagement with digital health platforms. This is consistent with findings by Karamagi et al. (2021), who noted that rural populations often struggle with access to digital health platforms due to poor connectivity and limited infrastructure. Similarly, Rahman et al. (2022) found that exposure to digital health services is closely linked to internet availability and social media presence, which are often more prevalent in urban settings. However, other studies have found that even in rural areas with limited infrastructure, strong community networks and use of basic mobile phones without internet can still enable widespread mHealth adoption (Mwangi et al., 2018). The difference could be due to variations in how mHealth services are designed and delivered, with some programs tailored to low-tech environments. This implies that expanding mHealth exposure in rural areas requires not only infrastructure improvement but also the development of low-bandwidth or SMS-based platforms suitable for such contexts. In this study, healthcare provider influence emerged as another critical factor in the adoption of mHealth services. The study found that respondents were more likely to use mHealth services if they were recommended by their healthcare providers. This is probably because trust in healthcare providers extends to their suggestions regarding digital health interventions. This is in line with findings by Cook et al. (2020), who emphasized that healthcare professionals play a pivotal role in influencing patient behavior towards adopting mHealth technologies. Similarly, Mahajan et al. (2019) showed that healthcare providers' endorsement of digital health tools increased their adoption rates. However, contrasting evidence from other settings indicates that healthcare provider influence may be limited when providers themselves lack adequate digital literacy or confidence in mHealth tools (Mutebi et al., 2021). The difference could be due to variations in training levels and digital health integration across different health systems. This implies that equipping healthcare providers with the

necessary skills and information about mHealth services is essential to optimize their influence on patient uptake.

The study revealed that the frequency of mHealth messages was another area of concern. Respondents indicated that too frequent messages were overwhelming, while infrequent ones led to disengagement. This is probably because a balanced approach is needed to maintain engagement without causing message fatigue. This is in line with studies by Kazi et al. (2019), who found that personalized and less frequent messages were more likely to be well-received by users, especially in rural areas. Similarly, Juma et al. (2020) noted that users preferred mHealth messages that were timely and relevant to their immediate health needs. However, other studies have found that higher message frequency—when combined with interactive features—can lead to better engagement and behavior change, particularly among younger or more tech-savvy populations (Thakkar et al., 2016). The difference could be due to variations in message content, user preferences, and demographic profiles. This implies that mHealth programs should use data-driven strategies to customize message frequency and format based on user characteristics, thereby enhancing relevance and retention. The study found that access to HIV-related information is a crucial aspect of mHealth services, yet many respondents faced challenges accessing accurate and timely information. This is probably due to limited privacy, unclear messaging, or inadequate resources. This is consistent with findings from Amritraj et al. (2021), who noted that access to reliable HIV-related information is a major barrier to effective health management for individuals living with HIV in rural regions. Similarly, Kamugisha et al. (2020) found that providing clear, accurate, and confidential HIV information through mHealth platforms could improve the health outcomes of individuals living with HIV. However, studies have reported that even when accurate information is available, stigma and fear of digital surveillance discourage individuals from using mHealth for HIV-related issues (Obonyo et al., 2019). The difference could be due to sociocultural contexts where HIV remains highly stigmatized, and digital platforms are perceived as less secure. This implies that mHealth programs addressing HIV must prioritize confidentiality and cultural sensitivity, ensuring that users feel safe and supported when accessing information.

Conclusion

This study established that mobile health (mHealth) initiatives have significant potential to promote timely initiation of antenatal care (ANC) among pregnant women living with HIV in Kamuli District. Exposure to services such as appointment reminders, medication alerts, and health education messages improved awareness of the importance of early ANC attendance and strengthened adherence to recommended maternal health practices.

Health workers played an important role in encouraging trust and uptake of mHealth services. However, the study also found that exposure and utilization of mHealth interventions were uneven, especially among women in remote rural areas. Key barriers included poor network coverage, low digital literacy, limited access to mobile phones, concerns about confidentiality, and inconsistent messaging systems. Therefore, while mHealth can strengthen maternal HIV care and timely ANC initiation, its effectiveness depends on addressing technological, social, and health-system challenges that limit equitable access.

Limitations.

A key limitation of this study is its geographical scope. Firstly, the research was conducted solely in Kamuli District, which may limit the generalizability of the findings to other districts or regions of Uganda, particularly those with different levels of infrastructure, cultural beliefs, or healthcare system capacity. Additionally, the study relied heavily on self-reported data, which is inherently subject to recall bias and social desirability bias. Some respondents may have misunderstood certain questions or provided answers they believed were expected or acceptable, potentially affecting the accuracy of the results. These limitations should be considered when interpreting the findings, and future studies could address them by expanding the study area and incorporating more objective data collection methods.

Recommendations

District health teams should integrate mHealth registration and orientation into routine ANC outreach programs, village health team activities, and HIV clinics so that more pregnant women are enrolled early and understand how to use the services.

Implementing partners should design SMS and voice-message platforms in local languages with personalized ANC reminders, HIV care information, and privacy safeguards to protect users from stigma and unauthorized disclosure.

Government and telecom partners should improve mobile network coverage in underserved communities, while training health workers to support women in using mHealth tools and troubleshooting common digital challenges.

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List of abbreviations.

ANC – Antenatal Care
ARV – Antiretroviral
EID – Early Infant Diagnosis
HIV – Human Immunodeficiency Virus
IDI – In-Depth Interview
LMICs – Low- and Middle-Income Countries
mHealth – Mobile Health
PCR – Polymerase Chain Reaction
PMTCT – Prevention of Mother-to-Child Transmission
PWLHIV – Pregnant Women Living with HIV
SMS – Short Message Service
UMU – Uganda Martyrs University
WHO – World Health Organization

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Availability of data.

Data used in this study are available upon request from the corresponding author.

The author's contribution.

AB designed the study, conducted data collection, cleaned and analyzed data, and drafted the manuscript. KO supervised all stages of the study from conceptualization of the topic to manuscript writing and submission.

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