

EXPERTS PERSPECTIVES ON DIGITAL HEALTH INTERVENTION TO IMPROVE HIV SELF-TESTING AND FACILITATE LINKAGE TO CARE

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Abstract

Background: Introduction

HIV is a high-burden disease in many low- and middle-income countries. Approximately 39.0 million people were living with HIV worldwide at the end of 2022, with the majority, 25.6 million people, residing in the African region (1,2). Globally 9.2 million people living with HIV do not have access to HIV treatment, over half of whom are in Africa (3). In Tanzania, the 2022 – 2023 demographic survey found that the prevalence of HIV is 4.4 percent among people aged 15 years and older (4.5 percent in mainland Tanzania and 0.4 percent in Zanzibar) and varies by residence (5.0 percent in urban areas and 4.0 percent in rural areas) and gender (5.6 percent in women and 3.0 percent in men). The national adult HIV prevalence estimate translates to approximately 1.5 million people aged 15 years and older living with HIV in Tanzania (2).

HIV testing is the first component of the HIV care cascade and is critical in achieving epidemic control (4–6). While rates of HIV testing and counseling (HTC) have increased globally in recent years (1,7), there is a need for continued expansion of HTC, coupled with linkage to care. As of 2022, only 86% of people living with HIV globally knew their status, falling short of the UNAIDS goal of 95%(3,8). To reach this target, an additional 3.5 million people living with HIV need to be made aware of their HIV status and linked to care and treatment (9). Despite improved testing coverage in the general population globally, hard-to-reach groups such as men, commercial sex workers (CSW), and adolescents are underserved (7,12–14), with poor access to testing and treatment services.

Barriers to testing through standard facility-based options are complex and varied, and include inconvenient clinic hours, stigma and discrimination, long distance from facilities and the associated cost of transportation (15,16). These barriers continue to limit uptake of HTC in many high HIV prevalence setting including in Sub-Saharan African countries (17–20). Based on increasing evidence regarding the feasibility and acceptability of HIVST in some parts of Africa (21–24), activists and public health policy makers argue that non-invasive HIV self-testing (HIVST)-an HIV test collected, performed and interpreted in private by the individual who wants to know their HIV status is capable of reaching a wider range of target groups, expanding geographical coverage and uptake of HTC and addressing some barriers to more conventional HTC models. However, the most significant argument against HIVST relates to concerns about the absence of in-person pre- and post-test counseling which results in lower rates of linkages to treatment and care after testing.

The lower rates of linkage to treatment and care following HIVST necessitates innovative strategies. The World Health Organization (WHO) has advocated for integration of digital health solutions to increase patient engagement and facilitate disease self-management. Smartphone app features, web-based systems, and text messages have the potential to engage patients more effectively and provide evidence-based information and advice (25). HIVST with digital supports is the use of digital interventions (e.g., website-based, social media, mobile HIVST applications (apps), text messaging (SMS), and phone calls to improve the efficiency and impact of HIVST (26,27).

Although many studies document the benefits of digital health interventions in terms of supporting the user to monitor, treat, and follow-up disease conditions, the quality of digital health platforms is a cause for concern, as many of them are not tailored to the user's needs (25). Many telemedicine and telehealth technologies are still not adequately meeting patients' and providers' needs (28,29). This may explain the low adoption and use of digital health as part of routine care in clinical practice. The digital health ecosystem is also very complex, involving actors and agencies from the public, community and not-for-profit groups, health service providers, and government, often with different and sometimes competing interests (25). There are numerous questions and issues to be resolved in facilitating the provision and efficacy of digital health interventions, including use of and access to electronic medical records and patient portals by health care consumers and provider (29).

Considering the ongoing efforts to expand digital health initiatives, particularly in low-resource settings, eliciting the views and experiences of the diverse constituents in the digital ecosystem is important. This study intends to explore the perspectives of various experts and practitioners involved in HIV research and clinical practice, and the developers of digital health interventions.

Objective: TO EXPLORE EXPERTS PERSPECTIVES ON DIGITAL HEALTH INTERVENTION TO IMPROVE HIV SELF-TESTING AND FACILITATE LINKAGE TO CARE

Methods: Methods

Theoretical Framework

We used the Consolidated Framework for Implementation Research (CFIR) to analyze and understand the factors influencing the successful implementation of digital health interventions in the context of HIVST in Tanzania (30,31). The CFIR was developed to guide the systematic assessment of multilevel contextual factors that influence the implementation of an intervention. CFIR is a determinant framework consisting of five domains that include characteristics of the intervention, inner setting, outer setting and individual characteristics and process of implementation (Damschroder et al., 2022). We used these domains to explore factors that shape the development and implementation of digital health interventions to support HIVST and linkage to care (32).

By doing so, we captured the unique perspectives, challenges, and facilitators presented by experts, contributing to the development of effective and inclusive digital health solutions for HIV prevention and care.

Study design

We used an exploratory qualitative design. This design is most appropriate because it allowed us to explore in detail the nuanced insights, opinions, and firsthand experiences of the experts in the field.

Study setting

This exploratory qualitative study engaged experts from diverse geographical locations, spanning various countries and institutions worldwide. The research transcended international boundaries, encompassing a global network of experts with extensive experience in the field of HIV and digital health. The study drew participants from different countries, reflecting a rich tapestry of perspectives and experiences within the global community of experts in the relevant domain.

Study participants, sampling and recruitment

The study utilized purposive sampling technique to select participants and achieve maximum-diversity in the study sample. Snowball (referral) sampling was also used to source additional participants for interviews. The experts were contacted via e-mail or telephonically and interviews were scheduled at their convenience. Key informant interviews (N=17) with experts were conducted from March to April, 2024 in Tanzania. The experts with diverse professional backgrounds and extensive experience in HIV-related initiatives and digital health interventions were included. These included five medical doctors (MD), four researchers, two community affairs leaders (CAL), three HIV technical advisors (TA), and three data analytics specialists (DAS). These experts had affiliations with prominent institutions such as Ifakara Health Institute, AMREF Health Africa, FHI 360, Elizabeth Glassier Pediatric AIDS Foundation (EGPAF)-USA, Muhimbili University of Allied Sciences (MUHAS), Ministry of Health in Tanzania (MOH). While their collective work experience spanned various sectors, including years of service within Ministries of Health and significant contributions to healthcare delivery at different levels, it's important to note that participants were selected based on their involvement in HIV research or program implementation rather than solely on their digital health experience or knowledge. Notably, the experts played pivotal roles in HIV prevention services, participated in the initiation of HIV self-testing (HIVST) interventions, and demonstrated expertise in implementation, monitoring and evaluation of HIV programs. Most of the key informants were national decision-makers in HIV programming, policy development, and researchers in Tanzania and beyond.

Data collection

Data was collected through key informant interviews. All interviews were conducted through Zoom except for one interview conducted face-to-face, at the request of the participants. Interviews were conducted in Swahili and English by a trained

qualitative researcher using a semi-structured interview guide. Interviews lasted between 40- and 60-min. Interview were audio-recorded, transcribed and the Swahili transcripts were translated into English. The interview guide was developed based on CFIR framework. All interviews were conducted by the first author FM, a PhD student with extensive training in qualitative research methods.

Data analysis

This study employed thematic analysis, an approach in which themes, patterns and relationships in qualitative data are identified and analyzed (33). Recorded interviews were transcribed verbatim in Swahili. Thereafter, English versions of the transcripts were developed to enable detailed review by the research team. The transcripts were then read several times to develop codes from which themes were synthesized. Codes and themes were developed both deductively using the CFIR constructs and inductively using the context-specific emergent issues from the data. Transcripts were also reviewed by other co-authors. Each member manually coded a specific number of transcripts and discussed with the research team to reach consensus on emergent issues.

Ethical considerations

Ethical approval for the study was obtained from the Research Ethics Committee of the University of Johannesburg. All participants provided written informed consent prior to their interview and gave consent to be audio recorded.

Results: RESULTS

Innovation domain

Innovation evidence-base, innovation relative advantage, innovation adaptability, innovation complexity, and innovation design were identified by participants as important constructs of innovation domain of CFIR. Most experts expressed a substantial level of understanding regarding digital health interventions, with their perspectives highlighting the diverse applications and potential impact of technology in addressing healthcare challenges.

“My understanding of digital health interventions is [they are] any technology or device or strategy that by its implementation, can either enhance, improve or need to efficient way of providing service or addressing health challenges so specifically using a mobile device or electronic device or electronic software system that can help to improve efficient address health related challenges...” (DAS, # 1)

Another participant articulated a comprehensive understanding of digital health services, emphasizing the transformative nature of these services in healthcare delivery.

“Regarding digital health services, I understand that there are healthcare services that you can access without visiting a doctor physically. There are services where you can receive treatment, injections, tests, and health advice, either at home or remotely. Mobile phones are widely used for communication in Tanzania, and people can consult with a doctor using their phones, receiving advice without physically going to a clinic.” (CAL # 1)

However, few participants expressed varying levels of familiarity with digital systems. This finding underscores that even individuals with years of experience and knowledge working in HIV may not necessarily possess extensive experience or knowledge regarding digital health technologies.

“Regarding my understanding of digital systems, I would say it's quite limited, around 40% from a total of 100%.” (Researcher, # 3)

Also, majority of participants emphasized the importance of simplicity in digital health interventions. They suggested avoiding unnecessary technological complexities, advocating for the use of basic phones to ensure broader accessibility.

“I believe we shouldn't complicate the technology. Even in the realm of mobile phones, we decided it's not necessary to use smartphones; even regular phones can be used. By simplifying, you expand your reach. In Tanzania, the coverage of phone usage is very good, and by using technology that is accessible to a broad population, including those with basic phones, we can reach a lot of end-users. So, simplifying the technology is crucial, allowing people at different economic levels to access it.” (MD, #1)

One expert insisted about the issue of interoperability of the digital health intervention, emphasizing the seamless integration of the intervention with various existing systems.

The last one is interoperability which will be easily linked up with other system because you are going to face different system from different self delivery approach by the government by the public just simple pharmacy, they all want to have their system they all want to link to this intervention and easy repoting and link to care and that shoud not be very complex by then it should be very simple to the users (Researcher, #1)

Participants also shared their experience and awareness of the existing technologies that could serve as models or inspiration for

the implementation of digital health interventions, particularly in the context of HIV self-testing. Few experts shared their experiences engaging in some of the digital health interventions highlighting their involvement in developing some technologies for HIV self-testing.

"I am not well updated, but I remember when I was working with this SPC project we developed one digital system where it was mainly aimed at collecting the results or report from the end users of HIV self-testing because by then the big challenge was on how we know what information we want to collect from the end users." (MD, #5)

Participants discussed their experience using digital health platforms outside of HIV care and expressed of high level of transferability of those platforms for patients following HIVST. One expert shared his awareness on the existing digital health intervention for skin diseases treatment implemented by the Ifakara Health Institute.

The Ifakara Health Institute has a digital health service for skin diseases, of which I am a leader. This service's model could be adapted for HIV self-testing. Using a mobile phone, individuals can self-test, input the results, have them reviewed by a doctor, and receive immediate feedback. While our institute currently uses this for skin diseases, the model can be applied to HIV testing. (CAL, # 2)

However, most of participants were not aware of any existing technologies or digital platform implemented for HIVST and linkage to care area.

Currently, for self-testing for HIV, there are no digital services available. Most of the studies conducted provided testing kits, and individuals went home, returning the next day for results. Door-to-door or person-to-person methods were used, but there is no digital approach for self-testing. (TA, #3)

All participants felt that digital health interventions are very useful and hold significant potential for enhancing HIVST and linkage to care services. Some experts mentioned that, digital health can guide user through self-testing process, reporting, and accessing information.

"I think I would still want to implement the idea (digital health) but on such I would improve it in three areas; one, the system should be able to give the user ability like first guidance on how to conduct the testing. Second on reporting and data management. The third is to provide promotion and education messages about self-testing and importance of confirmatory testing." (Researcher, #1)

Another expert highlights the usefulness of digital health intervention in enhancing healthcare services. The participant underscores the benefits of these digital solutions, emphasizing their ability to bring privacy to healthcare interactions and expedite service delivery.

"In my opinion, it's a good thing because it brings privacy and expedites service delivery, contributing to the improvement of the quality of care." (Researcher, #4)

Almost all experts highlighted the importance of simplicity, scalability, and openness in developing a successful digital health intervention. Experts mentioned how government preferences for sustainability and open-source solutions impact acceptance and scalability.

The third one is it has to be very simple to use, easy to scale up but also should be open source because most government they are looking for something which will be sustainable something which will be licensed and all those proprietor or it will face very difficulties to be accepted or for the scale up (TA, #1)

Outer settings

Partnership and connections, policy and laws, and financing were identified as important constructs of the outer settings that would serve as facilitators of development and implementation of digital health intervention. Almost all experts expressed the necessity of financial resources for implementing and scaling digital health intervention highlighting the multifaced demands on financial support.

"Well, the first factor is understanding the challenges and showing how digital intervention will address those. For us, it was easy to get funds and to get buy in for our digital health system because we were able to tackle the problems from the facility, the ministry and also from the user themselves. (Researcher, #3)

Another factor identified by the most experts revolve around garnering support from key stakeholders - the users, implementers, and regulatory entities such as the government.

"The second is the buy in from both the user and also the implementor and the regulator or the government. Before deploying or starting implementing, make sure your idea, your intervention is well received by those stakeholders (MD, #4)

On the other side, lack of prioritization by the Ministry of Health at various levels – regional, district, and local was mentioned as a potential barrier to the success of the digital health intervention.

"The primary obstacles would be the lack of prioritization by the Ministry of Health at various levels – regional, district, and

local. Additionally, if the pricing of the testing devices is not affordable, people will not buy them, and the service will not succeed.” (MD, # 2)

Inner setting domain

The culture was identified as the main construct in the inner setting domain of the CFIR. The participants statements about community readiness and acceptance of digital health interventions reflect share values, belief and norms in the community regarding healthcare and technology. Using their experiences from other digital health interventions, most of experts mentioned that the community is ready to embrace the digital health intervention for HIVST. One expert mentioned that the higher acceptability and readiness is seen among the young people.

“Using the experience that we have with the users on the piloted study, that we used USSD intervention as an interactive communication technology used in mobile phones to provide text-based services, I would say they are ready. I would say for young people the acceptability is high but am using that one pilot we did and that one tool we used (CAL, #2)

Another expert echoed similar sentiments, emphasizing the Tanzanian community's receptiveness to digital health services given the ability of digital health intervention to enhance healthcare accessibility and overcome challenges related to geographical distances to health facilities.

“The Tanzanian community is very open to using digital health services, especially through mobile phones as it makes healthcare more accessible and helps eliminate barriers like distance to health facilities.” (MD, # 1)

Despite the overall perception among experts that communities are willing to adopt the digital health intervention for HIV self-testing (HIVST), specifically emphasizing the use of digital interventions as medication adherence reminders, this optimism is moderated by the acknowledgment of substantial barriers, notably financial constraints.

“For the most part, I see a readiness in communities because services like reminders on mobile phones have been accepted, especially for medication reminders. The main hindrances are financial support. (TA, #3)

Individuals' domain

Motivation, capability and opportunity are some of the key constructs highlighted by the participants in the individual's domain of the CFIR. The individual characteristics construct highlights the importance of collaborative networks in cultivating interest and adoption of digital health interventions among both professionals and community members.

Healthcare providers readiness for implementation was also mentioned by the majority of experts as a crucial aspect of the digital health intervention's success. The satisfaction expressed by healthcare providers, particularly regarding a comprehensive digital platform designed to streamline various aspects of healthcare delivery and management systems in reducing paperwork, underscores their positive attitude toward incorporating technological solutions into their practices.

“Yes, on the side of healthcare providers, they are very pleased, especially with the UNIFIED COMMUNITY SOLUTION. They appreciated it, particularly in reducing paperwork. We provided them with tablets, and even though some had malfunctions, we observed a readiness in such a way that they resorted to using their own phones to continue reporting data to us. Therefore, indicators from the 326 facilities I work with show a positive response from healthcare providers. (CAL, #3)

For some experts marketing and awareness campaigns are crucial in promoting the adoption of digital health interventions for HIV self-testing.

“It requires marketing and awareness campaigns. Marketing is crucial because, in the end, even if it's a professional or a non-professional, everyone will be interested if they are aware. Conducting campaigns and raising awareness is crucial for the success of any intervention. Whether it's a professional or not, if they understand the benefits, they will be interested.” (Researcher, # 1)

Effective engagement of experts in the development and implementation of a digital health intervention for HIV self-testing and linkage to care was one of the aspects mentioned in the individual characteristics of CFIR. As conveyed by the majority of experts, the adoption of virtual meetings proved to be not just a necessary adaptation but a remarkably successful one. One expert shared his experiences and lessons learned from the COVID-19 era, highlighting the effectiveness and preference for virtual communication among stakeholders. This transition allowed for increased participation without disrupting regular activities, addressing a common challenge faced during in-person meetings.

“Communication through digital means, especially after the COVID experience, has become crucial. COVID taught us many things. I am a member of the IRB social review board at Ifakara, and we used to have monthly physical meetings. But after COVID, we shifted to virtual meetings, and it worked well. Most stakeholders prefer virtual meetings because it allows them to participate without disrupting their regular activities. Virtual communication has facilitated communication more effectively than actual meetings, especially considering the busy schedules of professionals. So, I would say that virtual communication is very good, and nowadays, many people prefer it.” (Researcher 3)

Implementation process domain

Assessing the needs, assessing context, engaging, teaming was identified as important constructs under the implementation process domain.

One participant emphasized the need for digital health intervention for patients to be integrated into facility-level electronic health record systems. This integration would facilitate tracking individuals who have used HIV self-testing kits and help in monitoring their subsequent interactions with health services.

“So maybe the last one I would add is the linkage to the main patient management information system or any health management system to be able to link those number because if this client has accessed X facility to get either confirmation or supportive interpretation then we can start linking them with the facility accessed so linking this app with the service provider so when they came or when you need any way of linking them all those who have used the HIV self-testing Kits how many have accessed the services for more information for confirmation and for linkage if they are positive so I can say that another feature we can add to close the loop I don’t know how but it will make sense.” (MD, #4)

One of the critical factors identified by most experts as potentially facilitating the implementation of digital health intervention at the organizational level (organizations, health clinics) was whether the digital intervention address their daily problems.

“Well, is it addressing their problem? that for me is critical because we did a different, we have several tools during my life with strategic information to key success they would grab it and go with if it addresses their problem. But if it adds some layers to their work and does not direct address the problem you will face difficult to implement to be accepted also to scale it up.” (MD, #5)

Financial, human and infrastructure resources were identified as important inner setting constructs that could drive the implementation of digital health intervention in the organizations. All experts underscored the necessity of having skilled human resources for the effective execution of digital health interventions.

“Enough human resources who would take up these interventions, so some key champions from the facility level must be skilled in this area (DAS, #3)

Almost all experts felt that financial resources play a pivotal role in the successful implementation of digital health interventions at the organizational level. The consensus among experts highlighted the multifaceted demands on financial support to implement the digital health intervention.

“I think financial resources will be needed to run this intervention because you will need a lot of promotion to support the intervention also to implement the development and to make sure it is operational. You will need enough fund to conduct capacity building scaling it up and also making it sustainable”. (Researcher, #3)

Another expert highlighted about infrastructure as a critical aspect for successful implementation of digital health interventions. The expert emphasized the need for a robust platform to manage information, potentially involving servers or clouding servers, forming the backbone of the main system.

“Also, the infrastructure, so in term of infrastructure I would say will be the platform to manage all the information may be servers may be clouding servers and the main system.” (Dr. Msofe)

Continuous improvement through ongoing feedback mechanism was emphasized as a critical process construct within the CFIR. Almost all experts underscored feedbacks as a pivotal aspect in the research process, emphasizing the need for frequently feedback during development and implementation of the digital health intervention.

Feedback is a significant aspect and many researchers, after completing their studies, vanish. They don't communicate effectively. You need to give feedback to professionals, stakeholders, and even to the community where you conducted the study. It's not good to just complete a study and disappear. It's essential to disseminate your findings to various levels, from international to regional, district level, and even the community involved in your study. This applies to the development of any intervention; you have to come back to the stakeholder to give the feedbacks. Giving feedback is mandatory, and it's crucial. (Researcher, #4)

Conclusions: Conclusion

Our study contributes to the growing body of literature on digital health interventions by providing insights into the perspectives of experts in the context of HIVST and linkage to care in Tanzania. The findings reinforce key themes present in existing literature and underscore the need for context-specific, user-friendly, and collaboratively developed interventions. Moving forward, interventions should consider the nuances of stakeholder perspectives, engage in ongoing communication, and leverage successful models to optimize the implementation and impact of digital health solutions in healthcare settings.

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Original Manuscript

EXPERTS¹ PERSPECTIVES ON DIGITAL HEALTH INTERVENTION TO IMPROVE HIV SELF-TESTING AND FACILITATE LINKAGE TO CARE

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ABSTRACT

Background:

HIV remains a significant global health challenge, particularly in sub-Saharan Africa. Despite advancements in HIV testing, substantial proportions of the population remain unaware of their HIV status, hindering efforts to achieve the 95-95-95 targets set by UNAIDS. Barriers to conventional facility-based HIV testing, such as stigma and accessibility issues persist, especially among hard-to-reach groups. Non-invasive HIV self-testing (HIVST) has emerged as a potential solution, but concerns about linkage to care after testing is an ongoing challenge. Integrating digital health solutions into HIVST has been proposed to enhance engagement and facilitate self-management.

Objective:

This qualitative study design, guided by the Consolidated Framework for Implementation Research (CFIR), explored the perspectives of global experts and practitioners in HIV research and digital health interventions.

Methods:

Key informant interviews using a semi-structured interview guide were conducted with 17 experts from diverse professional backgrounds, including medical doctors, researchers, community affairs leaders, HIV technical advisors, and data analytics specialists. Participants were purposively sampled and interviewed between March and April 2024, with data analyzed thematically.

Results: The study identified multifaceted factors influencing the successful implementation of digital health interventions in the context of HIVST. Participant responses encompassed a range of CFIR constructs including characteristics of the intervention, inner and outer settings, individual characteristics, and the process of implementation. Participants emphasized the need for high-quality interventions that meet healthcare standards and user needs, ensuring accessibility, user-friendliness, and cultural relevance.

Conclusions: This study contributes to understanding the perspectives of experts within the digital health ecosystem regarding digital health intervention to enhance HIVST. The findings emphasize the importance of addressing nuanced challenges to ensure effective digital health integration. Insights gained can inform the development of inclusive and tailored digital health solutions, advancing HIV prevention and care efforts on a global scale. Ethical considerations were prioritized throughout the study, ensuring participant consent and confidentiality.

Keywords: HIV, HIV self-testing, digital health, Consolidated Framework for Implementation

¹ Experts refers to individuals with significant knowledge, and experiences in the field of HIV research, public health, and digital health interventions.

Research, global health, linkage to care, qualitative research.

Introduction

HIV is a high-burden disease in many low- and middle-income countries. Approximately 39.0 million people were living with HIV worldwide at the end of 2022, with the majority, 25.6 million people, residing in the African region (1,2). Globally 9.2 million people living with HIV do not have access to HIV treatment, over half of whom are in Africa (3). In Tanzania, the 2022 – 2023 demographic survey found that the prevalence of HIV is 4.4 percent among people aged 15 years and older (4.5 percent in mainland Tanzania and 0.4 percent in Zanzibar), and varies by residence (5.0 percent in urban areas and 4.0 percent in rural areas) and gender (5.6 percent in women and 3.0 percent in men). The national adult HIV prevalence estimate translates to approximately 1.5 million people aged 15 years and older living with HIV in Tanzania (2).

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Barriers to testing through standard facility -based options are complex and varied, and include inconvenient clinic hours, stigma and discrimination, long distance from facilities and the associated cost of transportation (15,16). These barriers continue to limit uptake of HTC in many high HIV prevalence setting including in Sub-Saharan African countries (17–20). Based on increasing evidence regarding the feasibility and acceptability of HIVST in some parts of Africa (21–24), activists and public health policy makers argue that non-invasive HIV self-testing (HIVST)-an HIV test collected, performed and interpreted in private by the individual who wants to know their HIV status is capable of reaching a wider range of target groups, expanding geographical coverage and uptake of HTC and addressing some barriers to more conventional HTC models. However, the most significant

argument against HIVST relates to concerns about the absence of in-person pre- and post-test counseling which results in lower rates of linkages to treatment and care after testing.

The lower rates of linkage to treatment and care following HIVST necessitates innovative strategies. The World Health Organization (WHO) has advocated for integration of digital health solutions to increase patient engagement and facilitate disease self-management. Smartphone app features, web-based systems, and text messages have the potential to engage patients more effectively and provide evidence-based information and advice and advice (25). HIVST with digital supports is the use of digital interventions (e.g., website-based, social media, mobile HIVST applications (apps), text messaging (SMS), and phone calls to improve the efficiency and impact of HIVST (26,27).

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Study participants, sampling and recruitment

The study utilized purposive sampling technique to select participants and achieve maximum-diversity in the study sample. Snowball (referral) sampling was also used to source additional participants for interviews. The experts were contacted via e-mail or telephonically and interviews were scheduled at their convenience. Key informant interviews (N=17) with experts were conducted from March to April, 2024 in Tanzania. The experts with diverse professional backgrounds and extensive experience in HIV-related initiatives and digital health interventions were included. These included five medical doctors (MD), four researchers, two community affairs leaders (CAL), three

HIV technical advisors (TA), and three data analytics specialists (DAS). These experts had affiliations with prominent institutions such as Ifakara Health Institute, AMREF Health Africa, FHI 360, Elizabeth Glassier Pediatric AIDS Foundation (EGPAF)-USA, Muhimbili University of Allied Sciences (MUHAS), Ministry of Health in Tanzania (MOH). While their collective work experience spanned various sectors, including years of service within Ministries of Health and significant contributions to healthcare delivery at different levels, it's important to note that participants were selected based on their involvement in HIV research or program implementation rather than solely on their digital health experience or knowledge. Notably, the experts played pivotal roles in HIV prevention services, participated in the initiation of HIV self-testing (HIVST) interventions, and demonstrated expertise in implementation, monitoring and evaluation of HIV programs. Most of the key informants were national decision-makers in HIV programming, policy development, and researchers in Tanzania and beyond.

Data collection

Data was collected through key informant interviews. All interviews were conducted through Zoom except for one interview conducted face-to-face, at the request of the participants. Interviews were conducted in Swahili and English by a trained qualitative researcher using a semi-structured interview guide. Interviews lasted between 40- and 60-min. Interview were audio-recorded, transcribed and the Swahili transcripts were translated into English. The interview guide was developed based on CFIR framework. All interviews were conducted by the first author FM, a PhD student with extensive training in qualitative research methods.

Data analysis

This study employed thematic analysis, an approach in which themes, patterns and relationships in qualitative data are identified and analyzed (33). Recorded interviews were transcribed verbatim in Swahili. Thereafter, English versions of the transcripts were developed to enable detailed review by the research team. The transcripts were then read several times to develop codes from which themes were synthesized. Codes and themes were developed both deductively using the CFIR constructs and inductively using the context-specific emergent issues from the data. Transcripts were also reviewed by other co-authors. Each member manually coded a specific number of

transcripts and discussed with the research team to reach consensus on emergent issues.

Ethical considerations

Ethical approval for the study was obtained from the Research Ethics Committee of the University of Johannesburg. All participants provided written informed consent prior to their interview and gave consent to be audio recorded.

RESULTS

Innovation domain

Innovation evidence-base, innovation relative advantage, innovation adaptability, innovation complexity, and innovation design were identified by participants as important constructs of innovation domain of CFIR. Most experts expressed a substantial level of understanding regarding digital health interventions, with their perspectives highlighting the diverse applications and potential impact of technology in addressing healthcare challenges.

“My understanding of digital health interventions is [they are] any technology or device or strategy that by its implementation, can either enhance, improve or need to efficient way of providing service or addressing health challenges so specifically using a mobile device or electronic device or electronic software system that can help to improve efficient address health related challenges...” (DAS, # 1)

Another participant articulated a comprehensive understanding of digital health services, emphasizing the transformative nature of these services in healthcare delivery.

“Regarding digital health services, I understand that there are healthcare services that you can access without visiting a doctor physically. There are services where you can receive treatment, injections, tests, and health advice, either at home or remotely. Mobile phones are widely used for communication in Tanzania, and people can consult with a doctor using their phones, receiving advice without physically going to a clinic.” (CAL # 1)

However, few participants expressed varying levels of familiarity with digital systems. This finding underscores that even individuals with years of experience and knowledge working in HIV may not necessarily possess extensive experience or knowledge regarding digital health technologies.

“Regarding my understanding of digital systems, I would say it's quite limited, around 40% from a total of 100%.” (Researcher, # 3)

Also, majority of participants emphasized the importance of simplicity in digital health interventions. They suggested avoiding unnecessary technological complexities, advocating for the use of basic phones to ensure broader accessibility.

"I believe we shouldn't complicate the technology. Even in the realm of mobile phones, we decided it's not necessary to use smartphones; even regular phones can be used. By simplifying, you expand your reach. In Tanzania, the coverage of phone usage is very good, and by using technology that is accessible to a broad population, including those with basic phones, we can reach a lot of end-users. So, simplifying the technology is crucial, allowing people at different economic levels to access it." (MD, #1)

One expert insisted about the issue of interoperability of the digital health intervention, emphasizing the seamless integration of the intervention with various existing systems.

The last one is interoperability which will be easily linked up with other system because you are going to face different system from different self delivery approach by the government by the public just simple pharmacy, they all want to have their system they all want to link to this intervention and easy repoting and link to care and that shoud not be very complex by then it should be very simple to the users (Researcher, #1)

Participants also shared their experience and awareness of the existing technologies that could serve as models or inspiration for the implementation of digital health interventions, particularly in the context of HIV self-testing. Few experts shared their experiences engaging in some of the digital health interventions highlighting their involvement in developing some technologies for HIV self-testing.

"I am not well updated, but I remember when I was working with this SPC project we developed one digital system where it was mainly aimed at collecting the results or report from the end users of HIV self-testing because by then the big challenge was on how we know what information we want to collect from the end users." (MD, #5)

Participants discussed their experience using digital health platforms outside of HIV care and expressed of high level of transferability of those platforms for patients following HIVST. One expert shared his awareness on the existing digital health intervention for skin diseases treatment implemented by the Ifakara Health Institute.

The Ifakara Health Institute has a digital health service for skin diseases, of which I am a leader. This service's model could be adapted for HIV self-testing. Using a mobile phone, individuals can self-test, input the results, have them reviewed by a doctor, and receive immediate feedback. While our institute currently uses this for

skin diseases, the model can be applied to HIV testing. (CAL, # 2)

However, most of participants were not aware of any existing technologies or digital platform implemented for HIVST and linkage to care area.

Currently, for self-testing for HIV, there are no digital services available. Most of the studies conducted provided testing kits, and individuals went home, returning the next day for results. Door-to-door or person-to-person methods were used, but there is no digital approach for self-testing. (TA, #3)

All participants felt that digital health interventions are very useful and hold significant potential for enhancing HIVST and linkage to care services. Some experts mentioned that, digital health can guide user through self-testing process, reporting, and accessing information.

"I think I would still want to implement the idea (digital health) but on such I would improve it in three areas; one, the system should be able to give the user ability like first guidance on how to conduct the testing. Second on reporting and data management. The third is to provide promotion and education messages about self-testing and importance of confirmatory testing." (Researcher, #1)

Another expert highlights the usefulness of digital health intervention in enhancing healthcare services. The participant underscores the benefits of these digital solutions, emphasizing their ability to bring privacy to healthcare interactions and expedite service delivery.

"In my opinion, it's a good thing because it brings privacy and expedites service delivery, contributing to the improvement of the quality of care." (Researcher, #4)

Almost all experts highlighted the importance of simplicity, scalability, and openness in developing a successful digital health intervention. Experts mentioned how government preferences for sustainability and open-source solutions impact acceptance and scalability.

The third one is it has to be very simple to use, easy to scale up but also should be open source because most government they are looking for something which will be sustainable something which will be licensed and all those proprietor or it will face very difficulties to be accepted or for the scale up (TA, #1)

Outer settings

Partnership and connections, policy and laws, and financing were identified as important constructs of the outer settings that would serve as facilitators of development and implementation of digital health intervention. Almost all experts expressed the necessity of financial resources for implementing and scaling digital health intervention highlighting the multifaced demands on financial support.

“Well, the first factor is understanding the challenges and showing how digital intervention will address those. For us, it was easy to get funds and to get buy in for our digital health system because we were able to tackle the problems from the facility, the ministry and also from the user themselves. (Researcher, #3)

Another factor identified by the most experts revolve around garnering support from key stakeholders - the users, implementers, and regulatory entities such as the government.

“The second is the buy in from both the user and also the implementor and the regulator or the government. Before deploying or starting implementing, make sure your idea, your intervention is well received by those stakeholders (MD, #4)

On the other side, lack of prioritization by the Ministry of Health at various levels – regional, district, and local was mentioned as a potential barrier to the success of the digital health intervention.

“The primary obstacles would be the lack of prioritization by the Ministry of Health at various levels – regional, district, and local. Additionally, if the pricing of the testing devices is not affordable, people will not buy them, and the service will not succeed.” (MD, # 2)

Inner setting domain

The culture was identified as the main construct in the inner setting domain of the CFIR. The participants statements about community readiness and acceptance of digital health interventions reflect share values, belief and norms in the community regarding healthcare and technology. Using their experiences from other digital health interventions, most of experts mentioned that the community is ready to embrace the digital health intervention for HIVST. One expert mentioned that the higher acceptability and readiness is seen among the young people.

“Using the experience that we have with the users on the piloted study, that we used USSD intervention as an interactive communication technology used in mobile phones to provide text-based services, I would say they are ready. I would say for young people the acceptability is high but am using that one pilot we did and that one tool we used (CAL, #2)

Another expert echoed similar sentiments, emphasizing the Tanzanian community's receptiveness to digital health services given the ability of digital health intervention to enhance healthcare accessibility and overcome challenges related to geographical distances to health facilities.

“The Tanzanian community is very open to using digital health services, especially through mobile phones as it makes healthcare more accessible and helps eliminate barriers like distance to health facilities.” (MD, # 1)

Despite the overall perception among experts that communities are willing to adopt the digital

health intervention for HIV self-testing (HIVST), specifically emphasizing the use of digital interventions as medication adherence reminders, this optimism is moderated by the acknowledgment of substantial barriers, notably financial constraints.

"For the most part, I see a readiness in communities because services like reminders on mobile phones have been accepted, especially for medication reminders. The main hindrances are financial support. (TA, #3)

Individuals' domain

Motivation, capability and opportunity are some of the key constructs highlighted by the participants in the individual's domain of the CFIR. The individual characteristics construct highlights the importance of collaborative networks in cultivating interest and adoption of digital health interventions among both professionals and community members.

Healthcare providers readiness for implementation was also mentioned by the majority of experts as a crucial aspect of the digital health intervention's success. The satisfaction expressed by healthcare providers, particularly regarding a comprehensive digital platform designed to streamline various aspects of healthcare delivery and management systems in reducing paperwork, underscores their positive attitude toward incorporating technological solutions into their practices.

"Yes, on the side of healthcare providers, they are very pleased, especially with the UNIFIED COMMUNITY SOLUTION. They appreciated it, particularly in reducing paperwork. We provided them with tablets, and even though some had malfunctions, we observed a readiness in such a way that they resorted to using their own phones to continue reporting data to us. Therefore, indicators from the 326 facilities I work with show a positive response from healthcare providers. (CAL, #3)

For some experts marketing and awareness campaigns are crucial in promoting the adoption of digital health interventions for HIV self-testing.

"It requires marketing and awareness campaigns. Marketing is crucial because, in the end, even if it's a professional or a non-professional, everyone will be interested if they are aware. Conducting campaigns and raising awareness is crucial for the success of any intervention. Whether it's a professional or not, if they understand the benefits, they will be interested." (Researcher, # 1)

Effective engagement of experts in the development and implementation of a digital health intervention for HIV self-testing and linkage to care was one of the aspects mentioned in the

individual characteristics of CFIR. As conveyed by the majority of experts, the adoption of virtual meetings proved to be not just a necessary adaptation but a remarkably successful one. One expert shared his experiences and lessons learned from the COVID-19 era, highlighting the effectiveness and preference for virtual communication among stakeholders. This transition allowed for increased participation without disrupting regular activities, addressing a common challenge faced during in-person meetings.

“Communication through digital means, especially after the COVID experience, has become crucial. COVID taught us many things. I am a member of the IRB social review board at Ifakara, and we used to have monthly physical meetings. But after COVID, we shifted to virtual meetings, and it worked well. Most stakeholders prefer virtual meetings because it allows them to participate without disrupting their regular activities. Virtual communication has facilitated communication more effectively than actual meetings, especially considering the busy schedules of professionals. So, I would say that virtual communication is very good, and nowadays, many people prefer it.” (Researcher 3)

Implementation process domain

Assessing the needs, assessing context, engaging, teaming was identified as important constructs under the implementation process domain.

One participant emphasized the need for digital health intervention for patients to be integrated into facility-level electronic health record systems. This integration would facilitate tracking individuals who have used HIV self-testing kits and help in monitoring their subsequent interactions with health services.

“So maybe the last one I would add is the linkage to the main patient management information system or any health management system to be able to link those number because if this client has accessed X facility to get either confirmation or supportive interpretation then we can start linking them with the facility accessed so linking this app with the service provider so when they came or when you need any way of linking them all those who have used the HIV self-testing Kits how many have accessed the services for more information for confirmation and for linkage if they are positive so I can say that another feature we can add to close the loop I don't know how but it will make sense.” (MD, #4)

One of the critical factors identified by most experts as potentially facilitating the implementation of digital health intervention at the organizational level (organizations, health clinics) was whether the digital intervention address their daily problems.

“Well, is it addressing their problem? that for me is critical because we did a different, we have several tools during my life with strategic information to key

success they would grab it and go with if it addresses their problem. But if it adds some layers to their work and does not directly address the problem you will face difficulty to implement to be accepted also to scale it up.” (MD, #5)

Financial, human and infrastructure resources were identified as important inner setting constructs that could drive the implementation of digital health intervention in the organizations. All experts underscored the necessity of having skilled human resources for the effective execution of digital health interventions.

“Enough human resources who would take up these interventions, so some key champions from the facility level must be skilled in this area (DAS, #3)

Almost all experts felt that financial resources play a pivotal role in the successful implementation of digital health interventions at the organizational level. The consensus among experts highlighted the multifaceted demands on financial support to implement the digital health intervention.

“I think financial resources will be needed to run this intervention because you will need a lot of promotion to support the intervention also to implement the development and to make sure it is operational. You will need enough fund to conduct capacity building scaling it up and also making it sustainable”. (Researcher, #3)

Another expert highlighted about infrastructure as a critical aspect for successful implementation of digital health interventions. The expert emphasized the need for a robust platform to manage information, potentially involving servers or clouding servers, forming the backbone of the main system.

“Also, the infrastructure, so in term of infrastructure I would say will be the platform to manage all the information may be servers may be clouding servers and the main system.” (Dr. Msofe)

Continuous improvement through ongoing feedback mechanism was emphasized as a critical process construct within the CFIR. Almost all experts underscored feedbacks as a pivotal aspect in the research process, emphasizing the need for frequently feedback during development and implementation of the digital health intervention.

Feedback is a significant aspect and many researchers, after completing their studies, vanish. They don't communicate effectively. You need to give feedback to professionals, stakeholders, and even to the community where you conducted the study. It's not good to just complete a study and disappear. It's essential to disseminate your findings to various levels, from international to regional, district level, and even the community involved in your study. This applies to the development of any intervention; you have to come back to the stakeholder to give

the feedbacks. Giving feedback is mandatory, and it's crucial. (Researcher, #4)

Discussion

In this study, the Consolidated Framework for Implementation Research (CFIR) served as a comprehensive and systematic lens to explore the perspectives of experts on the facilitators and the barriers to creation and implementation of digital health interventions for HIV self-testing (HIVST) and linkage to care in Tanzania. The CFIR framework facilitated a structured examination of various constructs influencing the intervention development process, considering inner and outer settings, individual characteristics, and process-related factors.

The diverse applications and potential impact of technology in healthcare were acknowledged, ranging from guiding users through self-testing processes to facilitating reporting and data management. This was also documented by other studies (34). Notably, there were variations in the depth of understanding among experts, with some expressing limited familiarity with digital systems. This variation aligns with (34) assertion that the success of digital health interventions often hinges on the stakeholders' level of awareness and comfort with technology. This diversity in awareness emphasizes the importance of tailored approaches in introducing digital health interventions.

All experts unanimously highlighted the perceived usefulness of digital health interventions, emphasizing their potential to enhance HIVST and linkage to care services. Similarly, to our study, existing literature emphasizes the significant potential of digital health interventions in enhancing HIVST and linkage to care services (16,35). The interventions were viewed as valuable tools that could guide users through the self-testing process, provide reporting and data management capabilities, and offer educational messages. (16) suggest that the integration of digital solutions can improve the overall effectiveness of HIVST programs. The consensus on the positive impact of digital health interventions underscores their potential significance in improving healthcare delivery.

The experts stressed the importance of simplicity in digital health interventions, advocating for basic phone compatibility to ensure broader accessibility. Our finding mirrors the recommendations from previous studies emphasizing user-friendly design in digital health interventions (36). The call for simplicity aligns with (36) argument that complex interventions may hinder adoption, especially in resource-limited settings.

Experts expressed their awareness of existing technologies that could serve as models or inspiration for digital health interventions which includes the digital technology used for skin diseases and the digital intervention for reporting HIV testing results. The awareness of existing technologies serving as models for digital health interventions aligns with studies emphasizing the importance of leveraging successful models in technology adoption (37). The experts' experiences with feedback collection systems and models from other health services are reminiscent of (37) recommendation to draw inspiration from successful interventions in related domains.

Our study's identification of facilitators, such as stakeholder buy-in and government readiness, aligns with findings from studies stressing the importance of political support and stakeholder engagement in implementing digital health interventions (32). The perceived barriers, including lack of prioritization and affordability concerns, correspond with challenges outlined in previous literature (38,39). Similar to our findings, studies underscore the importance of community and healthcare provider readiness for successful digital health intervention implementation (34,40). The positive perception of digital health solutions reducing paperwork aligns with (40) argument that organizational factors play a crucial role in shaping the success of digital health initiatives.

Marketing and awareness campaigns were considered vital for promoting adoption, and effective engagement of experts and stakeholders was emphasized. This finding is well documented in previous studies (41,42). The experts' suggestions regarding marketing campaigns and effective engagement align with (42) findings on the importance of communication strategies in promoting technology adoption.

The experts highlighted the importance of disseminating findings to various levels, from international to community levels, and the significance of feedback in the development and implementation of digital health interventions. The emphasis on ongoing feedback mechanisms echoes findings from studies highlighting the significance of continuous communication in successful intervention development (43,44). Our study's practical approaches, such as creating common channels of communication, align with (44) recommendation for fostering a collaborative culture.

Conclusion

Our study contributes to the growing body of literature on digital health interventions by providing insights into the perspectives of experts in the context of HIVST and linkage to care in Tanzania. The findings reinforce key themes present in existing literature and underscore the need for context-specific, user-friendly, and collaboratively developed interventions. Moving forward, interventions should consider the nuances of stakeholder perspectives, engage in ongoing communication, and leverage successful models to optimize the implementation and impact of digital health solutions in healthcare settings.

Availability of data and materials

The dataset during and/or analysed during the current study is available from the corresponding author on reasonable request.

Abbreviations

HIV	Human Immunodeficiency Virus
HCT	HIV Counseling and Testing
CSW	Commercial Sex Workers
WHO	World Health Organization
HIVST	HIV Self-Testing
CFIR	Consolidated Framework for Implementation Research
MD	Medical Doctor
CAL	Community Affairs Leader
TA	HIV Technical Advisor
DAS	Data Analytics Specialist
EGPAF	Elizabeth Glassier Pediatric AIDS Foundation
MOH	Ministry of Health
AMREF	African Medical and Research Foundation
FHI 360	Family Health International 360
MUHAS	Muhimbili University of Allied Sciences

Contributions

This study was designed by FM and conducted with the supervision of DFC, and MN. Data collection and writing of the draft was done by FM . SJ reviewed and edited several the draft until it was ready for submission. All read and approved the final manuscript.

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Ethical considerations and consent to participate

Clearance to conduct this study was obtained from the University of Johannesburg, South Africa Ethical Committee and given an ethical clearance number JBSREC202303B. Informed consent to participate was obtained from all participants before data collection.

Consent for publication

Not applicable.

Competing interest

The authors declare to have no competing of interest.

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