Clients' and providers' perspectives in informing a digital health intervention to improve linkage to care after Index HIV self-testing in Hai and Moshi Districts, Tanzania

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Abstract

Background Digital health interventions have the potential to improve linkage to care after HIV self-testing (HIVST). This study aimed to understand clients' and providers' perceptions of benefits, and barriers of a digital health intervention designed to improve linkage to care after HIV self-testing in Tanzania.

Methods This exploratory qualitative research study was conducted in Hai and Moshi, districts in Kilimanjaro region, Tanzania. Four health facilities were selected based on their involvement in an HIVST pilot program implemented by Elizabeth Glassier Pediatric AIDS Foundation (EGPAF) Tanzania through the USAID funded program. The study included female index clients and their partners, and healthcare providers at the healthcare facilities. We used a semi-structured interview guide with open-ended questions for data collection. Data collection was conducted from 16th January 2023 to 3rd February 2023. Thematic analysis of the qualitative data was conducted, guided by the Health Belief Model (HBM), and results were developed in collaboration with the community partners.

Results A total of 42 participants were included in the study, comprising 9 male clients, 17 female index clients, and 16 health care workers (HCWs) (4 male and 12 female) who were involved in delivering HIVST services. The study's findings revealed mixed feelings about the use of a digital health intervention. Majority of participants perceived digital health as a valuable intervention for enhancing linkage to care, improved health outcomes, improved communication with healthcare workers, and increased privacy. Therefore, they supported scale-up of a digital health intervention. Participants also expressed that the potential benefits of a digital health intervention include the convenience of accessing healthcare services from the comfort of their homes or any location. However, a few participants expressed concerns about potential risks associated with sending health-related text messages. They feared that recipients might not be in a safe space, leading to stigma and avoidance of engagement. A few female participants expressed concerns about confidentiality breaches, particularly regarding shared phones with family or friends. Fear of being judged or misunderstood by others could deter them from reading or acting upon these messages.

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Most participants recommended tailored strategies that prioritize confidentiality and trust. Recognizing these psychological aspects is vital for customizing digital health interventions to effectively address participants' concerns.

Conclusions Digital health interventions may improve the linkage of HIV self-testers to care. Recommendations include personalized and culturally relevant communication and technical accessibility to make interventions effective and inclusive. This study provides valuable insights for designing patient-centered interventions for HIV care and treatment.

Keywords Digital health intervention, HIV self-testing (HIVST), Linkage to HIV care, Digital health

Background

HIV remains a significant cause of death worldwide, impacting individuals, families, and communities on a profound scale [1]. In 2021, global HIV/AIDS statistics revealed that an estimated 38.4 million individuals were living with HIV worldwide [2], of whom 36.7 million were adults aged 15 years and older and 1.7 million were children between the ages of 0 and 14 [2].

In Tanzania, the national HIV prevalence estimates translates to approximately 1.5 million people aged 15 years and older living with HIV [3]. The 2022–2023 survey found the percentage of people living with HIV known as HIV prevalence, is 4.4% among people aged 15 years and older (4.5% in mainland Tanzania and 0.4% in Zanzibar), and varies by residence (5.0% in urban areas and 4.0% in rural areas) and gender (5.6% in women and 3.0% in men) [3]. Progress has been made in achieving the UNAIDS 95-95-95 targets for 2025, whereby the survey estimated that among people aged 15 years and older living with HIV in Tanzania, 83% are aware of their status, 98% of those aware of their HIV status are on ART, and 94% of those on ART are virally suppressed. Given these statistics, innovative methods such as HIV self-testing (HIVST) serve as crucial alternatives to reach the UNAIDS targets by addressing various barriers such as stigma, privacy concerns, time, and expenses associated with traveling and waiting at the clinic, particularly for men [4, 5].

As of 2018, the World Health Organization (WHO) reported that 59 countries globally had adopted HIVST, with an additional 53 in the process of developing policies [5]. The UNITAD Self-testing Africa Initiative, in November 2018, distributed nearly 2.3 million HIVST kits to facilitate the ongoing expansion of HIV testing, particularly in higher-risk areas [5]. The distribution of HIVST kits in East and Southern Africa was substantial, with a significant allocation to countries including South Africa, Zimbabwe, Malawi, Zambia, eSwatini, and Lesotho [5]. HIVST has emerged as a valuable strategy to expand access to HIV testing, particularly for populations facing barriers to traditional testing services [6, 7]. Tanzania's guidelines for HIV testing recognize the value of HIV testing and view it as a practical alternative [8].

According to the guidelines, those who get results from an HIV self-test should get tested again at a medical facility to confirm the results and make sure they are properly linked to care and treatment facilities [8].

While HIVST has demonstrated the potential to improve testing rates [5, 9], a critical challenge is ensuring that individuals who test positive are effectively linked to appropriate care and treatment services [7]. Linkage to HIV care can be defined as: (i) enrolling in care upon diagnosis; (ii) determining eligibility for antiretroviral therapy; (iii) starting antiretroviral therapy; and (iv) adhering to antiretroviral therapy [10]. Previous studies have identified several challenges associated with linkage to care following HIV self-testing (HIVST). One challenge is the lack of immediate counseling and support, which can leave individuals without the necessary guidance to interpret their results and take appropriate follow-up actions [11]. Financial accessibility also poses a barrier, as the cost of self-testing kits can be prohibitive for low-income individuals, undermining the widespread adoption of HIVST [11, 12]. Additionally, self-testing requires a certain level of literacy and competency, which can be challenging for less-skilled users, necessitating comprehensive instructions and support materials, including video demonstrations, to ensure accurate testing and result interpretation [12].

Several studies have proposed digital interventions to tackle the challenges associated with linkage to HIV care after self-testing [13–15]. Mobile health (mHealth) applications, Short Messaging Service (SMS) reminders, telemedicine, and community-based support networks are examples of digital interventions that can improve communication, provide information and support, and facilitate the linkage process [16]. Specific to HIVST, studies have shown that digital technologies, including SMS reminders, can improve and enhance linkage to care following a self-test [17, 18]. However, based on a review of the current literature, there are limited publications that have explored the development of digital health interventions linked to HIV care following HIVST in Tanzania. Therefore, this study explored the experiences and opinions of female index clients, male clients, and healthcare providers to inform the development of a digital health

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intervention aimed at improving linkage to HIV care after HIVST in Tanzania. The study was informed by the Health Belief Model (HBM) [19], which is a widely recognized theoretical model in health behavior research. This model was designed to illuminate the factors influencing individuals' health-related decisions and behaviors. Specifically, the perceived benefits, perceived barriers, and self-efficacy HBM constructs were used in this study.

Methods

Study design and setting

The consolidated criteria for reporting qualitative research (COREQ) checklist was used to ensure that the reporting of the study procedures and findings was consistent with the guidelines [20]. We aimed to provide a detailed and systematic account of how the study was designed, the settings in which data were collected, and the procedures followed during the research process. An exploratory qualitative study design was used to capture a comprehensive exploration of the perspectives, attitudes, and preferences of the target population to inform a digital health intervention to improve linkage to HIV care for HIVST users. In soliciting participant feedback on a digital health intervention, we defined a digital health intervention as any communication strategy that utilized mobile phones or computers to convey general or personalized health information to the participant. The study was conducted in the Kilimanjaro region of Tanzania. The region has diverse populations, including both urban and rural communities, which allow for exploring the different perspectives and experiences within the study population [2]. The study included four health facilities which were purposively chosen based on their experiences in delivering HIVST and involvement in the pilot HIVST project, which was funded by the United States Agency for International Development (USAID) and implemented by the Elizabeth Glaser Pediatric AIDS Foundation (EGPAF) in the Kilimanjaro Region.

Participants

A purposive and convenience sampling approach was used to recruit participants, including 9 male clients, 17 female clients, and 16 healthcare workers (HCWs) including 4 male HCWs and 12 female HCWs. The analysis excluded 4 male clients from the final dataset due to inconsistencies in their recruitment that deviated from the protocol. The total number of participants included in this study was 42 after excluding the 4 men. The participants for this study were not selected based on their specific exposure or coverage of digital health technology. The study consisted of adult participants with varying age ranges. The age range for male clients participating in the study was between 22 and 58 years old, while

female clients' age range was between 22 and 51 years old. As for health care workers (HCWs), the age range for male participants was between 24 and 47, and for female HCWs, the age range was between 24 and 49 years old. Female index clients who received HIV treatment at the healthcare facilities involved in the study, were given HIVST kits to distribute to their partners. They were also encouraged to invite their male partners to participate in the study. Male clients were those who received HIVST kits from their female partners and were subsequently willing to participate in the study. HCW comprised those directly involved in delivering HIVST services. The majority of the HCWs were nurses (8), while others were doctors (3), nonphysician clinicians (3) and counselors (2). Including women living with HIV, their partners, and healthcare workers was essential to gather insights from those directly impacted by HIVST and those responsible for its implementation. Women living with HIV and their partners provided perspectives on the personal and relational dynamics of HIVST, while HCWs offered professional insights into the service delivery and potential systemic barriers. The participants received reimbursement equivalent to USD 10 to cover transportation.

Data collection

Data collection involved in-depth interviews conducted with participants using semi structured interview guides with open-ended questions. The data from these interviews has not been published elsewhere. In-depth interviews were chosen to further explore each participant's experiences, perceptions, and insights related to the Health Belief Model constructs (HBM), allowing for flexibility to probe specific areas of interest and follow the natural flow of participants responses. HBM was used to develop the interview guides, with a focus on the following constructs of the theory: perceived benefits, perceived barriers, and self-efficacy [19]. *Perceived benefits* within the context of this study addressed participants' beliefs regarding the potential advantages of HIV-related digital health intervention, specifically in linking them to care following HIV self-testing. The *perceived barriers* construct encompassed perception of hindrances, including illiteracy, technology, trust and privacy concerns, and perceptions of cost (monetary, time, interpersonal) related to receipt of digital health intervention post-HIVST. Lastly, *self-efficacy* concerns a person's confidence in engaging in a particular health behavior and their belief in their personal ability to carry out that behavior successfully. The selected constructs were deemed most relevant to understanding the specific challenges and opportunities related to digital health interventions for linking individuals to HIV care following self-testing. The interview guides were pretested

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to ensure clarity, relevance, and appropriateness. This process helped identify potential issues and areas for improvement in the interview guide. The interviews covered topics such as participants' experiences with healthcare and HIVST services, the use of HIVST kits, follow-up services, development of linkage to HIV care programs, and digital health interventions.

The interviews were conducted by two researchers with experience in conducting interviews and collecting qualitative data. Prior to data collection, they underwent a two-day training covering project aims and methodologies, data collection tools, research ethics, and responsible conduct, participant recruitment, confidentiality, informed consent, and data handling procedures. The interviews were recorded using a digital audio recorder and conducted in person in a closed and quiet room at the health facilities to ensure privacy and confidentiality. Each interview lasted between thirty and sixty minutes. Some of the key digital health questions include the following: What are some potential benefits to receiving HIVST education materials on your phone? What are some potential barriers to engaging with HIVST education materials on your phone? (i.e., signal, safety, inappropriate to use, stigma, privacy); What language would you prefer to receive the information in? This study was approved by the National Institute for Medical Research in Tanzania, Advarra in the USA and the George Washington IRB. Participants were assured anonymity and provided written informed consent prior to participation.

Data analysis

Audio files were labeled with unique interview IDs and uploaded into a secured computer. Initially, all audio recordings were transcribed verbatim in Kiswahili and then meaningfully translated into English to ensure an accurate representation of participants' responses. Concurrently, detailed notes taken during the interviews were reviewed. To facilitate systematic analysis, a rigorous coding process was undertaken. Prior to coding, a collaborative effort took place involving investigators who participated in the interview guide preparation and interviews, along with three individuals who assisted in coding. A codebook was developed through the review of the interview guides, literature reviews, field notes, and insights following transcript review, and it related to the HBM constructs by including predefined codes such as perceived benefits, perceived barriers, and self-efficacy. However, new codes that emerged from the data were also included during the coding process.

The analysis was guided by the HBM, providing a structured lens to interpret participants' perspectives and experiences. The coding process involved a collaborative effort to ensure intercoder reliability. Coding was performed in pairs, where two coders independently coded the same transcript and discussed discrepancies until consensus was reached. In cases where the two coders could not reach an agreement, a senior researcher was involved. This collaborative effort ensured that the coding process was consistent and reliable.

After defining the codes, the responses in the transcripts were coded, and quotes for inclusion were selected based on their ability to vividly illustrate key themes and provide a comprehensive representation of participants' experiences. The selection of quotes was done manually in a collaborative word processor platform to ensure a nuanced consideration of context and meaning, contributing to the authenticity of qualitative findings. Then, the analysis team developed a collaborative matrix for the codes and their respective excerpts, after which the matrix was used to develop code summaries for each parent code/domain. The code summaries were then reviewed by two co-authors, DC (PhD) and SEM (PhD), and the code summaries and supporting quotes were used to identify relevant themes to our research question Finally, the identified themes were discussed and reiterated with the entire team through various online meetings. For example, codes related to perceived barriers such as illiteracy, technology, and privacy concerns were condensed to form a theme on perceived barriers to digital health interventions.

The themes and categories have been reported with the support of succinct quotes from participants' responses. To improve validity, we employed Guba's qualitative trustworthiness criteria (Guba, 1981) during and after the inquiry and throughout the coding process. This involved periodic debriefing sessions to collectively reflect on findings, interpretation, and potential biases, ensuring the credibility, transferability, dependability, and confirmability of the research findings.

Results

The collaborative analytic process resulted in the development of four main themes from the data. Perceived benefits, perceived barriers, and high self-efficacy which were predefined concepts identified based on the HBM. Additionally, the theme of recommendations emerged organically from the analysis of participant responses. The study comprised of 42 participants with age ranging from 22 to 58 years. Among those 13 were men and 29 were women. Regarding the roles of healthcare workers, 8 were nurses, 3 doctors, 3 nonphysicians, and 2 counselor (Table 1).

Perceived benefits of digital health intervention use

Participants readily identified two benefits that they believe stem from the use of digital health interventions.

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Table 1 Socio-demographic characteristics of the participants

Participants group	Total participants	Male participants	Female participants	Age range	HCWs roles
Overall	**42**				
Health care workers (HCWs)	16	4	12	24–57	**8** Nurses, **3** Doctors, **3** Non-physician clinicians, and **2** Counselors
Male clients'	9	9		22–58	
Female clients	17		17	22–51	

Digital health reminders

One of the perceived benefits mentioned for the digital health intervention was related to its potential to serve as a reminder for certain health-related behaviors, such as medication adherence. Within this theme, the intervention was viewed as a valuable tool to support individuals in adhering to prescribed medication regimes, ensuring that they consistently take their medication as prescribed.

> *For me, if I could receive a message or a phone call every week to remind me, that would be helpful. For example, if I forgot to take my medicine, I could get a call or message on the same day to remind me. This would be especially useful if I'm far or busy. When you receive a message or information about your health, it becomes a priority, and you can adjust your schedule to attend to it. (MC)*

Increase understanding and encouragement to seek HIV care and treatment services

Nearly all male clients believe that information about health is crucial and can change rapidly, making it difficult to predict when updates might be needed. They expressed the concern that setting a limit on digital health messages might lead to missing out on important updates that arise in between visits. Receiving constant messages and calls from healthcare providers was believed to enhance understanding and encourage them to seek care and other health services.

> *I cannot set a limit on information. How can I? Because every hour, every minute, things change. However, if I limit it every month here in the middle, something might come up and I need information about my health. Therefore, you can give me information at any time because my health is everything and that (message or call) increases understanding for a person who does not understand. In addition, when announcements or messages come, they make a person who had difficulty in understanding if he was not in the mood to listen, can now listen to them and get educated. (MC)*

A female index client described that knowledge provided through messages can also benefit individuals who live with someone living with HIV, helping them understand the situation better and potentially encouraging them to become a source of support and guidance in linkage to care in a timely manner, as highlighted in the following quote:

> *Direct communication methods such as phone calls and text messages offer significant advantages. Unlike general announcements, which might be missed if someone is absent, a direct phone call ensures message delivery. Text messages hold benefits, as they can provide useful information and insights into how to support someone who lives with HIV. Information such as someone who has an infection who uses medicine correctly can give birth, or you can live with her as a wife, and if you know her situation, then even you can become a teacher to her. Now such messages can bring him something that he might want to know. (FC)*

Perceived barriers to digital health intervention use

While digital health intervention was readily acknowledged to increase understanding and encourage individuals to seek HIV care and treatment, participants described unique barriers to the use of digital health interventions, including stigma, lack of trust and privacy, concerns about costs, technical difficulties, and concerns about wrong numbers.

Stigma, lack of trust and lack of privacy

Few participants described an inherent risk in sending health messages via text because the recipient might not be in a private space to receive these messages. Participants expressed that this could lead to fear and stigma and that recipients may be afraid to read the messages or follow up on the contents of the message.

> *"No, that is bad, because the text message could be sent to me and at that time my friend might have my phone and he will see the notification… With a*

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message, it's a big no, maybe you should call so that someone else would not see the message. Calling is an easy way for me." (FC).

A healthcare worker shared that a recipient of the call, potentially surrounded by others, could become alarmed by the introduction and identification of the caller as a healthcare worker. The person might react defensively and deny any connections, asserting that the caller had the wrong number. This reaction could arise due to concerns about privacy and stigma, reflecting the complex dynamics that exist when attempting to communicate health-related information via digital health interventions.

The other person may panic because you may have called and introduced yourself as a health worker at the hospital. He may be with other people, and even if it is not him who is the victim, he reacts and tells you that you have the wrong number when you call him like that. (HCW)

Concerns about costs and technical difficulties

Most male and female participants expressed apprehensions regarding the financial implications and technical challenges with utilizing digital health interventions. A male participant highlighted the concern of incurring costs when responding to messages, emphasizing that even a simple reply could entail financial expenditure that some individuals might not be able to afford. The participant suggested that such services should ideally be provided without any financial burden to users.

If a message has been posted, answering it is for money because it will use some amount of money and people cannot manage; this service should be free. (MC)

A female participant raised a concern in relation to accessibility and usability of the technology. The participant pointed out that some individuals, such as elderly individuals or those with limited literacy, might encounter difficulties in responding to messages or comprehending the content.

Other challenges that you may find are that someone can't answer the message, maybe they are old or can't read or something else." (FC).

Concerns about wrong number and difficulties in contacting clients

Nearly all healthcare workers raised a concern regarding the accuracy of contact information provided by the clients for digital health intervention. The concerns stemmed from the possibility of clients providing incorrect phone numbers, which could impede effective communication. Some healthcare workers highlighted the potential obstacle of reaching a client if the provided contact details were inaccurate.

There is a bit of a challenge because you may find that there is another customer who changed the number and you are unable to contact him. You may look for him but with no avail, or you may call them and someone else picks up the phone. (HCW)

High self-efficacy toward digital health intervention use

Both female clients and healthcare workers demonstrated a strong sense of self-efficacy in utilizing a digital health intervention. For the female clients, the confidence in their ability to effectively engage with the intervention was notably linked to the assurance that these communications originated from trusted healthcare workers. One female client noted the ease of use of getting a message and its quick benefit of relaying information:

I used to think it was easy on the phone, because if I get the message on the phone, when I hear that it has come in, I will open it and read it. Once I read it there, I already gained knowledge. (FC)

Health care workers emphasized their ability to implement a digital health intervention and their perception that it would be highly beneficial to patients and in reaching those who will not come to the health care facility in person. They said:

Yes, we are prepared and ready because we see that it is a service that is good and beneficial for our customers, and it is useful as we will also be able to reach those customers who cannot come to the center. (HCW)

Recommendations for Digital Health Intervention

Participants provided several recommendations for optimizing the effectiveness of digital health interventions. These recommendations reflect their insights into enhancing the impact of such interventions on healthcare engagement and outcomes. The recommendations were related to the content that should be included in the messages, the frequency of the messages and calls, and the methods that should be used for communication.

Content of messages for digital health intervention

Participants across different groups shared recommendations on the content of messages for digital intervention. A number of the participants emphasized that messages should stress the importance of one's health, emphasize the need to obtain confirmatory testing, be linked to HIV care, and be reassuring about life after an HIV diagnosis.

All I have is advice for a person not to be afraid to come to check their health. They should come and test to know their health status and, if they are infected, should come and get medication. If he is a victim, he should take medicine. Being infected is not the end of one's life. (MC)

Within the group of healthcare workers, a series of insightful content suggestions emerged that resonated with the prevailing sentiments. This suggestion encapsulated strategic approaches for conveying messages through digital platforms. A distinctive proposal from a healthcare worker advocated for an inviting message:

We can say "Majengo health facility invites you for HIV testing so that you know your HIV status". Another can say "Life is wealth. If you know your HIV status you will protect your partner". Another "Welcome to get HIV counseling and testing". In addition, for those who have tested at home and we have their contact from their partners we can say "Mr. X we know you have used the HIV self-test to test yourself for HIV and that is a preliminary test. You are invited to the facility for confirmatory test and to get counseling and how to protect yourself". (HCW)
One example we can say maybe 'My health is my capital. I test myself to know my health and to know how to protect my health or'... Another example for those who are married or in a relationship, you can say maybe 'To love my partner is to protect him/her and to protect him/her, I should know my health and know how to protect him/her.' (HCW).

Frequency and timing of digital health intervention

Participants offered insights into their preferences regarding the frequency and timing of digital health intervention. Their recommendations aimed to strike a balance between consistent communication and respecting individuals' schedules and commitments. Some participants expressed willingness to receive messages daily, highlighting the importance of considering the appropriate timing to avoid disrupting their activities.

Receiving messages every day is not an issue for me, however, it is essential to consider the timing. Sometimes there are times when you have work or you are busy. The best time to call me is during the day; I usually go to church in the evening. Even if you were a little late today, you would not find me. (FC)

Participants also stressed the significance of timing calls appropriately, taking into account individuals' availability and avoiding instances where they might be engaged in work.

The service provider should check how long he calls him so that he does not call him when he is in a group of people or he is at work, he is busy with work. They should find a quiet time when they can call him when he is resting. First, before they talk to him, they should ask first if he is ready to talk ..., the service provider should make sure that the person he wants to communicate with has a chance to listen before they start the conversation. (HCW)

Language preference

A significant recommendation across different groups was language preference. Nearly all the 42 participants recommended Kiswahili as a language to be used in a digital health intervention.

I suggest Swahili language but right now you can go anywhere and find that they use the white people language, English, but others do not know English. I like to use Kiswahili because I understand it easily. (MC)

Method of communication

Participants engaged in a thoughtful exploration of the most effective methods of communication for digital health interventions, encompassing calls, texts, and social media. Male participants conveyed general acceptance of both calls and texts but identified limitations of each. Some preferred text messages due to their ease of access and visibility, allowing recipients to catch up on messages even if they were momentarily offline. Conversely, others favored calls for their ability to convey comprehensive information and facilitate interactive discussions, addressing potential queries.

As for me, I can see the message, you know when I get a call because of our work, you can call and miss me, but once you send a message, even if I am not on the network, when I get to the network, I will see all the messages without any problem. (MC)
It is better for me to be called because the message may come with only a small point that will ask for instructions and all of the information you will not be able to get through the text message. However, the phone makes it easier because you will be given the message and then you will ask questions, but the message will be short. (MC)

Female participants exhibited flexibility in their preferences, stating that both calls and texts were suitable options. They recognized the convenience of text messages for later reading and acknowledged the limitation of missing calls when not immediately available.

For me either way is fine, they can call or text. How-

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ever, they can call you and you might not be able to answer because you might be far from your phone, but a text message will stay and you can read it later. However, both are a good way of reminding. (FC)

Healthcare workers endorsed the dual viability of phone calls and text messages for reaching clients effectively. They highlighted the practicality of phone calls, particularly considering the familiarity of phone usage among the population, including elderly individuals.

The phone may be the best way because Tanzanians have not been able to have high technology regarding digital things, you see, but even the elderly now own a phone, so it is something that is very simple (for them). (HCW)

Beyond traditional communication methods, healthcare workers expressed interest in diverse strategies, including social media platforms, radio broadcasts, posters, and community education. They recognized the power of various channels to disseminate information widely and to engage individuals in HIV care.

Other methods that will be used are telephone, radio, posters and education; if a person takes a test kit, then they should return their results to the health service center. These methods should be used because they will reach many people since many people listen to the radio, people watch the TV, and people pass by and read the posters. Therefore, the education will spread to the community, it will make it easier for them to come and know that this is something important and that they need to return those results to the service provider. (HCW)

Eehh, yes, it is like that, maybe it is advertising in the media, the media is also nice, at least we have staff who go to talk directly to the media or something like that and we have our own small TV, maybe EGPAF TV (HCW).

Readiness to use digital health intervention due to previous experiences

Participants' readiness to engage with digital health intervention was often influenced by their past experiences. Many participants recalled receiving frequent calls and messages from healthcare workers after being tested for HIV. This historical context informed participants' appreciation for ongoing communication that reinforces health priorities.

Yes, there was a period when those messages were coming in the past, but later they were no longer there. When AIDS started, there was a great aware-

ness in the media and together with newspaper flyers, there were a lot of them, and then it came to a point where they did not continue after a lot of people came to understand how big of a problem it was. (MC)

Direct conversations with healthcare workers and receipt of SMS played a pivotal role in motivating individuals to take positive actions. Participants expressed comfort and reassurance when engaging in direct communication with healthcare professionals. They viewed these interactions as sources of guidance, advice, and encouragement.

I have been called by a doctor here, he called me wanting to know how I am doing. I truly do not have a problem because if there is a problem, I can tell him and he gives me guidance. Therefore, if he gives me that guidance, I follow it and life goes on. (FC)

Discussion

This study delves into the perceptions of clients and health care workers regarding a digital health intervention to improve linkage to care after HIV self-testing in Tanzania. The study undertook in-depth exploration to understand the underlying factors influencing participants' responses, guided by the Health Belief Model (HBM). The participants in our study recognized the potential of digital health interventions to serve as reminders for crucial health activities, echoing the principle of the HBM, which posits that individuals are more likely to take action if they believe they are susceptible to the health condition, understand the severity of the condition, perceive benefits in taking a specific action, and face limited barriers. The convenience of receiving regular messages and calls prompt individuals to adopt a recommended health action. Our findings resonate with previous studies [21, 22] that have highlighted the effectiveness of text messaging as a communication tool in healthcare settings, showing its ability to provide timely information and reminders, ultimately promoting behavior change and improving health outcomes. Other studies have also highlighted the convenience and privacy offered by mobile health interventions, allowing individuals to access healthcare information and services in a timely and confidential manner [23], and identified improved access to healthcare services and increased patient engagement as key benefits of mobile health interventions [24].

Despite the recognized benefits, participants expressed concerns related to stigma, trust, and privacy, highlighting the potential psychological barriers influencing their responses to the intervention. Some participants recognized the potential risk of sending health-related

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messages via text, expressing fears that recipients might not be in a safe or private space to receive such messages. This could lead to unintended disclosure of their health status, resulting in stigma and avoidance of engagement with the intervention. For example, a participant might receive a health-related message while in the presence of others who are unaware of their health condition, leading to uncomfortable questions or assumptions. This anticipated stigma was especially pronounced among female clients, who worried that others might see the messages and make negative judgments about their health status. Such judgments could manifest as social stigma, where individuals are discriminated against or ostracized based on their perceived health condition. Both male and female clients acknowledged that the fear of being judged or misunderstood could deter them from reading or acting upon these messages. For instance, they might fear that others would interpret the messages as evidence of a serious or contagious health condition, leading to social exclusion or gossip. Additionally, some participants expressed concerns about being monitored, particularly in cases where their phones were shared with family members or friends. They feared that health-related messages could be seen by these unintended recipients, leading to breaches of privacy and further stigmatization.

Cost emerged as a significant barrier to the adoption of digital health interventions among participants, particularly in resource-limited settings like Tanzania. The financial burden associated with sending and receiving health-related messages was highlighted by healthcare workers, who noted that the expense could deter both clients and providers from fully engaging with the intervention. In Tanzania, where many individuals live on limited incomes, the additional cost of mobile data or airtime for health communication can be prohibitive. This barrier is not unique to Tanzania; other studies have also identified cost as a critical factor impacting the feasibility and sustainability of mobile health interventions. For instance, research conducted in low- and middle-income countries has shown that subsidizing the cost of mobile services or integrating health messaging into existing free services can enhance engagement and reduce financial strain on users [25]. Furthermore, implementing cost-effective strategies, such as using bulk SMS services or leveraging community health workers to facilitate communication, has been effective in other contexts [24]. Addressing the cost barrier is crucial for the successful implementation and scalability of digital health interventions in settings where financial constraints are a significant concern.

While some participants expressed no significant concerns, the majority did highlight issues such as stigma, trust, privacy and costs. The fear of stigma and breach of privacy acted as substantial barriers, potentially outweighing the perceived benefits and acting as deterrents to engagement. Understanding these psychological aspects becomes crucial for effectively tailoring interventions to address participants' concerns. These findings are consistent with previous studies that have identified similar barriers to the adoption and utilization of digital health technologies [26, 27].

While this study provides valuable insights, it is important to note that there are some limitations that may impact the applicability of its results. The study focused solely on the Kilimanjaro region, which may limit its relevance to other areas with differing sociocultural or healthcare contexts. The study's rigorous qualitative research analysis is a significant strength. The research team employed a collaborative and structured approach, involving a diverse group of investigators and coders who developed a comprehensive codebook and ensured inter-coder reliability through paired coding and senior researcher involvement. Regular debriefing sessions and adherence to Guba's criteria for trustworthiness, including techniques such as prolonged engagement, member checking, and peer debriefing, strengthened the study's rigor and credibility. These elements collectively contribute to the depth and reliability of the study's findings.

Conclusions

In summary, this study highlights the potential benefits and significant barriers to utilizing digital health interventions for HIV care and treatment. The participants acknowledged the value of reminders and information updates but expressed concerns about stigma, privacy, and trust. To successfully implement digital interventions, strategies must address these barriers with tailored, culturally sensitive approaches. This research contributes to the enhancement of intervention strategies and emphasizes the need for context-aware solutions across diverse participant groups. To effectively scale up digital health interventions, future studies could explore integrating additional features, such interactive elements, which may enhance the acceptability and impact of digital interventions. Furthermore, investigations into the long-term effectiveness and sustainability of these interventions and their adaptability across diverse participant groups would contribute to advancing the field.

Abbreviations
ART   Antiretroviral therapy
FC   Female Client
MC   Male Client
HCW   Health Care Workers
STEP   Self-testing Education and Promotion
HIV   Human immunodeficiency virus
HIVST   Human Immunodeficiency Virus Self-testing

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Supplementary Information

> Supplementary Material 1.

Availability of data and materials
The datasets generated and/or analyzed in the current study are not publicly available due to sensitive information about the participants. However, data are available from the PI or corresponding author (dxc341@gmail.com) upon reasonable request.

Declarations

Ethical approval and consent to participate
This study was approved by the ethics committee/Institutional Review Board of the University of Johannesburg, George Washington University, National Institute of Medical Research of Tanzania, and Advarra. Participants were assured anonymity and were asked to provide written informed consent for participation. All methods were carried out in accordance with relevant guidelines and regulations or declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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