KIT INSTITUTE

THE POTENTIAL OF DIGITAL HEALTH TECHNOLOGIES IN STRENGTHENING HIV CONTINUUM OF CARE IN TANZANIA: LITERATURE REVIEW

FELIX RICHARD MANYOGOTE

MASTER OF PUBLIC HEALTH & HEALTH EQUITY 2024/2025

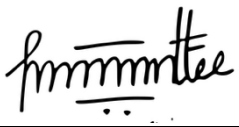
Word Count: 13,722

This dissertation has been submitted in partial fulfilment of the requirements for the award of Masters in Public Health and Health Equity (MPH-HE)

By **Felix Richard Manyogote**

Declaration:

I hereby declare that this work is the result of my own independent effort. Where the ideas, data, or quotations of other authors have been used whether from printed, digital, or any other sources they have been clearly acknowledged and appropriately cited in line with the referencing guidelines prescribed by the department. I affirm that this work has not been submitted, either wholly or in part, for the award of any other degree or qualification at this or any other institution.

Signature: 

Master of Science in Public Health and Health Equity (MPH-HE)
09 September 2024 – 30 August 2025
KIT Institute/Vrije Universiteit Amsterdam, The Netherlands

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral Therapy
CHW	Community Health Worker
DHIS2	District Health Information Software 2
DHT	Digital Health Technology
EHR	Electronic Health Record
eLMIS	Electronic Logistics Management Information System
EMR	Electronic Medical Record
FSW	Female Sex Worker
GIS	Geographic Information Systems
GoTHoMIS	Government of Tanzania Hospital Management Information System
HSC	Health Smart Card
HEID	HIV Early Infant Diagnosis
HIV	Human Immunodeficiency Virus
ICT	Information and Communication Technology
IVR	Interactive Voice Response
mHealth	Mobile Health
MoHS	Ministry of Health and Social Welfare
MSM	Men Who Have Sex with Men
NICTBB	National ICT Broadband Backbone
PLHIV	People Living with HIV
PMTCT	Prevention of Mother-To-Child Transmission
PoC	Point of Care
PrEP	Pre-Exposure Prophylaxis
RTMM	Real-Time Medication Monitoring
SMS	Short Message Service
U=U	Undetectable Equals Untransmittable

UHC	Universal Health Coverage
UNAIDS	Joint United Nations Programme on HIV/AIDS
WHO	World Health Organization

DEFINITION OF KEY TERMS

Digital health: refers to the application of digital tools and technologies (such as mobile apps, electronic health records, telemedicine, and data analytics) to enhance the delivery of healthcare services, improve patient outcomes, and increase system efficiency (1).

M-health (mobile health) refers to the use of mobile and wireless devices (like smartphones, tablets, and wearable tech) to deliver health services, monitor health data, and support health behavior change, especially in remote or underserved areas (2).

Human Immunodeficiency Virus (HIV) is a virus that weakens the body's immune system, particularly the white blood cells (CD4/T-cells) that play a key role in defending against infections(3).

HIV Continuum of Care is a public health model describing the sequence of steps of HIV medical care that people living with HIV go through from diagnosis to achieving and maintaining viral suppression, including diagnosis, linkage to care, retention in care, initiation of antiretroviral therapy (ART), adherence and viral suppression (4).

ACKNOWLEDGEMENTS

This thesis marks a significant milestone in my academic and professional journey, and it would not have been possible without the support, guidance, and encouragement of many individuals and institutions.

First and foremost, I extend my heartfelt appreciation to my academic advisor and thesis supervisor, whose insightful guidance, constructive critiques, and unwavering support greatly enriched the quality of this work. Your mentorship has been instrumental in shaping my research direction and strengthening my analytical skills.

I am equally grateful to the faculty and academic staff of the Master of Public Health and Health Equity program at KIT Institute. Your commitment to academic excellence and public health advancement has provided me with a strong foundation to engage critically with health equity issues, including digital health and HIV service delivery.

To my fellow MPH colleagues, thank you for the intellectual camaraderie, thoughtful discussions, and shared commitment to advancing equitable health outcomes. Your support has made this academic journey both enriching and enjoyable.

I am deeply thankful to my friends and extended support network, whose encouragement and moral support have helped me persevere through challenging moments.

Most importantly, I would like to thank my family particularly my parents and siblings for their love, patience, and constant belief in my potential. Your sacrifices and encouragement have been my anchor throughout this process.

This work is dedicated to the ongoing efforts of all individuals and institutions committed to ending the HIV epidemic and strengthening digital health systems in Tanzania and beyond.

INTRODUCTION

My name is Felix Richard Manyogote, a public health physician with a strong passion for digital health and health systems strengthening. My interest in digital health began in 2017 when I attended the World Summit on Artificial Intelligence and served as a judge for the Botnar Challenge. This challenge focused on recognizing and empowering youth-driven innovative and digital solutions aimed at improving the health and wellbeing of young people in Tanzania. This experience ignited my dedication to exploring how technology can transform healthcare delivery in resource-limited settings.

In 2022, I graduated with a Master's degree in Tropical Medicine and Infectious Diseases from the Liverpool School of Tropical Medicine in the United Kingdom. Following this, I began working as an Infectious Diseases Specialist within the HIV unit at the Tanzania Ministry of Health. Through my role, I have gained in-depth insight into the ongoing challenges in the HIV continuum of care in Tanzania, particularly around linking patients to care, retention, and viral suppression.

This thesis explores the potential of digital health technologies to strengthen the HIV continuum of care in Tanzania. Despite significant progress, many gaps and inefficiencies remain in the continuum, undermining efforts to control the epidemic. Digital health tools offer promising avenues to improve patient engagement, streamline service delivery, and enhance health outcomes. I chose this topic because of my commitment to leveraging innovative approaches to overcome healthcare challenges in Tanzania. I believe that understanding how digital health technologies can be effectively integrated into the HIV care system will provide valuable guidance for policymakers and practitioners aiming to improve HIV service delivery.

The general objective of this thesis is to assess the role and impact of digital health technologies in enhancing the HIV continuum of care in Tanzania, with the goal of identifying practical recommendations to inform future implementation and scale-up efforts. Through this research, I hope to contribute to strengthening Tanzania's HIV response and supporting progress toward global HIV targets.

ABSTRACTS

Introduction:

The HIV epidemic remains a critical public health challenge in Tanzania, with substantial gaps along the HIV Continuum of Care from diagnosis to viral suppression particularly in rural and underserved populations. Digital Health Technologies (DHTs) have emerged as innovative tools with the potential to strengthen healthcare delivery systems. This review explores how DHTs have been utilized to enhance the HIV Continuum of Care in Tanzania, synthesizing evidence to inform policy and programmatic strategies.

Methodology:

This study employed a comprehensive literature review design guided by the HIV Continuum of Care framework. A total of 623 articles published between 2010 and May 2025 were retrieved from databases such as PubMed, Scopus, Web of Science, and Google Scholar using keywords like “digital health,” “HIV,” and “Tanzania.” After applying inclusion and exclusion criteria, 38 studies were included for final analysis. Data were extracted using a standardized form, focusing on intervention type, target population, stage of care addressed, and reported outcomes.

Results:

Digital health interventions identified included mHealth solutions (SMS reminders, chatbots, mobile apps), electronic health records (EHRs), HIV self-testing kits, telemedicine platforms, biometric systems, and real-time adherence tools. These technologies primarily targeted early and middle stages of the HIV care cascade, including diagnosis, linkage to care, and ART adherence. Fewer interventions addressed ART initiation and viral suppression. Key facilitators of digital health uptake included strong government policy frameworks, mobile phone penetration, and locally tailored innovations. However, barriers such as infrastructure limitations, digital literacy gaps, fragmentation of digital systems, and data privacy concerns were also identified.

Conclusion:

Generally, digital health technologies show great promise for improving HIV continuum care in Tanzania. However, to maximize impact, more focus is needed on overcoming systemic barriers. A holistic, equity-driven approach is key to advancing national HIV goals and universal health coverage.

CHAPTER 1: BACKGROUND INFORMATION

1.1: GEOGRAPHY AND DEMOGRAPHY OF TANZANIA

Tanzania is a country located in East Africa region covering approximately 947,300 square kilometers with 31 administrative divisions, making it a largest country within East Africa (5). The Country is characterized by vast geographic diversity from coastal lowlands and inland plateaus to mountainous regions and remote rural communities (6). This geographic diversity presents significant logistical challenges for healthcare delivery, particularly in ensuring equitable access especially in rural and hard-to-reach areas(7, 8). Demographically, Tanzania has a population of about 65 million people with two-third of her citizens being youth residing outside urban centers (9).

Figure 1 Above shows a map of Tanzania(10) .

1.2: SOCIOECONOMIC AND POLITICAL LANDSCAPE OF TANZANIA

Tanzania is a lower-middle-income country, with mixed economy relying on agriculture, which employs more than 65% of the population contributing to 27% of the country GDP (11). Despite recent economic growth, Unemployment among youth remains high, and education levels vary widely by region, affecting health literacy and engagement with digital health tools (11). Access to quality health services remains uneven, often constrained by poverty, geographic isolation, and limitations in infrastructure, including electricity and internet connectivity, which are critical enablers for digital health implementation (7, 8, 12, 13).

Politically, Tanzania has demonstrated a growing commitment to digital transformation in the health sector by promoting digital health polices and strategies (14).

1.3. TANZANIA HEALTH SYSTEMS

Tanzania's health system is decentralized as a strategy to improve health equity and ensuring efficient use of resources, increased accountability and reduced bureaucracy (15, 16). The health system consists of both public (70%) and private sectors (30%) and operates across multiple tiers (figure 1), beginning at the community level and ascending through primary, secondary, and tertiary care levels (15, 17, 18). At the community level, healthcare is often provided by Community Health Workers (CHWs), who play a vital role in preventive services, health education, and outreach, particularly in rural and underserved regions (17, 19). Having a total of 11,805 health facilities, Dispensaries are the most prevalent (7,804 in number) followed by health centers (1,126 in number) (20). They both serve as the first point of contact for many citizens especially in rural and remote areas, while district hospitals offer more comprehensive services(20). Specialized and advanced care is delivered at regional referral and national hospitals, which represent the top tier of the system. The Ministry of Health holds responsibility for national health policy development, strategic planning, and regulatory functions(20). Concurrently, Local Government Authorities (LGAs) oversee the implementation and administration of health services at the local level. This decentralized governance model is intended to enhance accountability and better align services with community-specific health needs (18). The financing of health services in Tanzania is multifaceted, relying on a blend of public, private, and donor resources(20).

Despite being decentralized, Tanzania's health system faces several challenges including shortage of skilled health workers**,** maldistribution favoring urban areas and Infrastructural weaknesses, especially in lower-level facilities (rural areas) where there is inadequate electricity

supply (8, 13, 15, 16). Infectious diseases, such as malaria, tuberculosis, and HIV/AIDS, continue to strain the system, while infrastructure gaps, including long distances to healthcare facilities, remain a barrier for many (21, 22). Despite these challenges, Tanzania's health sector holds substantial opportunities for advancement. Digital health technologies, provide a modern solution to improve access and operational efficiency thus strengthening the system (14).

Figure 2 above: Tanzania health system structure (23)

1.4 Global Digital Health Overview:

The World Health Organization (WHO) defines digital health as the use of digital technologies for health to enhance health outcomes and access to care, emphasizing its role in strengthening health systems and achieving Universal Health Coverage (UHC) (2). Digital health encompasses a broad array of tools, including electronic health records (EHRs), mobile health (mHealth) applications, telemedicine, artificial intelligence (AI), big data analytics, and wearable devices. (1, 24). The WHO's Global Strategy on Digital Health (2020–2025) underscores the importance of equitable access to digital health tools and the need for robust governance to ensure their effective implementation(25) . Ensuring inclusivity in design and implementation is critical so that all users, regardless of background, have the necessary skills and access to benefit from these technologies (26, 27). Complementing this, the WHO's 2023 Digital Health Intervention Typology

offers a structured framework to classify digital health solutions based on three dimensions: health system challenges (e.g., equity, resilience), digital health interventions (e.g., client communication, decision support), and digital service applications (e.g., mobile apps, EHRs). This typology provides a common language to better design, implement, and evaluate digital interventions across contexts, especially in resource-limited settings (28).

The adoption of digital health strategies varies significantly across countries, influenced by factors such as infrastructure, digital literacy, policy environment, and socioeconomic conditions (29, 30, 31, 32). High-income nations have leveraged advanced technologies to create integrated health systems, while low- and middle-income countries have focused on scalable solutions to bridge healthcare gaps (33, 34). In low- and middle-income countries, challenges such as limited literacy, digital literacy, internet access, and device availability are compounded by poverty, gender inequality, and weak infrastructure, particularly for marginalized populations (35, 36). Despite these barriers, the use of digital technology in Africa is growing rapidly, with roughly 570 million Internet users as of early 2025 (with users expected to exceed 780 million by 2029) (37). Recent estimates indicate that approximately 50% of mobile connections in the Sub-Saharan Africa are attributed to smartphones (38). This shift shows a promising opportunity to leverage digital health for improved health service delivery. Despite the promise of digital health, it is also important to consider concerns about data privacy, interoperability, scalability, and equitable access especially in rural and underserved populations (39, 40, 41, 42, 43).

To ensure sustainable and impactful implementation, digital solutions must be aligned with local needs, cultural contexts, and healthcare priorities (39, 43). Addressing these concerns requires collaborative efforts among governments, healthcare providers, and technology developers to create sustainable and inclusive digital health ecosystems (24, 43).

Figure 4 above: Illustration of Digital health technologies (44).

1.5 Tanzania Digital Health Landscape:

Tanzania's digital landscape is rapidly advancing, fueled by growing use of mobile phones and increased internet penetration (45, 46). As of 2024, the country recorded approximately 86.8 million internet subscribers, reflecting a 275% increase during five years period (47). Recent reports show that, as of 2024 the country has an internet penetration rate of 31.9% with approximately 47.9 million mobile internet subscriptions of whom 22.3 million users rely on 2 G technologies (48). Strategically positioned as a key node in the East African fiber-optic network, Tanzania has attracted significant public and private investments in information and communication technology (ICT) infrastructure (47). This investment has contributed to the growing affordability and accessibility of digital devices such as smartphones and tablets by the majority, reinforced by 4G (88% coverage**)** and evolving 5G (20% coverage) technologies (47). In response to such progress, the government of Tanzania has made considerable progress in integrating digital health technologies into its healthcare system, driven by the government's commitment to achieving universal health coverage (UHC) and the Sustainable Development Goals (SDGs)(14).

The National Digital Health Strategy (2019–2024) outlined the country's vision for harnessing digital innovations to support health information systems, service delivery, health workforce

development and strengthening data-driven decision-making, and build resilient digital systems (49). Its implementation is guided by policies and protocols concerning data governance, interoperability, and ethical standards, aimed at ensuring responsible and inclusive deployment of digital health technologies (49). This strategy is consistent with national and global commitments, such as the Health Sector Strategic Plan (HSSP V) and the Sustainable Development Goals (SDGs. It was complemented by the Digital Health Investment Roadmap (2018–2023) to provide detailed plan for efficient resources allocation and prioritization of digital health projects (50).

The government of Tanzania in collaboration with her development partners has managed to develop the National ICT Broadband Backbone (NICTBB**)** project that has facilitated expansion of broadband connectivity advancing industries including the health care sector (51). This extensive fiber-optic network connects healthcare facilities across the country, enhancing efficient data sharing and communication (51).The development of this infrastructure has further enabled the deployment of various digital health platforms, including the District Health Information Software (DHIS2), electronic logistics management information systems (eLMIS), electronic Health facility registries, Government of Tanzania Hospital Management Information System (GoTHoMIS) and mobile health initiatives targeted for patient education, appointment scheduling, and remote consultations, particularly in rural areas (49). Despite these advancements, the digital health landscape in Tanzania has been shaped by both opportunities and challenges (35). On the positive side, the country has benefited from strong political will, partnerships with international organizations, and lessons learned from previous digital Health strategies (49). However, challenges such as limited internet connectivity in rural areas, unreliable electricity infrastructure, inadequate human resources, and resistance to transitioning from paper-based systems (insufficient digital literacy among healthcare workers) persist (45, 49).

Taking a consideration of these barriers, the Government of Tanzania in collaboration with development stakeholders has recently launched the Digital Economy Strategic Framework (2024–2034) that places digital technologies at the core of national development (52).

This Framework emphasizes on strengthen digital infrastructure, enhancing digital literacy through capacity building and fostering digital inclusion especially among underserved and rural populations through implementation of context specific digital innovations (52).

1.6 HIV OVERVIEW

Human Immunodeficiency Virus (HIV) is a virus that weakens the body's immune system, particularly the white blood cells that play a key role in defending against infections. Without treatment, HIV can progress to Acquired Immunodeficiency Syndrome (AIDS) (3). A person can acquire HIV through unprotected sexual intercourse (vaginal sex, anal sex, or oral sex), blood transfusion, Sharing Needles or Syringes with an infected person, and from HIV mother to her child. Unlike other viruses, the body cannot eliminate HIV, so it remains lifelong, but with Antiretroviral therapy (ART), it can be controlled by enhancing viral suppression and preventing disease progression (53).

HIV remains to be a global public health of concern with more than 39.9 million people living with the virus as of 2023 of whom 77% were on ART. (53). Globally, Sub-Saharan Africa bears highest burden with approximately 25.6 million people living with HIV accounting for 65% of all HIV infections highlighting the need for effective prevention, testing, and treatment strategies. (53).

To lower mortality rates and improve the quality of life for those living with HIV, the World Health Organization (WHO) recommends optimal engagement on the HIV care Cascade (54). The recommended HIV care cascade includes a sequence of stages ranging from diagnosis, linkage to care, early initiation of ART irrespective of CD4 count and clinical stage, retention in care, and achievement of viral suppression. Weaknesses at any stage of this cascade can weaken the overall effectiveness of HIV care service for those living with HIV (54).

As global efforts increase toward achieving HIV control, UNAIDS sets 95-95-95 targets aiming to speed up efforts to eliminate AIDS as a public health threat by the year 2030 (55). The goals include ensuring that 95% of all individuals living with HIV are aware of their status, 95% of those diagnosed receive continuous ART, and 95% of those on ART achieve viral suppression by 2025 (55). In Tanzania Similar to other Sub-Saharan African countries, HIV remains to be a major public health of concern causing death and impacting significantly individuals, families, and communities on a profound scale (56). It is estimated that as of 2023, Tanzania had about 1.7 million people living with HIV(PLHIV) and more than 34,000 deaths that were associated to HIV/AIDS (56). The country has got an HIV prevalence of rate of 4.7 percent with variations across regions, whereas Mbeya had 14 percent, Iringa at 13 percent and Dar es Salaam at 11 percent (56).Over the past decade, Tanzania has made significant progress toward achieving the UNAIDS 95-95-95 targets for 2025 whereas statistics shows that 83% of PLHIV know their status, 98% of those aware of their HIV status are on ART and 94% of those on ART have achieved viral suppression (57). Despite the progress, health system gaps remain especially in early diagnosis, linkage to care, and retention to care, which are often aggravated by systemic barriers such as health workforce shortages, long Travell distance to access health facilities, inadequate data management

systems, and poor patient follow-up (58, 59). Additionally, Socio-economic and Cultural Factors influencing engagement of HIV services along the HIV continuum of care includes poverty, Stigma and lack of social and family supports (60, 61, 62).

Addressing the challenges to optimal engagement to HIV Continuum care requires multifaceted and integrated approaches that strengthen the HIV care cascade, improve quality and access to HIV service and address socio-economic and cultural determinants of health (63).Digital Health technologies have emerged as innovative promising tools to strengthen each of the HIV care cascade by improving patient engagement and communication, coordinate clinical processes, and enabling real-time data collection, improve patient-provider communication, support data-driven decision-making and foster better adherence and retention to care (64, 65). If utilized effectively, these technologies have the potential to bridge HIV service delivery gaps contributing to achieving universal health coverage (UHC) in Tanzania (64).

CHAPTER 2: PROBLEM STATEMENT, JUSTIFICATION AND OBJECTIVES

HIV remains a major challenge for Tanzania's healthcare system, with an estimated adult prevalence rate of 4.7% as of 2023 (56).Despite progress made by the country to increase access to ART and reduce new Infections, significant gaps remain in in fully optimizing the HIV care continuum (57). The HIV care continuum, which highlights the chronological stages from HIV diagnosis to successful viral suppression, remains sub-optimal in many settings disproportionately affecting vulnerable groups including adolescents and women contributing significantly to poor health outcomes and unsuppressed viral load (55). High-levels engagements on the HIV Continuum Care of more than 95% are crucial for optimizing viral suppression and reduce new infections as undetectable viremia implies the disease is untransmittable (U=U) (66). Undetectable viremia contributes to improved health outcomes, reduced risk of HIV related complications, morbidity and mortality for people living with HIV (66). Available Literature reveals that People living with HIV in Tanzania, face numerous difficulties in engaging at multiple stages of the of HIV Continuum care leading to delayed diagnosis, insufficient viral suppression and ongoing transmission risks limiting the achievement of UNAIDS 95-95-95 targets aimed at ending the HIV epidemic (61). Evidence shows that such gaps are aggravated by Health system challenges such as health workforce shortages, long Travell distance to access health facilities, inadequate data management systems, and poor patient follow-up (61, 67, 68).

Further studies have highlighted, Socio-economic factors such as poverty, lack of social and family (psychological) supports and inability to afford transport costs limit access to healthcare facilities and further exacerbate disparities in healthcare access and adherence to ART (66, 69, 70). Another piece of Literature has highlighted Cultural Factors such as Stigma, fear and discrimination as factors influencing gaps on fully optimizing the HIV care continuum for people living with HIV (60, 71, 72, 73). Individual factors such as HIV Literacy also remains as a critical issue as misinformation and misconception can discourage individuals from accessing HIV care contributing to delayed diagnosis and frequent interruptions on HIV care contributing to poor health outcomes (61, 74, 75). All mentioned factors influencing gaps on fully optimization of the HIV care continuum are exacerbated by lack of secured platforms for accessing HIV services (61).

Recent evidence from several studies in Sub-Saharan Africa shows that emerging Digital technologies offer potential solutions in strengthening patients and healthcare providers engagement throughout the HIV continuum of care leading to improved health outcomes (76, 77, 78). Furthermore, digital health technologies were found to address barriers such as stigma, privacy concerns, long waiting time, and costs associated with traveling to health facilities for HIV Services (78, 79).

For instance, in Kenya mHealth interventions like text messaging, or short-message-service (SMS) have improved access to HIV care by strengthening patient and healthcare provider communications motivating patients to adhere to their ART appointments at health facilities and facilitates timely follow-ups for PLHIV (80). Similar findings were reported in South Africa, where SMS notifications led to a 16% increase in retention to care among key populations enrolled in CTC clinics. While these studies highlighted the potential of SMS reminders, they highly relied on generic messages without customization to individual patient needs based on the context, raising concerns about their long-term engagement potential and scalability in rural or low-literacy populations (81). Additionally, in Uganda Mobile phone Applications such as MakCHS Health app and Medly Uganda were found to increase engagement in HIV care by facilitating patient-provider communication, streamlining data reporting and timely follow up contributing to adherence to antiretroviral therapy (ART) (82). However, the uptake of such apps remains uneven, largely limited by digital literacy, smartphone ownership, and intermittent internet connectivity factors particularly prevalent in rural areas (83).

Furthermore, digital diagnostic innovations like Point-of-care (POC) digital HIV self-testing kits have been potential in Kenya and Uganda enhancing early diagnosis and linkage to care (84, 85). A study by Wachinger in 2021 found that digital self-testing linked to SMS-based counseling improved both uptake and timely linkage to confirmatory testing and ART initiation (86). Another study by Muendo conducted in 2024 has revealed that digital HIV self-testing kits enhance

accessibility and reduce stigma during the diagnostic process, making it easier for people to learn their status in privacy (87). However, these studies largely targeted urban populations in these two countries, limiting insights into their application in rural contexts where stigma, access, and cultural beliefs differ significantly.

Beyond patient engagement interventions, Available Literatures highlighted that electronic health records (EHRs**)** and digital monitoring systems have played a potential role in improving HIV service delivery in Sub Saharan Africa (88, 89). For instance, in Uganda, the implementation of EHRs led to reductions in missed appointments and better tracking of patient progress along the HIV Continuum care (90). Likewise, a study in Mozambique found that digitizing ART registers helped health workers detect patients at risk of dropping out of care and intervene early (91). Despite these successes, challenges such as system interoperability, inadequate training, and data security concerns continue to hinder full integration and scale-up of EHR systems in many Sub-Saharan Countries (92).

Previous studies have also documented that Telemedicine in Sub-Saharan African has been potential to address the shortage of HIV specialists and reduce the burden on tertiary facilities (93, 94). For example, a teleconsultation program in South Africa enhanced access to HIV specialist care in rural clinics, reducing the necessity for patients to travel long distances to healthcare facilities (95). Nevertheless, limited infrastructure, poor connectivity, and inconsistent policy frameworks present obstacles to mainstreaming telemedicine into HIV care systems (94, 95).

Furthermore, studies have identified that Digital adherence platforms, such as real-time electronic dose monitoring (EDM) tools and smart pillboxes, have been used in high burden settings like South Africa, Kenya and Uganda (96, 97, 98, 99). A study conducted in South Africa using the Wise pill real-time electronic adherence device showed an 10% improvement in medication adherence among youth. However, concerns remain about the feasibility of scaling due to the device's high cost and technical complexity(98, 99) .

JUSTIFICATION

While Digital health technologies have been deployed in various regions of Tanzania to enhance HIV service delivery, persistent gaps in the HIV care continuum threaten progress particularly in rural and resource-limited areas (100, 101). Despite available scattered primary researches, pilot projects and donor-funded interventions, there is limited synthesis of existing consolidated context-specific evidence to understand their collective impact on the HIV care cascade. There is thus an urgent need to explore and understand how digital health technologies are functioning to strengthen the HIV Continuum Care in the specific context of Tanzania's health system. Exploring and understanding the impact of these technologies in strengthening the HIV care cascade is critical for proposing evidence-based strategies, informing future investments and policy decisions in Tanzania. This review critically synthesizing evidences from existing literatures on the roles and impacts of digital health innovations on strengthening the entire HIV Continuum of Care in Tanzania. This review further identifies enablers and barriers influencing acceptability and uptake of Digital health technologies among diverse populations as well as factors influencing their effective integration in the Tanzania HIV response and provide evidence-based recommendations to enhance national scale up. Furthermore, this review will serve as a potential resource for policymakers, implementers, and researchers seeking to optimize HIV service delivery and improve health outcomes in Tanzania.

RESEARCH QUESTION:

What is the Potential of digital health technologies on strengthening the HIV Continuum Care in Tanzania?

OBJECTIVES:

Main Objective

- To conduct a comprehensive literature review exploring the potential of digital health technologies on strengthening the HIV Continuum of care in Tanzania and propose evidence-based policy recommendations to the Government of Tanzania for effective and strategic implementation.

Specific Objectives

(i) To Identify and examine digital health interventions used to enhance HIV care in Sub-Saharan Africa, with an emphasis on their relevance and potential applicability within the Tanzanian context.

(ii) To Discuss effectiveness of digital health interventions on key components of the HIV care Continuum in Tanzania, including testing, linkage to care, ART initiation, retention, adherence, and viral suppression.

(iii) To identify enablers and barriers influencing acceptability and uptake of Digital health technologies among diverse stakeholders as well as factors influencing their effective integration in the Tanzania HIV response.

(iv) To propose evidence-based recommendations to the government of Tanzania and her stakeholders for enhancing and scaling up digital health technological interventions into Tanzania's HIV health care system.

CHAPTER 3: METHODOLOGY AND ANALYTICAL FRAMEWORK

3.1: METHODOLOGY

3.1.1: Study Design

This study adopts a literature review design to explore and critically analyze existing evidence on the Potential of digital health technologies on strengthening the HIV continuum of care in Tanzania.

A Literature review is an appropriate methodology for synthesizing existing knowledge from a wide range of studies and identifying patterns, outcomes, and gaps in the literature. Given the increasing integration of digital health interventions in public health, this design allows for a robust evaluation of their specific applications across different stages of HIV care.

3.1.2: Search Strategy

To identify relevant literature, I employed a comprehensive search strategy using multiple electronic databases, including PubMed, Scopus, Web of Science, and Google Scholar. The search covered studies published between January 2010 and May 2025, a period marked by significant advances in digital health globally and in Tanzania. I created search terms using keywords such as "digital health," "eHealth," "mHealth," "HIV," " HIV continuum of care**,"** and "Tanzania." Boolean operators such as AND/ OR were applied to refine the search and ensure the retrieval of studies that specifically address digital health technologies within Tanzania's HIV care system. I also conducted a snowballing search by following the references of the identified

studies to gather additional sources that might not have been captured in the initial search thus contributing to more comprehensive findings. Furthermore, I explored related information from government and NGO reports and publications in Tanzania. This robust search strategy aims to gather diverse perspectives, evidence, and case studies relevant to the research objectives.

3.1.3: Inclusion and Exclusion Criteria

To ensure the relevance and quality of the included studies, I employed specific inclusion and exclusion criteria. Studies were included if they were published from 2010 to 2025 and examined the use of digital health technologies records in the context of HIV care in Tanzania. Only studies focusing on Tanzania or similar low-resource settings were included, as they offer a comparable healthcare context.

Eligible studies also needed to address at least one stage of the HIV Continuum of Care, such as testing, linkage to care, ART initiation, retention, or viral suppression. Peer-reviewed articles, policy reports, and reputable grey literature were included, provided they were published in English. Conversely, studies were excluded if they focused non-digital technologies, exclusively focus on non-HIV-related interventions, and conducted outside Tanzania without a clearly transferable context, or were not available in English. Research with insufficient data on digital health's role in HIV care were also excluded to ensure a high-quality dataset for analysis. These criteria help ensure that the review remains focused, contextually appropriate, and methodologically sound.

3.1.4: Data Extraction

A structured data extraction process was implemented to ensure consistency and completeness across all selected studies. A standardized data extraction form was used to capture key details, including the author names, year of publication, study location, target population, type of digital health intervention examined, HIV care stage addressed, reported outcomes, and identified challenges or enablers. This rigorous data extraction process allowed for comparison and synthesis of findings across different studies and contexts, enabling a nuanced understanding of how digital technologies are influencing each component of the HIV care continuum in Tanzania.

3.1.4: Limitations of Study Design/Methodology

While this Literature review provides valuable insights into the potential of digital health technologies in strengthening HIV care in Tanzania, several limitations exist. One major limitation is language bias, as only English-language publications were included, potentially excluding relevant studies published in Swahili or other languages. Additionally, although grey literature was

included to reduce publication bias, studies with negative or inconclusive findings may still be underrepresented, potentially skewing the overall analysis of digital health technologies on strengthening the HIV care cascade in Tanzania. Furthermore, methodological differences across studies may limit comparability, as variations in study design, sample size, and data collection methods could influence results. Another Limitation is contextual applicability, as findings from studies conducted in different settings may not entirely reflect Tanzania's unique healthcare environment, particularly in rural areas. Despite these limitations, the study mitigated potential biases by including diverse sources and critically evaluating the quality and relevance of each study selected for review.

3.2: ANALYTICAL FRAMEWORK

HIV Continuum of Care Framework

The HIV continuum care is a framework that tracks the pathway of individuals with HIV, from diagnosis to achieving and maintaining viral suppression. This framework outlines sequential steps a person living with HIV goes through from diagnosis to sustained viral suppression. These steps include HIV testing and diagnosis, linkage to care, initiation of antiretroviral therapy (ART), retention in care, and achieving viral suppression (4). Each component of the HIV Continuum of Care is connected and follows a specific order, where advancement in one step is necessary for success in the in the next step. For instance, without effective and widespread HIV testing, individuals cannot be diagnosed and connected to care. Prompt and effective linkage to care is crucial to start antiretroviral therapy (ART), and maintaining ongoing care helps ensure adherence, which ultimately results in viral suppression (102).

The HIV Continuum of Care framework was chosen as the analytical lens for this study due to its widespread applicability in evaluating the performance of HIV service delivery systems. The HIV Continuum of Care framework directly aligns with the main research objectives of this study, which seek to explore the potential of digital health technologies on strengthening the HIV Continuum care in Tanzania. The framework enables a structured exploration of how different technologies are applied across each stage and where gaps (barriers) exist such as underrepresented stages or underserved populations and highlight where digital health has the most and least influence (4). By using the continuum as a guiding structure, the study systematically assesses how digital innovations contribute to improved patient outcomes and overall system performance, offering evidence-based insights for public health stakeholders and policymakers.

Figure 4 above illustrates the HIV Care Continuum (102).

4.0: CHAPTER 4: RESULTS

4.1: OVERVIEW

This section presents findings from a comprehensive literature review of 38 articles published between 2010 and 2025 exploring the potential of digital health technologies in strengthen the HIV Continuum of Care in Tanzania.

The results are organized according to the study's specific objectives, beginning with identification of digital health interventions in similar context to Tanzania, followed by their effectiveness in Tanzania's HIV care continuum, factors affecting their uptake and integration, and concluding with policy-relevant recommendations to the government of Tanzania.

Study Selection and Characteristics

The initial search yielded a total of 623 records. After removal of 103 duplicate entries, 520 unique records remained. Of these, 88 articles were excluded for lack of open access or full-text availability, resulting in 432 records eligible for title and abstract screening. During the preliminary screening of titles and abstracts, 297 articles were excluded for failing to meet the basic inclusion criteria mainly due to focus on non-HIV conditions, lack of digital intervention, or relevance to high-income settings. The remaining 135 articles were subjected to full-text assessment. Following a detailed review, 97 articles were excluded thus, a total of 32 articles were retained for inclusion in the final review (Figure 4).

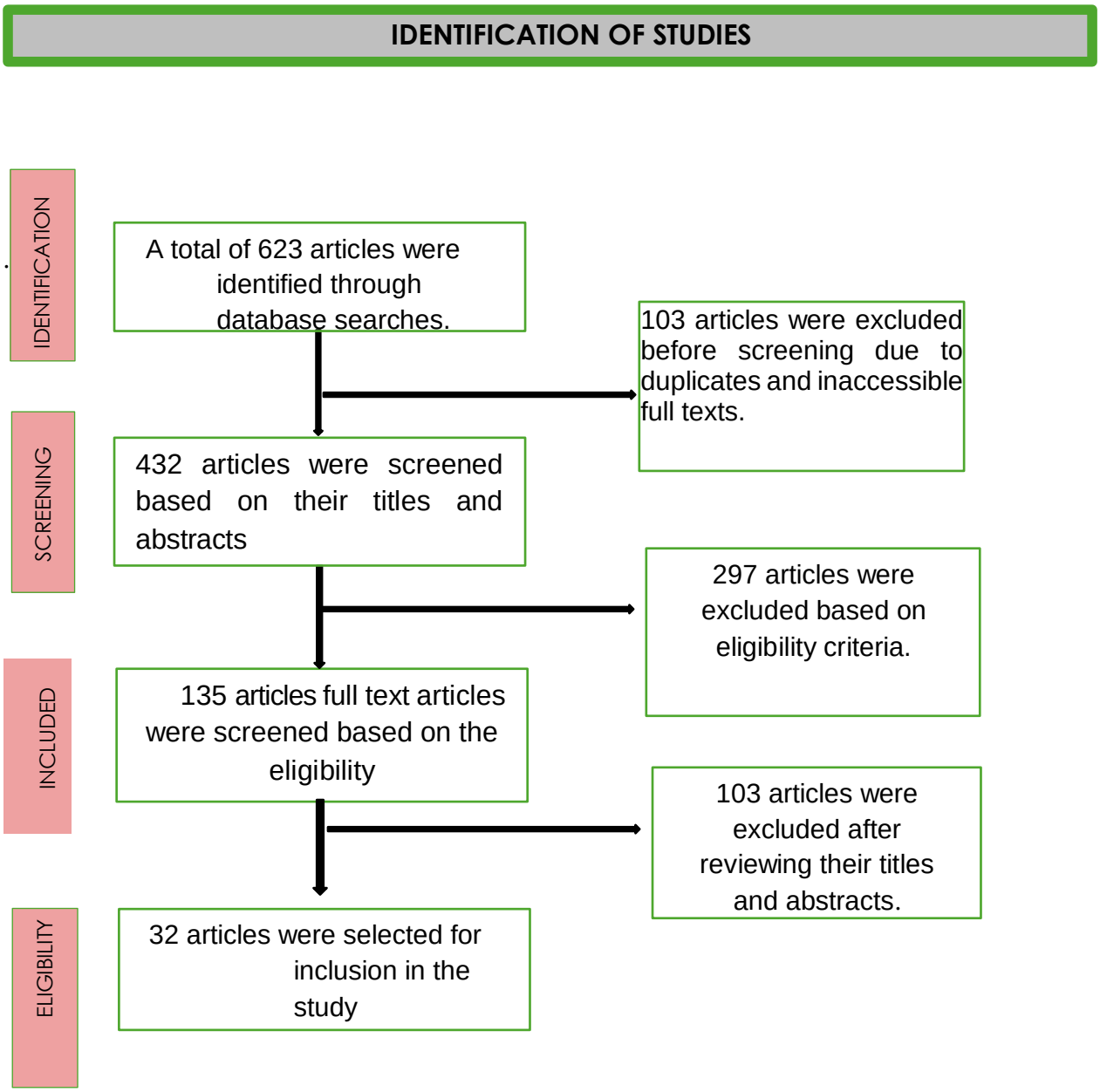


Figure 5: study selection and characteristics

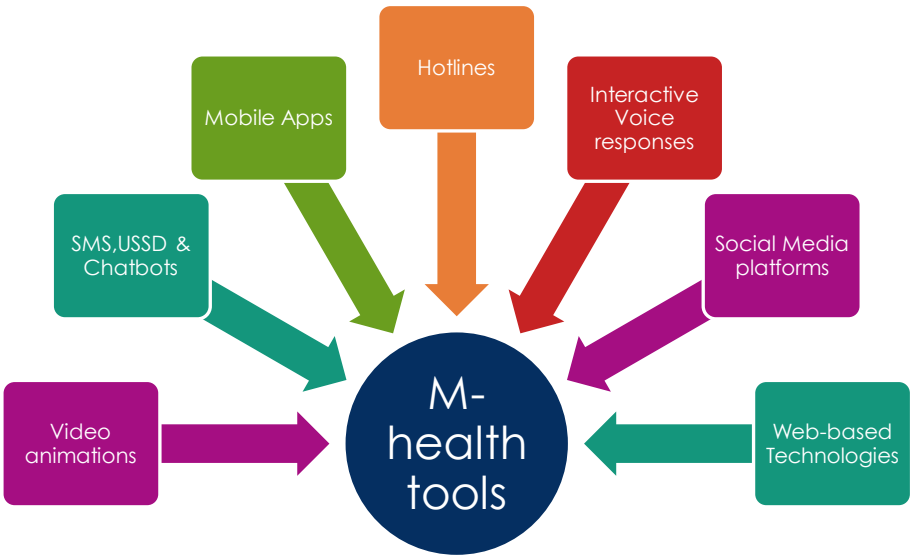
DIGITAL HEALTH INTERVENTIONS IN SIMILAR CONTEXT TO TANZANIA

This section presents findings related to the first objective of the study which is to identify and analyze digital health interventions used to enhance HIV care in Sub-Saharan Africa, with an emphasis on their relevance and potential applicability within the Tanzanian context. This review identified a broad range of digital health interventions implemented in Sub-Saharan Africa to support various stages of the HIV Continuum of Care. These include:

(i) Mobile health (mHealth) technologies:

mHealth technologies are among the most widely adopted digital health interventions for enhancing the HIV continuum of care in Sub-Saharan Africa. Leveraging widespread mobile phone access, interventions such as SMS reminders, chatbots, hotlines, and interactive voice response (IVR**)** systems have improved ART adherence, appointment attendance, and patient education. Mobile apps and web-based platforms also support service delivery and engagement, while video animations (e.g., promoting *Undetectable = Untransmittable [U=U]*) are used in youth-friendly services to reduce stigma and encourage treatment adherence. Additionally, social media platforms like Facebook, WhatsApp, and TikTok play a growing role in HIV education, stigma reduction, and linking users to prevention and care services .

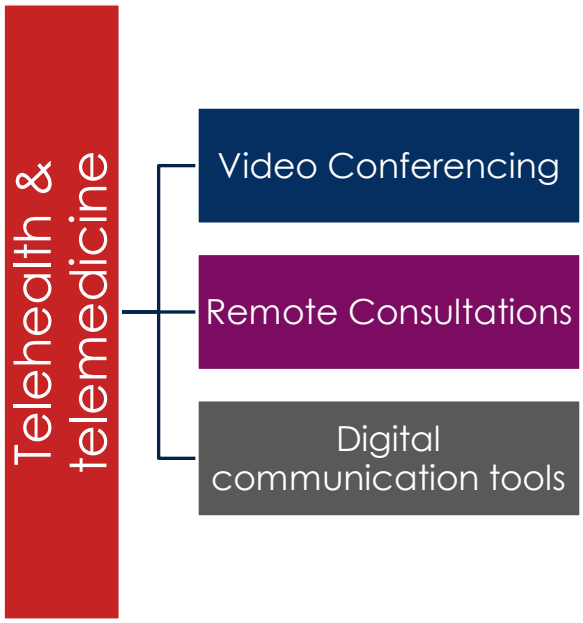
According to available evidences, mHealth is recognized as a cost-effective and scalable solution for strengthening patient engagement and system-level efficiencies by facilitating real-time communication and improved service delivery, especially in rural and underserved areas where health infrastructure is limited. With growing government support for digital health platforms, these m-health technologies are vital in bridging service gaps and enhancing the quality and continuity of HIV care in Tanzania.



(ii) Telehealth and Telemedicine:

Telemedicine refers to remote clinical care, while telehealth includes both clinical and non-clinical services delivered through tools like video conferencing and digital communication. In Sub-Saharan Africa, these technologies have improved the HIV continuum of care by overcoming geographic and infrastructure barriers.

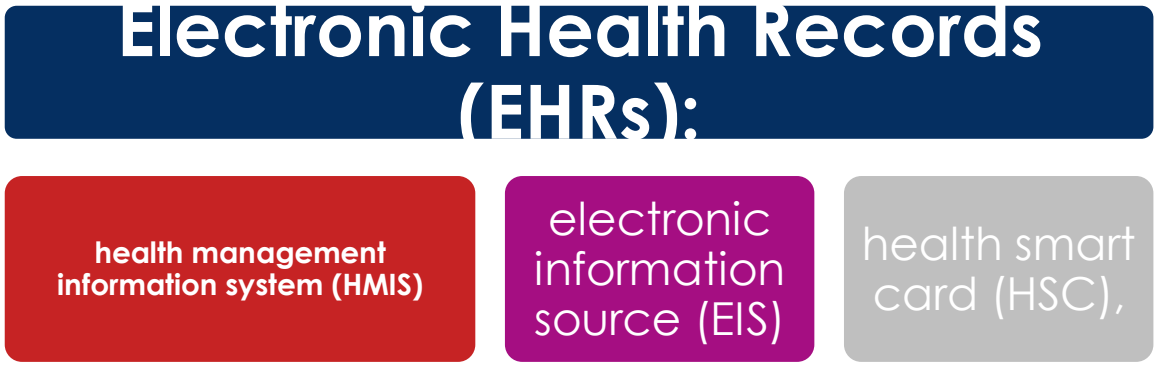
This review has found that, in many Sub-Saharan African countries these platforms have facilitated remote clinical consultations, medication adherence support, psychosocial counseling, and follow-up care particularly in rural and underserved areas. Several studies reported that video conferencing enables timely consultations between primary care providers and HIV specialists, improving clinical decision-making and reducing unnecessary referrals. Additionally, telehealth supports the management of stable patients and the delivery of follow-up care, thereby easing the burden on overtaxed urban healthcare facilities. The relevance of telehealth in the Tanzanian context is underscored by its potential to bridge gaps in healthcare access, especially in remote settings with limited healthcare personnel and HIV specialists.



(iii) Electronic Health Records (EHRs):

EHRs involve Digital systems that store and manage patient health information, allowing healthcare providers to track HIV diagnosis, treatment regimens, viral load results, and follow-up care efficiently across different facilities. This review has found that EHRs are a central component of digital HIV care in Sub Saharan Africa, significantly improving data quality, clinical efficiency, and program monitoring. Several studies conducted in Sub Saharan Africa highlighted health information technology, health management information system (HMIS), tablet-based electronic data capture (EDC), electronic information source (EIS), health smart card (HSC), and Android-based data collection system as most prevalent EHR of interest in the continent.

Recent evidence shows that, the transition from paper-based records to digital formats has reduced transcription errors, improved data retrieval, and enhanced provider decision-making. EHRs allow for longitudinal tracking of HIV-positive clients, enabling continuity of care even when patients transfer between facilities. The relevance of EHRs in the Tanzanian context is underscored by its potential to bridge gaps in data quality, clinical efficiency, and program monitoring.



EFFECTIVENESS OF DIGITAL HEALTH INTERVENTIONS ON THE HIV CONTINUUM OF CARE IN TANZANIA

This section presents findings related to the second objective of the study which is to discuss effectiveness of digital health interventions on key components of the HIV care Continuum in Tanzania, including testing, linkage to care, ART initiation, retention, adherence, and viral suppression.

Digital health technologies identified in this review were categorized according to the specific stages of the HIV Continuum of Care they targeted. Interventions were assigned to multiple categories if they addressed more than one stage. Out of the 32 articles included in the review, a total of 25 digital health interventions were identified as addressing various components of the HIV Continuum of Care in Tanzania. The majority of these interventions focused on HIV diagnosis, linkage to care and adherence to treatment, while relatively few targeted ART initiation and viral suppressions. While this reflects strategic prioritization, it also underscores the need for a more comprehensive and balanced approach that addresses all stages particularly the later stages like viral suppression to improve quality and equity across the HIV care continuum.

Table 2: Distribution of digital health technologies based on the specific HIV Continuum Care

HIV Continuum care (Stage)	Number of digital health interventions
HIV Diagnosis/Testing	8
Linkage to Care	4
ART Initiation	3
ART adherence & Retention to care	7
Viral Suppression	3
TOTAL	25

Table 1: **Distribution of digital health technologies**

In this review the majority of digital interventions (n=12) were designed to support clients engaging with HIV care. A total of 9 interventions aimed at supporting healthcare workers, and 2 interventions focused on health managers and 2 on data users

HIV Continuum care (Stage).	Clients	Health care providers	Health Managers	Data Users
HIV Diagnosis/Testing	5	3	0	0
Linkage to Care	3	1	0	0
ART Initiation	0	2	1	0
ART adherence & Retention to care	4	2	0	1
Viral Suppression	0	1	1	1
TOTAL	12	9	2	2

Table 2: HIV Continuum care addressed

I: DIGITAL TECHNOLOGIES ENHANCING HIV TESTING/DIAGNOSIS

The diagnosis of HIV represents the foundational entry point in the HIV Continuum of Care. In Tanzania, one of the most widely adopted digital interventions or HIV Diagnosis in Tanzania is mobile health (mHealth). Through SMS reminders, Chatbots USSD services, mHealth platforms have been widely used to disseminate HIV awareness messages, promote testing campaigns, and guide individuals to the nearest testing sites (103, 104). SMS based interventions have shown considerable promise in increasing HIV testing uptake, particularly among youth. Research indicates that text message reminders, significantly enhance testing rates and adherence to follow-up care. A study conducted in Kilimanjaro region found that approximately 42% of youth aged 15 to 24 expressed willingness to undergo HIV testing when prompted by a confidential SMS, highlighting the strong feasibility and acceptability of such digital approaches (105).

Chatbots and USSD-based reporting tools are increasingly integrated into HIV digital strategies, providing on-demand information and decision support particularly appealing to youth and tech-savvy users seeking discreet and stigma-free engagement. These conversational tools help expand the reach of care, improve user engagement, and reduce the burden on human counselors. For instance, the “My Wangu” chatbot guides adolescents and young people toward HIV diagnosis by offering self-assessment, kit usage and linking users to nearby testing services

while reducing stigma and access barriers with 79% of users preferred chatbot support over human counseling (106).

Furthermore, this review has identified that the use of HIV self-testing (HIVST) through digital health platforms have been potential innovations in enhancing HIV Diagnosis in Tanzania while promoting accessibility. One of the most innovative approaches to increasing HIV testing access in Tanzania has been the deployment of digital vending machines in Mwanza and Geita regions, implemented by ICAP in partnership with CDC and PEPFAR (107). These machines operate 24 hours a day dispensing oral HIV self-testing kits, making HIV testing accessible outside of traditional clinic hours. Their operational display brief instructional videos on how to use the kits. Users access the machines with an anonymous ID, which also enables counselors to provide follow-up support through phone or WhatsApp, ensuring that individuals who test positive are linked to confirmatory testing and care. Their anonymous and discreet nature appeals to individuals who may avoid facility-based services due to stigma showing high uptake among men who have sex with men (MSM) and female sex workers (FSWs). Nevertheless, concerns around data privacy and confidentiality, especially when accessing these tools in shared living environments remain significant challenges (107).

In parallel, the AfyaDepo platform allows individuals mainly in urban centers like Dar es Salaam to order online SD Bioline self-test kits for home delivery receive virtual counseling, and report results through QR codes, reducing stigma associated with clinic-based testing, though access remains limited in rural and low-connectivity regions (108).

This review has further identified digital decision-support tools to assist healthcare providers in identifying individuals eligible for HIV testing based on risk assessments through use of artificial intelligence (AI) and machine (109). A study in Northern Tanzania showed that predictive models using demographic and behavioral data accurately identified likely HIV-positive contacts, improving the efficiency of index testing. When integrated with mobile platforms, these tools can support more precise community-based testing and better allocation of diagnostic resources (109).

Geographic Information Systems (GIS) have been applied to enhance spatial targeting of HIV testing services. By mapping HIV prevalence and identifying underserved populations, GIS tools enable better planning of mobile outreach and community testing services (110). A USAID-supported initiative in Iringa Region used GIS mapping to direct mobile testing units to high-priority areas, resulting in a 35% increase in testing coverage. Despite their demonstrated effectiveness, the use of GIS remains sporadic, largely due to the technical expertise required and challenges in maintaining up-to-date data. Nonetheless, GIS remains a cost-effective strategy in the long run, optimizing the use of testing resources and expanding coverage in remote areas (111).

At the laboratory level, point-of-care (PoC) diagnostic tools, such as GeneXpert machines for early infant diagnosis (EID), are being supported by digital solutions like the HITSystem, which tracks samples and notifies both providers and caregivers via SMS (112). This has led to significant reductions in EID result turnaround times (from 17 to 9 days) and improved ART initiation rates. A study in Iringa District, Tanzania, explored factors influencing HIV early infant diagnosis (HEID) uptake among HIV-positive mothers found that digital tools improved data quality and service delivery. Perceived self-efficacy and awareness boosted by digital interventions were key predictors of HEID uptake (112). Another pilot study evaluating the T-HIT mHealth system in rural Tanzania documented 1,530 antenatal visits, with 695 women (45.42%) tested for HIV and 55 (3.59%) testing positive. Additionally, 103 women (6.73%) could not be tested due to reagent shortages, a barrier captured by the digital system but typically missed in paper records. While HIV testing rates did not significantly differ between T-HIT and control sites, a statistically significant increase in HIV-positive cases was observed postintervention (P = .04) (113).

II: DIGITAL TECHNOLOGIES ENHANCING LINKAGE TO HIV CARE

Linkage to care is the process of connecting a person who has tested positive for HIV to healthcare services for evaluation, treatment planning, and initiation of care. A range of digital health interventions have been implemented across Tanzania to strengthen the linkage to HIV care following diagnosis.

A qualitative study conducted in Hai and Moshi districts explored both client and provider perspectives on digital interventions following HIV self-testing. The findings highlighted that digital tools such as SMS reminders and mobile health applications helped reduce barriers such as stigma and misinformation, while guiding individuals to appropriate care (114).

Although these tools were found helpful in guiding newly diagnosed individuals toward timely care, concerns were raised about digital literacy and the need for user-friendly interfaces to ensure effective uptake (114). The study emphasized the need for community engagement and the tailoring of interventions to local contexts to enhance acceptability and effectiveness.

In a different setting, a study conducted in Mbeya by the National Institute for Medical Research explored mobile HIV Testing and Counseling (mHTC) services that combined mobile testing with digital tracking systems. The intervention significantly improved linkage to care, especially in rural and key populations, by physically accompanying clients to health facilities and using digital records to support active follow-up. This approach addressed logistical challenges such as distance to facilities and poor referral tracking (115).

A broader scoping review conducted in 2025 synthesized findings from across Sub-Saharan Africa, including Tanzania, and confirmed the growing adoption of mobile apps, SMS reminders, hotlines, and chatbots to support post-diagnosis linkage. These technologies were particularly

effective among youth and marginalized groups, providing discreet, real-time support and appointment reminders (79).

Complementing this, a 2019 study conducted in Dar es Salaam assessed the acceptability of mobile phone-based follow-up through Tanzania's National HIV Hotline among men who used HIVST. The findings showed that over 98% of participants had access to mobile phones, and prior engagement with HIV-related text messaging significantly increased their willingness to receive post-test counseling, indicating high accessibility and acceptability of such mobile interventions (116).

Another review of mHealth applications in Sub Saharan Africa including Tanzania, further support the cost-effectiveness and feasibility of these digital interventions. Low-cost technologies like SMS reminders and mobile counseling platforms have shown consistent benefits in improving linkage and early ART initiation (101). However, challenges persist, including digital literacy gaps, concerns over confidentiality, and the limited integration of digital tools with national health information systems. Despite these barriers, the evidence strongly supports that digital health interventions when contextually adapted and equitably implemented can significantly enhance linkage to HIV care in Tanzania by bridging information gaps, addressing psychosocial barriers, and improving system coordination (79, 114, 115, 116).

III: DIGITAL TECHNOLOGIES ENHENCING ART INITIATION

ART Initiation implies Starting of antiretroviral medications that suppress HIV replication, after diagnosis, regardless of CD4 count.

This review has identified a growing body of evidence demonstrating the potential of digital health technologies in enhancing the initiation of ART in Tanzania. A key example is the implementation science study conducted between 2022 and 2023 in Njombe and Mbeya regions, which piloted a community-based ART delivery model for female sex workers (FSWs) using digital platforms (117). This intervention employed digital referral tracking to track, follow up, and deliver home based ART initiation to newly HIV diagnosed individuals. Outreach teams employed digital case-management tools via tablets or smartphones to monitor patients through the ART initiation process. The results were striking: ART initiation rates among FSWs reached 83% within 14 days of diagnosis, substantially higher than rates achieved through traditional facility-based models (117).

This approach effectively addressed longstanding barriers such as stigma, distrust of formal health facilities, and high mobility among FSWs. Moreover, the digital aspect of the program

allowed for efficient data collection and follow-up, enhancing both care coordination and accountability. Despite its promising outcomes, the intervention faced challenges related to confidentiality, the digital literacy of outreach staff, and integration with national information systems.

Another significant digital innovation is the Afya-Tek initiative, launched in the Kibaha districts in 2021. The Afya-Tek digital health initiative demonstrates considerable potential to enhance antiretroviral therapy (ART) initiation in Tanzania by addressing critical barriers in referral efficiency, care coordination, and accessibility. Designed to digitally link community health workers (CHWs), public health facilities, and accredited private drug dispensing outlets (ADDOs), Afya-Tek facilitates timely referral and tracking of clients across multiple levels of the health system (118). Although not initially developed as an HIV-specific platform, its functionalities align well with key requirements for early HIV treatment initiation. Available evidence from pilot implementations in the Kibaha districts indicates improved referral completion rates and more efficient service uptake when compared to traditional paper-based systems (118). By enabling CHWs to provide referral through mobile applications, and track treatment-seeking behavior in real time, Afya-Tek strengthens the linkage between HIV testing and ART initiation, particularly in community and peripheral settings. While challenges related to digital literacy, connectivity, and data security remain, the adaptability and scalability of Afya-Tek suggest that, with appropriate integration into HIV programs, it could play a significant role in accelerating ART initiation and advancing progress toward Tanzania’s 95-95-95 targets.

At the facility level, digital technologies such as biometric patient registration and electronic medical records (EMRs) have the potential to significantly improve ART initiation outcomes. If widely implemented, these tools could enable real-time identification of ART-eligible clients, streamline clinical workflows, and enhance patient tracking within health facilities. For example, automated systems could support faster clinical decision-making, facilitate same-day ART initiation, and reduce delays often caused by manual record keeping (119).

At the national level, Tanzania's adoption of the District Health Information Software 2 (DHIS2) platform marked a critical step in leveraging digital tools to monitor ART initiation at scale. Through the integration of HIV-specific indicators into this centralized dashboard, health managers gained the ability to track ART uptake trends in real time, disaggregate data by region and population group, and make evidence-based decisions for program improvement (120). The use of DHIS2 has facilitated greater accountability and responsiveness, with district health managers reporting high satisfaction in terms of usability, data visualization, and support for decision-making (121). However, challenges remain in ensuring full and consistent data reporting from facilities,

particularly in resource-constrained settings. The coexistence of paper-based and digital reporting systems also continues to undermine data quality and completeness.

IV: ADHERENCE AND RETENTION SUPPORT THROUGH DIGITAL TOOLS

Adherence refers to consistently taking ART as prescribed, while retention involves regular, ongoing HIV care engagement. Studies in Tanzania (2010–2025) highlight how digital tools support both. This section analyzes their features, accessibility, impact, cost-effectiveness, and challenges.

- **SMS-Based Reminders**

Short Message Service (SMS) reminders have been one of the most widely studied digital tools for ART adherence in Tanzania (116, 122, 123, 124).These systems typically send automated messages to ART clients, prompting timely medication intake or clinic attendance. Some platforms offer bidirectional functionality, allowing recipients to respond or report how they are feeling, which enhances personalization. Although a randomized controlled trial conducted in 2021 in the Kilimanjaro region revealed that the SMS interventions were feasible and well-accepted by patients (124),but adherence remained high across all participants (approximately 90% by pharmacy refill and over 95% by self-report), there were no statistically significant differences between the SMS group and the control group receiving standard care over a 48-week period(124). A 2023 mixed-methods study conducted in Kilimanjaro region assessed the acceptability of SMS reminders among 426 participants (284 children aged 0–14 and 142 adolescents aged 15–19). Results showed that 85% of participants were willing to receive SMS reminders, while 90% reported that adherence feedback delivered via SMS was helpful (122).

Another study conducted in Tanzania in 2021 also reported on the acceptability of SMS Interventions among PLHIV but some study participants suggested on the need to consider Personalized SMS contents as this would fit their context. Of 166 participants, 143 (86%) were interviewed, with 98% expressing satisfaction, 99% feeling motivated, 97% confident receiving SMS, while 6% reported discomfort and 8% felt it lacked personalization (125).

The wide accessibility of mobile phones in Tanzania where ownership exceeds 89% supports the scalability of such interventions, even among populations in semi-rural settings. Cost analysis indicates that SMS-based interventions remain relatively low cost, leveraging existing telecommunications infrastructure and requiring minimal resources per user (125). Furthermore, challenges identified include risks of inadvertent HIV status disclosure from SMS content and disparities in both digital literacy and device access among rural and marginalized populations (122, 124).

- **Real-Time Medication Monitoring (RTMM) Devices**

Real-time medication monitoring (RTMM) technologies, particularly electronic pillboxes such as the Wisepill device, represent a more technologically advanced method of tracking ART adherence. These smart pillboxes are equipped with SIM-enabled transmitters that record each opening event and send time-stamped data to healthcare providers. Additionally, they can trigger SMS reminders when expected openings are missed (124, 126). Evidence a recent study conducted in Kilimanjaro region indicates that RTMM devices are feasible and acceptable among diverse populations, including adults, adolescents, and postpartum women particularly when combined with automated SMS and tailored feedback. Results demonstrated that these technologies facilitate targeted adherence counseling and improved data-driven clinical decision-making. Participants reported positive experiences with real-time monitoring, and healthcare providers appreciated the ability to deliver targeted counseling based on individualized adherence data (126). While the technology offers precise adherence tracking, its accessibility remains limited due to higher costs and logistical challenges. Distribution has primarily occurred in urban and peri-urban areas with stable mobile networks, excluding more remote communities. Cost-effectiveness analyses note that although RTMM devices entail higher upfront expenses than SMS systems, they may prove economical over time by preventing ART failure, reducing unnecessary clinic visits, and improving retention when linked to effective counseling protocols (127). Nevertheless, challenges such as device loss or damage, inconsistent network connectivity, low digital literacy among certain users, and privacy concerns around carrying a conspicuous health-related device must be addressed (122, 123).

- **Mobile Apps Platforms**

Evidence from available studies, supports the use of mobile Apps as scalable tools to support ART adherence and retention among PLHIV in Tanzania. For instance, the FASTA mobile ART service, an mHealth initiative introduced in the Ruvuma region in 2020 incorporated mobile self-assessment tools and SMS reminders to schedule multi-month ARV pickups (128). Through mobile self-assessment features, patients can evaluate their health status independently, allowing for early detection of complications and timely clinical follow-up a key to maintaining adherence. Additionally, the app facilitates rapid antiretroviral (ARV) refill requests, helping patients avoid treatment interruptions caused by long travel distances, high costs, or stigma associated with

clinic visits. By decentralizing ART services, FASTA reduces congestion at health facilities and shortens waiting times, both of which are known to improve retention (128).

On the other side, the JICHUNGE mobile health App represents a more interactive and feature-rich approach to supporting ART adherence, though it has been primarily studied in the context of PrEP among female sex workers in Dar es Salaam (129). The app offers several functionalities, including educational content about HIV and ART, appointment reminders, medication tracking, and access to online peer support forums (129). A study conducted among female sex workers in Dar es Salaam found that users who engaged with at least three app features within the first 30 days were significantly more likely to remain retained in care at one month. However, app engagement declined sharply over time, with only about 13% of participants remaining active users after six months (130). This decline was largely attributed to smartphone access issues, including phone loss, theft, data costs, and low digital literacy among some participants. The intervention also highlighted generational and socioeconomic disparities in smartphone ownership, with older and more informed participants demonstrating better retention in app usage (130). While the cost of app development and dissemination was moderate, the long-term impact was diminished by low sustained engagement particularly, poor network coverage in rural areas, and challenges in customizing SMS content for language (130). Despite these challenges, JICHUNGE demonstrates the potential of mHealth apps to empower users and personalize adherence support, particularly among urban populations with stable access to smartphones and internet services.

- **Mobile based hotlines**

Recent studies highlight hotlines as a low-cost, scalable intervention that provides post-test counseling, peer support, and adherence guidance via voice calls (114, 116). These services have demonstrated high acceptability, particularly among men, who are often underrepresented in facility-based retention programs. Observational data indicate that hotline use enhances patient comfort with HIV-related discussions, reduces stigma, and encourages care-seeking behaviors (114, 116). Their low operating costs and broad accessibility have allowed for nationwide deployment (127). However, implementation has faced challenges such as inconsistent service availability in remote regions, intermittent network reliability, and variable user comfort with disclosing sensitive information over mobile lines. Ensuring continuous staff training and building trust among users remain critical to the long-term effectiveness of hotline-based adherence support (114).

- **Virtual Consultations (Telehealth and Telemedicine)**

Emerging evidence from Tanzania highlights the effectiveness of telehealth and telemedicine in supporting antiretroviral therapy (ART) adherence and retention in HIV care. A notable example is the telemedicine initiative implemented by Aga Khan Hospital in Dar es Salaam between April and June 2020, in response to the COVID-19 pandemic (131). Promoted through social media platforms, this program enabled virtual consultations for HIV patients, with approximately 53% of interested callers successfully completing sessions. These consultations allowed healthcare providers to remotely assess patients' clinical status, monitor ART adherence, adjust treatment plans, and address concerns, significantly reducing the need for in-person visits. In parallel, telehealth platforms were also employed to provide adherence support and counseling services, maintaining continuity of care during a period of restricted mobility (131).

In addition, ongoing research in the Kilimanjaro Region is evaluating the impact of nurse-delivered telehealth interventions aimed at improving HIV care engagement and mental health outcomes among adults living with HIV. These virtual sessions focus on addressing psychosocial barriers to adherence and have demonstrated both feasibility and acceptability within resource-constrained environments. Preliminary findings suggest that remote counseling can positively influence retention in care and strengthen patient engagement, particularly when integrated with routine HIV services (132).

- **Biometric Attendance Verification**

Another innovative approach tested in Tanzania involves the use of biometric fingerprint systems integrated with mobile money transfers to incentivize ART clinic attendance and adherence (133, 134). In this model, patients are rewarded with cash incentives for attending scheduled clinic visits, which are verified through biometric fingerprint scanners installed at health facilities. Payments are distributed automatically through mobile money platforms, creating a streamlined and secure incentive system. Studies conducted in multiple Tanzanian clinics revealed that this approach significantly improved ART retention and viral suppression (133). At six months, approximately 83–86% of participants in the intervention arms achieved viral suppression compared to 73% in the control group. Although the effect waned somewhat by 12 months, retention and viral suppression remained higher among those receiving incentives. Accessibility was relatively high, with most participants owning mobile phones and using mobile money services (133). However, biometric systems introduced operational challenges, including hardware failures, electricity outages, and delays in payments due to connectivity issues. Additionally, some participants expressed concerns over privacy and data security, particularly with regard to fingerprint data and visible mobile money transfers (133).

- **Electronic Medical Records (EMR) and Pharmacy refills**

In Tanzania, the integration of electronic medical records (EMRs) and electronic pharmacy refill systems has shown significant potential in improving adherence to antiretroviral therapy (ART) and retention in care (135). Strengthened appointment tracking systems, combined with real-time monitoring of pharmacy refill data, have facilitated timely identification of patients at risk of nonadherence. Evidence from a study supported by Management Sciences for Health (MSH) demonstrated that the use of standardized electronic appointment registers and systematic follow-up of missed visits reduced the rate of missed appointments from 15–20% to approximately 11%. These improvements were associated with better adherence outcomes and enhanced continuity of care (135). Electronic pharmacy refill data serve as an important proxy for ART adherence, offering clinicians actionable insights into patients' medication pickup patterns. When effectively integrated into EMR platforms, these data support automated alerts, adherence flagging, and targeted follow-up, allowing for more individualized patient support (135). Despite promising results, further evaluation and scaling of integrated EMR–pharmacy systems are essential to fully realize their potential for real-time adherence monitoring and improved ART program performance.

V: VIRAL LOAD MONITORING AND SUPPRESSION THROUGH DIGITAL TECHNOLOGIES

Digital health technologies have played a transformative role in improving viral load (VL) monitoring and suppression in Tanzania, which is critical to achieving effective HIV treatment outcomes. The most robust evidence of impact comes from the national HIV Viral Load (HVL) surveillance system, which uses Open Laboratory Data Repository (OpenLDR) to integrate HIV data into District Health Information Software 2 (DHIS2) (136). This integration enables real-time data tracking, dashboard visualization, and data-driven HIV program management. Covering over 90% of ART clinics, the system has significantly improved data completeness and reduced VL result turnaround time to a median of 13 days. It also enables health authorities to monitor suppression trends and rapidly respond to underperforming regions or facilities (136).

At the facility level, decentralized molecular testing supported by electronic medical records (EMRs) like OpenMRS has shortened VL result turnaround from 59 to 21 days, particularly in rural areas. This has enabled more prompt clinical decisions for patients with elevated VL,

although sustained success depends on infrastructure, equipment maintenance, and staff capacity (137, 138).

In parallel, mobile health (mHealth) platforms combining biometric patient registration, SMS reminders, and automated result uploads have improved appointment attendance, timely VL testing, and ART adherence specially among young adults. Despite positive outcomes, implementation in remote areas is constrained by limited connectivity and concerns over data privacy (123, 133).

FACILITATORS AND BARRIERS TO IMPLEMENTING DIGITAL HEALTH INTERVENTIONS TO STRENGTHENING HIV CONTINUUM CARE IN TANZANIA

This section presents findings related to the third objective of the study which is to identify enablers and barriers influencing to the uptake and integration of digital health technologies in Tanzania's HIV response. Understanding these factors is crucial for effective, equitable, and sustainable implementation.

FASCILITATORS TO IMPLEMENTATION OF DIGITAL HEALTH TECHNOLOGIES

I: Government Supportive Policy and Regulatory Environment

A major facilitator to implementation of digital health technologies to support HIV continuum care in Tanzania comes from the government supportive policy and regulatory environment. National strategic documents such as the National Digital Health Strategy (2019–2024) (49), and the Health Sector Strategic Plan V (2021–2026), provide the policy backbone for digital innovation within the health sector (50). These frameworks promote digital health integration through stakeholder alignment, interoperability, and coordinated investments, while providing guidance on governance and ethics which is key to scaling and sustaining HIV programs.

II. Mobile Phone Penetration and Network Coverage

With over 90% mobile phone access and growing network coverage, Tanzania is well-positioned for mHealth. This connectivity supports SMS-based care, smartphone apps, and telehealth, improving HIV service access and engagement, especially in remote areas (139).

III. Stakeholder Engagement and Multisectoral Collaboration

Robust engagement of stakeholders including the Ministry of Health, development partners, NGOs, academic institutions, private tech firms, and communities has played a central role in the

successful design and implementation of DHTs in Tanzania (103, 129, 137). This collaborative environment fosters innovation, ensures alignment with national HIV priorities, and promotes accountability.

IV. Local Innovations Tailored to Local Needs (Context)

A growing enabler of digital health integration in Tanzania is the emergence of locally developed digital solutions that are customized to the specific needs and contexts of Tanzanian communities (103, 129). Innovations such as the Jichunge App, developed by local technologists in collaboration with the Ministry of Health, provide real-time data on patient visits and treatment adherence tailored for use in local clinics(130). Similarly, National Hotlines and other Swahili-language mobile platforms offer culturally and linguistically appropriate content for health education and HIV stigma reduction. These tools incorporate community norms, local language, and user behavior patterns into their design, making them more acceptable and user-friendly (100).

BARRIERS TO IMPPLEMENTATION OF DIGITAL HEALTH TECHNOLOGIES:

Infrastructure limitations/ deficiencies:

Infrastructural deficiencies such as poor internet, unreliable electricity, and limited access to digital devices remain a major barrier to the successful deployment of digital health technologies in Tanzania. (104).These limitations compromise the real-time functionality of digital platforms like EMRs and reporting dashboards. Without adequate infrastructure, digital interventions become unreliable or unsustainable, undermining trust among users and contributing to low uptake (104).

Limited Digital Literacy & Human Resource Constraints

Digital literacy remains uneven across the Tanzanian population. Many patients, especially older adults, rural residents, and those with low levels of education, struggle to use mobile apps or interpret SMS-based messages (129). Another significant barrier to the effective uptake and integration of digital health technologies in Tanzania's HIV response lies in the human resource constraints faced at various levels of the healthcare system. Shortage of trained health workers, particularly in rural areas, hinders effective use of systems like EMRs and DHIS2, leading to inconsistent usage and data errors. (104).

Fragmentation and Lack of Interoperability

The proliferation of siloed, digital platforms has led to fragmentation within the health information ecosystem. Many systems operate independently, lack interoperability, and duplicate data entry efforts, resulting in inefficiencies, data quality issues, and poor user experience (104). Without unified standards and integration, digital tools cannot effectively support the full HIV care continuum(122).

Data Privacy and Confidentiality Concerns

Concerns about the privacy and security of sensitive health information particularly HIV status are significant barriers to the use of digital platforms. Fear of data misuse is acute for stigmatized groups, while weak regulations and cybersecurity increase risks, undermining trust and uptake among key populations (129).

CHAPTER 5: DISCUSSION

Overview

This literature review aimed to explore the potential of digital health technologies in strengthening the HIV Continuum of Care in Tanzania. The primary objective was to assess how various digital health interventions have impacted the different stages of the HIV care cascade, from diagnosis and linkage to care, through to ART initiation, adherence, retention, and viral suppression. By critically synthesizing the evidence, the study sought to identify gaps, highlight effective strategies, and inform policy and programmatic decisions.

Key Findings and Novel Insights

This review revealed that digital health technologies such as mHealth platforms, telemedicine, electronic health records (EHRs), HIV self-testing kits, biometric systems, and mobile-based hotlines play a pivotal role in enhancing engagement across the HIV Continuum of Care. Among these, mHealth interventions emerged as the most widely adopted tools, often tailored for appointment reminders, behavior change communication, and service accessibility. SMS reminders, mobile apps, and virtual consultations were featured prominently across this review and were particularly influential in improving HIV diagnosis, linkage to care, and ART adherence. This signals a strategic focus on the early and middle stages of the continuum, although downstream stages such as ART initiation and viral suppression were relatively underexplored.

A surprising finding is the effective use of digital HIV self-testing methods, such as vending machines and web/app-guided HIVST delivery such as AfyaDepo. These interventions, especially when integrated with follow-up systems like SMS-based counseling or virtual referral tracking, demonstrate significant potential for scaling. Such interventions not only lower stigma-related barriers but also demonstrate how digital solutions can integrate behavioral change to enhance care engagement especially for vulnerable groups such as sex workers and MSM. These findings are particularly novel as they demonstrate a shift from conventional facility-based testing to more discreet, client-centered models.

Another innovative finding is the potential of artificial intelligence-based predictive tools and GIS mapping to enhance targeted testing, making service delivery more efficient and data-driven.

Further, the review highlights the integration of biometric technologies and real-time monitoring devices that support ART adherence and follow-up. Tools such as Wisepill and mobile-based hotlines not only improve medication adherence but also offer tailored feedback and remote counseling. Similarly, context-specific digital platforms like "Jichunge App" and "Afya-Tek App" showcase the value of locally developed and culturally aligned digital solutions. These interventions are promising, but their sustainability and scalability require further exploration.

In this review, digital innovations supporting ART initiation and viral suppression were underrepresented. Only a few studies focused on these downstream stages, suggesting a critical service gap. ART initiation has seen moderate digital integration through systems like Afya-Tek and DHIS2-linked tracking, but viral load monitoring still faces bottlenecks, particularly in rural settings with limited infrastructure. This gap suggests a need to shift attention from predominantly testing and adherence-based technologies toward comprehensive interventions covering the full care cascade.

This review demonstrates that client-focused digital health interventions significantly outnumber those aimed at health workers or managers. This disparity suggests a need for Tanzania to broaden its digital focus beyond patient interfaces to include provider-facing technologies that enhance clinical decision-making and operational efficiency. Given these findings, there is a critical need for policy-makers and implementing partners in Tanzania to prioritize the development of integrated digital ecosystems, support equitable access to devices and connectivity, and promote sustainable financing models. Emphasis should be placed on contextually adapting proven models from other African countries while ensuring alignment with Tanzania’s unique health system architecture and sociocultural landscape.

The findings reveal critical interlinkages across different stages of the continuum. For example, digital Health interventions that initially targeted diagnosis often extended to support linkage to care and early ART initiation. Tools such as SMS follow-ups and hotline counseling bridged these transitional gaps, reflecting a growing awareness of the importance of continuity across the cascade. A good example is how biometric attendance systems and mobile money incentives tied to clinic visits not only supported retention but also indirectly promoted viral suppression through increased adherence. Furthermore, the interaction between infrastructure and technology emerges as a central theme. While digital platforms have improved access and service delivery in urban areas, their reach remains limited in rural communities due to poor internet connectivity, electricity supply, and digital literacy. These infrastructural challenges significantly constrain the utility of electronic health records (EHRs) and teleconsultation services. For instance, while real-time viral load monitoring through integrated EMRs shows potential, its success heavily depends on consistent power supply and health worker training. Moreover, the evidence suggests that digital tools are highly client-focused, while few interventions target healthcare providers or managers. This imbalance limits the systemic integration of digital health into clinical workflows and managerial decision-making. For example, although EHRs and dashboard tools have improved ART tracking and stock management in some settings, they are often standalone systems with limited interoperability. Other Sub-Sahara African countries have made more progress in this domain, offering transferable models for Tanzania to consider.

RELEVANCE AND LIMITATION OF THE ANALYTICAL FRAMEWORK

This review used the HIV Continuum of Care framework that provided a useful structure for mapping digital health interventions and identifying gaps across the care cascade. It facilitated a review of how digital tools influence patient progression from diagnosis to viral suppression. However, the framework could benefit from incorporating broader social determinants of health such as education, income, gender dynamics, and stigma that influence care engagement. Future adaptations could also integrate digital readiness indicators to better align with eHealth evaluations.

STRENGTH AND LIMITATION OF THE STUDY

A major strength of this review is its comprehensive scope, covering multiple databases and including grey literature and local sources. It synthesized evidence from various digital tools and provided contextual insights specific to Tanzania. Furthermore, by categorizing interventions according to both the care cascade and user types (clients, providers, managers), the review offers actionable guidance for stakeholders.

Despite the breadth of interventions identified in this review, several knowledge gaps persist. There is limited disaggregated data on digital health usage by gender, age, or rural-urban location. Most studies focused on urban settings, with minimal representation of rural populations where HIV burden and service access issues are often more pronounced. Similarly, data on marginalized groups such as MSM, people who inject drugs, and sex workers were sparse, despite these populations being at higher risk. Additionally, the long-term sustainability and cost-effectiveness of many interventions remain unclear. Few studies evaluated scalability or conducted cost-benefit analyses, leaving uncertainty around financial viability in public health programs. The heterogeneity in study designs and outcome measures further limits comparability across studies.

STUDY IMPLICATIONS

The findings of this study carry significant implications for health policy, program planning, and the broader digital health agenda in Tanzania. First, they underscore the urgent need for harmonized and integrated digital health infrastructure that avoids duplication and improves continuity of care across the HIV continuum. Fragmented systems remain a major barrier to scalability and sustainability, and thus should be prioritized in national digital health strategies.

Second, the evidence highlights the importance of tailoring digital interventions to the unique needs of different populations, particularly youth, women, rural communities, and key populations such as MSM and sex workers. Policymakers and health implementers should invest in user-centered design, local language adaptation, and inclusive content delivery to improve acceptability and utilization.

Third, the findings suggest that a shift from short-term, donor-driven pilots to long-term, government-led digital health investments is essential for scale and sustainability. This includes institutionalizing digital literacy training for healthcare workers, ensuring routine maintenance of digital tools, and embedding digital interventions within the health financing ecosystem.

Lastly, the study supports the expansion of digital innovations beyond client-level engagement to include provider-facing systems such as decision-support tools and EMRs. Strengthening the digital capacity of healthcare workers is crucial to improving care coordination, treatment accuracy, and patient outcomes across all stages of the HIV care cascade.

DIRECTION FOR FUTURE RESEARCH

Several gaps identified in this review warrant further research. First, more studies are needed that explore the long-term impacts of digital interventions, including their cost-effectiveness, scalability, and sustainability in diverse Tanzanian settings. Economic evaluations and implementation science approaches should be integrated into future research to guide investment decisions. Second, future studies should strive for more disaggregated data analysis by gender, age, geographic location, and key population status. This would allow for more precise targeting of digital interventions and reduce inequities in HIV service delivery. Third, there is a need for research on the ethical, legal, and data governance dimensions of digital health in Tanzania. As the adoption of biometric tracking, AI-driven tools, and teleconsultation grows, robust frameworks must be developed to protect user privacy, ensure informed consent, and build public trust.

Fourth, community-based participatory research is recommended to ensure that end-users especially marginalized and high-risk populations are involved in the design, implementation, and evaluation of digital health solutions. This participatory approach will enhance relevance, ownership, and long-term engagement. Lastly, research on digital literacy interventions and their influence on uptake of digital health tools is essential. Understanding how digital competence among both providers and clients influences engagement will be crucial to optimizing the impact of digital interventions across the HIV continuum of care in Tanzania.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Digital health technologies present a promising avenue for strengthening the HIV Continuum of Care in Tanzania. However, their potential can only be fully realized through context-specific adaptations, investment in infrastructure, user training, and alignment with national systems. The insights generated through this review provide a foundation for targeted policy and programmatic decisions that advance Tanzania toward its HIV care goals and broader Universal Health Coverage agenda.

6.2 RECOMMENDATIONS:

Based on the findings and implications of this study, several recommendations are proposed to enhance the role of digital health technologies in strengthening the HIV Continuum of Care in Tanzania.

6.2.1 Recommendations to the Government of Tanzania:

Short-term:

- **Infrastructure Investment and Connectivity:**

The government should Prioritize investment in digital infrastructure (internet connectivity, electricity, mobile networks) in underserved areas to support smoother deployment of electronic records, telemedicine services, and provider-client communication.

- **Capacity Building:**

The government should train healthcare workers, administrators and clients on the use of digital tools, ensuring digital literacy and smooth adoption at primary, secondary, and tertiary levels. A digitally literate population is foundational to successful implementation.

- **Data Governance Framework:**

The government should establish clear data privacy and security regulations for digital health systems, aligned with international standards as this will build more trust among users. These safeguards are critical to avoiding stigmatization and ensuring that vulnerable populations engage confidently with digital services

Long term:

- **Develop Sustainable Financing Models:**

The government should develop sustainable financing mechanisms (such as digital health investment funds, public-private partnerships) to ensure long-term support for digital Health solutions.

- **Establish Interoperability Standards:**

The government should Mandate interoperability of digital health systems to ensure seamless data sharing among clinics, labs, pharmacies, and other stakeholders.

6.2.2 Recommendations to Civil society and other Private Agencies:

Short-term:

- **Contextualization of digital health tools/Interventions:**

Digital tools and interventions should promote beneficiary Inclusive and participatory design approaches taking in account user-friendly digital health contents personalized maintain user engagement over time.

Long - term:

- **Establish Strong M&E Systems:**

Implement continuous monitoring and evaluation to track impact, improve performance, and ensure digital health programs meet community needs.

6.2.3 Recommendations to Donors:

- **Support/Fund Infrastructure Development:**

Donors should prioritize funding initiatives that enhance technological infrastructure like internet access and electricity in underserved regions to enable the effective scale-up of digital health solutions.

- **Fund Capacity Building Initiatives**

Fund training programs that enhance digital literacy and professional skills among healthcare workers, ensuring they can effectively use digital health technologies.

REFERENCES

1. Erku D, Khatri R, Endalamaw A, Wolka E, Nigatu F, Zewdie A, et al. Digital health interventions to improve access to and quality of primary health care services: a scoping review. International journal of environmental research and public health. 2023;20(19):6854.
2. WHO. Digital health 2022 [Available from: https://www.who.int/europe/health-topics/digital-health#tab=tab_1.
3. Holmes EC. On the origin and evolution of the human immunodeficiency virus (HIV). Biological reviews. 2001;76(2):239-54.
4. Hogg RS. Understanding the HIV care continuum. The Lancet HIV. 2018;5(6):e269-e70.
5. World Bank. Tanzania - Country Brief 2010 [Available from: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/668001468341084237/tanzania-country-brief.
6. Tourism TMoNRa. TANZANIA WILDLIFE CORRIDORS ASSESSMENT, PRIORITIZATION, AND ACTION PLAN 2022 [Available from: https://maliasili.go.tz/assets/pdfs/WildlifeCorridorAssessmentandActionPlanReport_Final_compressed.pdf.
7. Mahmud Khan M, Hotchkiss DR, Berruti AA, Hutchinson PL. Geographic aspects of poverty and health in Tanzania: does living in a poor area matter? Health policy and planning. 2006;21(2):110-22.
8. Munga MA, Mæstad O. Measuring inequalities in the distribution of health workers: the case of Tanzania. Human resources for health. 2009;7:1-12.
9. NBS. National Bureau of Statistics Tanzania 2025 [Available from: https://www.nbs.go.tz/.
10. maps W. Tanzania regions map 2025 [Available from: https://ontheworldmap.com/tanzania/tanzania-regions-map.html.
11. Bank W. The World Bank Tanzania Overview 2022 [Available from: https://www.worldbank.org/en/country/tanzania/overview.
12. Klemick H, Leonard KL, Masatu MC. Defining access to health care: evidence on the importance of quality and distance in rural Tanzania. American Journal of Agricultural Economics. 2009;91(2):347-58.
13. Kitole FA, Lihawa RM, Mkuna E. Equity in the public social healthcare protection in Tanzania: does it matter on household healthcare financing? International Journal for Equity in Health. 2023;22(1):50.
14. Watts G. The Tanzanian digital health agenda. The Lancet Digital Health. 2020;2(2):e62-e3.
15. Maluka SO, Hurtig AK, Sebastian MS, Shayo E, Byskov J, Kamuzora P. Decentralization and health care prioritization process in Tanzania: from national rhetoric to local reality. The International journal of health planning and management. 2011;26(2):e102-e20.
16. Boex J, Fuller L, Malik A. Decentralized local health services in Tanzania. Urban Inst. 2015;1.
17. Kapologwe NA, Kibusi SM, Borghi J, Gwajima DO, Kalolo A. Assessing health system responsiveness in primary health care facilities in Tanzania. BMC health services research. 2020;20:1-10.

18. Kigume R, Maluka S, Kamuzora P. Decentralisation and health services delivery in Tanzania: analysis of decision space in planning, allocation, and use of financial resources. The International Journal of Health Planning and Management. 2018;33(2):e621-e35.
19. Minja BJ. Contribution of Community Health Workers on Improvement of Primary Health Services in Tanzania: A case of Kilolo District: The Open University of Tanzania; 2020.
20. Health Mo. TANZANIA HEALTH FACILITY ATLAS 2023 2023 [Available from: https://www.moh.go.tz/storage/app/uploads/public/674/eb8/6d6/674eb86d688d4542845162.pdf.
21. Mbugi EV, Kayunze KA, Katale BZ, Kendall S, Good L, Kibik GS, et al. 'One Health'infectious diseases surveillance in Tanzania: Are we all on board the same flight? Onderstepoort Journal of Veterinary Research. 2012;79(2):01-7.
22. Kwesigabo G, Mwangu MA, Kakoko DC, Warriner I, Mkony CA, Killewo J, et al. Tanzania's health system and workforce crisis. Journal of public health policy. 2012;33:S35-S44.
23. Kwesigabo G, Mwangu MA, Kakoko DC, Warriner I, Mkony CA, Killewo J, et al. Tanzania's health system and workforce crisis. Journal of public health policy. 2012;33(Suppl 1):S35-S44.
24. Abernethy A, Adams L, Barrett M, Bechtel C, Brennan P, Butte A, et al. The promise of digital health: then, now, and the future. NAM perspectives. 2022;2022:10.31478/202206e.
25. Organization WH. Global strategy on digital health 2020-2024. 2019.
26. Zallio M, Clarkson PJ. Designing the metaverse: A study on inclusion, diversity, equity, accessibility and safety for digital immersive environments. Telematics and Informatics. 2022;75:101909.
27. Sin J, L. Franz R, Munteanu C, Barbosa Neves B, editors. Digital design marginalization: New perspectives on designing inclusive interfaces. Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems; 2021.
28. WHO. Classification of digital interventions, services and applications in health 2023 [Available from: https://www.who.int/publications/i/item/9789240081949.
29. Tuitert I, Marinus JD, Dalenberg JR, van't Veer JT. Digital Health Technology Use Across Socioeconomic Groups Prior to and During the COVID-19 Pandemic: Panel Study. JMIR public health and surveillance. 2024;10(1):e55384.
30. Alrahbi D, Khan M, Hussain M. Exploring the motivators of technology adoption in healthcare. International Journal of Healthcare Management. 2021;14(1):50-63.
31. Palacholla RS, Fischer N, Coleman A, Agboola S, Kirley K, Felsted J, et al. Provider-and patient-related barriers to and facilitators of digital health technology adoption for hypertension management: scoping review. JMIR cardio. 2019;3(1):e11951.
32. Trinh M. Understanding older adults' motivations to use digital health technology: University of Illinois at Urbana-Champaign; 2023.
33. Kumar V, Cheng SYC. A comparative literature review of integrated approach in health care in high and low-middle-income countries. Social Development Issues. 2023;46(1).
34. Bhattacharyya O, Shaw J, Sinha S, Gordon D, Shahid S, Wodchis WP, et al. Innovative Integrated Health And Social Care Programs In Eleven High-Income Countries: Study reports on thirty health and social care programs in eleven high-income countries that delivered care in innovative ways. Health Affairs. 2020;39(4):689-96.
35. Duggal M, El Ayadi A, Duggal B, Reynolds N, Bascaran C. Challenges in implementing digital health in public health settings in low and middle income countries. Frontiers Media SA; 2023. p. 1090303.

36. Archita M. Fostering digital skills in developing countries–what works?-Archita Misra. 2022.
37. Statista. Number of smartphone subscriptions in Sub-Saharan Africa from 2012 to 2029 2025 [Available from: https://www.statista.com/statistics/1133777/sub-saharan-africa-smartphone-subscriptions/.
38. GSMA. The Mobile Economy Sub-Saharan Africa 2023 2023 [Available from: https://event-assets.gsma.com/pdf/20231017-GSMA-Mobile-Economy-Sub-Saharan-Africa-report.pdf.
39. Perski O, Short CE. Acceptability of digital health interventions: embracing the complexity. Translational behavioral medicine. 2021;11(7):1473-80.
40. Mathews SC, McShea MJ, Hanley CL, Ravitz A, Labrique AB, Cohen AB. Digital health: a path to validation. NPJ digital medicine. 2019;2(1):38.
41. Grande D, Marti XL, Feuerstein-Simon R, Merchant RM, Asch DA, Lewson A, et al. Health policy and privacy challenges associated with digital technology. JAMA network open. 2020;3(7):e208285-e.
42. Mulukuntla S, Gaddam M. Overcoming Barriers to Equity in Healthcare Access: Innovative Solutions Through Technology. EPH-International Journal of Medical and Health Science. 2017;3(1):51-60.
43. Vij R. Revolutionizing Healthcare: Unleashing the Power of Digital Health. Federated Deep Learning for Healthcare: CRC Press. p. 17-30.
44. Techtarget. Digital Health care 2024 [Available from: https://www.techtarget.com/searchhealthit/definition/digital-health-digital-healthcare.
45. Kibanda AN. Embracing digital disruption in Tanzania: insights from Mwananchi communications Limited print-to-digital multimedia journey. 2025.
46. Haji SH, Silla BS, Musuguri JN. Tanzania as an Emerging Digital Economy. Global Scientific Journal. 2017;5(5):120-48.
47. TICGL. Tanzania's Internet Revolution 2025 [Available from: https://ticgl.com/tanzanias-internet-revolution-with-over-48-million-users-and-expanding-opportunities-in-2024/.
48. reportal D. Digital 2024: Tanzania 2024 [Available from: https://datareportal.com/reports/digital-2024-tanzania.
49. WHO. THE NATIONAL DIGITAL HEALTH STRATEGY 2019 – 2024 2019 [Available from: https://extranet.who.int/countryplanningcycles/sites/default/files/public_file_rep/TAN_Tanzania_Digital-Health-Strategy_2019-2024.Pdf.
50. Health TMo. TANZANIA DIGITAL HEALTH INVESTMENT ROAD MAP 2017-2023 2017 [Available from: http://api-hidl.afya.go.tz/uploads/library-documents/1573688147-xrkVuNtD.pdf.
51. NICTBB. The National ICT Broadband Backbone : Tanzania 2007 [Available from: http://www.nictbb.co.tz/about.php?in=nictbb.
52. Tanzania Ministry of Information CT. Tanzania digital Economy Strategic Framework 2024-2034 2024 [Available from: https://ictc.go.tz/storage/44/01J5TJNDHDVTA3AHVQN9CR6BV7.pdf.
53. WHO. HIV and AIDS key facts 2024 [Available from: https://www.who.int/news-room/fact-sheets/detail/hiv-aids.
54. WHO. Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitorin 2021 [Available from: https://www.who.int/publications/i/item/9789240031593.

55. Ehrenkranz P, Rosen S, Boulle A, Eaton JW, Ford N, Fox MP, et al. The revolving door of HIV care: revising the service delivery cascade to achieve the UNAIDS 95-95-95 goals. PLoS medicine. 2021;18(5):e1003651.
56. UNAIDS. HIV and AIDS Estimates: Tanzania Fact Sheets 2023 [Available from: https://www.unaids.org/en/regionscountries/countries/unitedrepublicoftanzania.
57. UNAIDS. HIV PREVENTION 2025: Road Map 2025 [Available from: https://www.unaids.org/sites/default/files/media_asset/prevention-2025-roadmap_en.pdf.
58. Iseselo MK, Ambikile JS, Lukumay GG, Mosha IH. Challenges in the delivery of health services for people living with HIV in Dar es Salaam, Tanzania: a qualitative descriptive study among healthcare providers. Frontiers in Health Services. 2024;4:1336809.
59. Frumence G, Nathanaeli S. Health system barriers to provider-initiated HIV testing and counselling services for infants and children: a qualitative study from 2 districts in Njombe, Tanzania. East African Health Research Journal. 2017;1(2):123-9.
60. Kigombola A, Lyimo J, Mizinduko M, Mkembela D, Maziku E, Kafura W, et al. Low engagement of key populations in HIV health services in Tanzania: analysis of community, legal and policy factors. The Pan African Medical Journal. 2023;45(Suppl 1):8.
61. Layer EH, Kennedy CE, Beckham SW, Mbwambo JK, Likindikoki S, Davis WW, et al. Multi-level factors affecting entry into and engagement in the HIV continuum of care in Iringa, Tanzania. PloS one. 2014;9(8):e104961.
62. Evans R. Poverty, HIV, and barriers to education: street children's experiences in Tanzania. Gender & Development. 2002;10(3):51-62.
63. Sambayi GL, Bwire GM, Kilapilo MS, Myemba DT, Mosha IH, Kilonzi M, et al. Barriers and Enablers to Retention in HIV Care and Adherence to Antiretroviral Therapy: Evidence from Dar es Salaam, Tanzania. HIV/AIDS-Research and Palliative Care. 2024:301-11.
64. Olu O, Muneene D, Bataringaya JE, Nahimana M-R, Ba H, Turgeon Y, et al. How can digital health technologies contribute to sustainable attainment of universal health coverage in Africa? A perspective. Frontiers in public health. 2019;7:341.
65. Kemp CG, Velloza J. Implementation of eHealth interventions across the HIV care cascade: a review of recent research. Current HIV/AIDS Reports. 2018;15:403-13.
66. Mugavero MJ. Elements of the HIV care continuum: improving engagement and retention in care. Topics in antiviral medicine. 2016;24(3):115.
67. Idindili B. Challenges of continuum of HIV/AIDS care and treatment in Tanzania: the effects of parasites co-infections, HIV clinical manifestations, and adherence to antiretroviral therapy: University_of_Basel; 2012.
68. Bendera A, Baryomuntebe DM, Kevin NU, Nanyingi M, Kinengyere PB, Mujeeb S, et al. Determinants of Late HIV Diagnosis and Advanced HIV Disease Among People Living with HIV in Tanzania. HIV/AIDS-Research and Palliative Care. 2024:313-23.
69. Mpondo BC, Gunda DW, Kilonzo SB. HIV epidemic in Tanzania: the possible role of the key populations. AIDS research and treatment. 2017;2017(1):7089150.
70. Kamori D, Barabona G, Maokola W, Rugemalila J, Mahiti M, Mizinduko M, et al. HIV viral suppression in the era of dolutegravir use: Findings from a national survey in Tanzania. Plos one. 2024;19(8):e0307003.
71. Ismail N, Matillya N, Ratansi R, Mbekenga C. Barriers to timely disclosure of HIV serostatus: A qualitative study at care and treatment centers in Dar es Salaam, Tanzania. Plos one. 2021;16(8):e0256537.

72. Kisinza W, Makundi E, Mwisongo A, Mubyazi G, Magesa S, Malebo H, et al. Stigma and discrimination on HIV/AIDS in Tanzania. Tanzania Journal of Health Research. 2002;4(2):42-6.
73. Walker D, Johnson K, Moore J. Stigma related to fear and shame restricts access to HIV testing and treatment in Tanzania. Journal of Family Medicine and Disease Prevention. 2019;5(1):99.
74. Swilla J, Mweya C. Barriers to HIV prevention among adolescents in Njombe, Tanzania: Knowledge gaps and accessibility of sexual and reproductive health services. Tanzania Journal of Health Research. 2024;25(4):1413-24.
75. Abebe M, Asgedom YS, Gebrekidan AY, Wondimagegne YA, Hareru HE, Tebeje TM. Factors associated with HIV testing among young women in Tanzania: Insights from the 2022 Tanzanian Demographic and Health Survey using Anderson's Behavioral Model. Frontiers in Public Health. 2025;12:1518314.
76. Lepere P, Babington-Ashaye A, Martínez-Pérez GZ, Ekouevi DK, Labrique AB, Calmy A. How mHealth Can Contribute to Improving the Continuum of Care: A Scoping Review Approach to the Case of Human Immunodeficiency Virus in Sub-Saharan Africa. Public Health Reviews. 2022;43:1604557.
77. Thalia OP. The Impact of Digital Health Interventions on Antiretroviral Therapy Adherence among Adolescents Living with HIV in Sub-Saharan Africa.
78. Jongbloed K, Parmar S, van der Kop M, Spittal PM, Lester RT. Recent evidence for emerging digital technologies to support global HIV engagement in care. Current HIV/AIDS Reports. 2015;12:451-61.
79. Kamulegeya LH, Kagolo I, Kabakaari B, Atuhaire J, Nasamula R, Bwanika J. Technology-Assisted Interventions in the Delivery of HIV Prevention, Care, and Treatment Services in Sub-Saharan Africa: Scoping Review. Journal of Medical Internet Research. 2025;27:e68352.
80. van der Kop ML, Muhula S, Nagide PI, Thabane L, Gelmon L, Awiti PO, et al. Effect of an interactive text-messaging service on patient retention during the first year of HIV care in Kenya (WelTel Retain): an open-label, randomised parallel-group study. The Lancet Public Health. 2018;3(3):e143-e52.
81. Steward WT, Agnew E, de Kadt J, Ratlhagana MJ, Sumitani J, Gilmore HJ, et al. Impact of SMS and peer navigation on retention in HIV care among adults in South Africa: results of a three-arm cluster randomized controlled trial. Journal of the International AIDS Society. 2021;24(8):e25774.
82. Nakanjako D, Mayanja EK, Rwashana AS, Semitala F, Katureebe C, Ssali M, et al. Mobile Phone-based Intervention to promote un-interrupted HIV treatment during the COVID-19 pandemic. African Health Sciences. 2022;22(2):85-92.
83. Logie CH, Okumu M, Berry I, Hakiza R, Baral SD, Musoke DK, et al. Findings from the Tushirikiane mobile health (mHealth) HIV self-testing pragmatic trial with refugee adolescents and youth living in informal settlements in Kampala, Uganda. Journal of the International AIDS Society. 2023;26(10):e26185.
84. West RL, Freeman L, Pahe C, Momanyi H, Kidiga C, Malaba S, et al. Characterising the HIV self-testing market in Kenya: awareness and usage, barriers and motivators to uptake, and propensity to pay. PLOS Global Public Health. 2023;3(4):e0001776.
85. Nasuuna E, Namimbi F, Muwanguzi PA, Kabatesi D, Apolot M, Muganzi A, et al. Early observations from the HIV self-testing program among key populations and sexual partners of pregnant mothers in Kampala, Uganda: A cross sectional study. PLOS Global Public Health. 2022;2(1):e0000120.

86. Wachinger J, Kibuuka Musoke D, Oldenburg CE, Bärnighausen T, Ortblad KF, McMahon SA. "But i gathered my courage": HIV self-testing as a pathway of empowerment among Ugandan female sex workers. Qualitative health research. 2021;31(3):443-57.
87. Muendo NK, Thigiti J, Tembu O, Mohamed A, Audi S, Karanja M. Exploring HIV Self-Testing: Barriers and Facilitators Among Undergraduate Students in Nairobi, Kenya. The Annals of Family Medicine. 2024;22(6):502-8.
88. Fraser HS, Mugisha M, Bacher I, Ngenzi JL, Seebregts C, Umubyeyi A, et al. Factors Influencing Data Quality in Electronic Health Record Systems in 50 Health Facilities in Rwanda and the role of clinical Alerts: cross-sectional observational study. JMIR Public Health and Surveillance. 2024;10(1):e49127.
89. Castelnuovo B, Kiragga A, Afayo V, Ncube M, Orama R, Magero S, et al. Implementation of provider-based electronic medical records and improvement of the quality of data in a large HIV program in Sub-Saharan Africa. PloS one. 2012;7(12):e51631.
90. Alamo ST, Wagner GJ, Sunday P, Wanyenze RK, Ouma J, Kamya M, et al. Electronic medical records and same day patient tracing improves clinic efficiency and adherence to appointments in a community based HIV/AIDS care program, in Uganda. AIDS and Behavior. 2012;16:368-74.
91. Manders E-J, José E, Solis M, Burlison J, Nhampossa JL, Moon T. Implementing OpenMRS for patient monitoring in an HIV/AIDS care and treatment program in rural Mozambique. MEDINFO 2010: IOS Press; 2010. p. 411-5.
92. Odekunle FF, Srinivasan S, Odekunle RO. Why sub-Saharan Africa lags in electronic health record (EHR) adoption and possible strategies to increase EHR adoption in this region. Journal of Health Informatics in Africa. 2018;5(1):8-15.
93. Chigaro S, Ruredzo IM, Marembo T. Integration of telehealth systems into HIV care services in sub-Saharan Africa: a scoping review. 2023.
94. Cuadros DF, Huang Q, Mathenjwa T, Gareta D, Devi C, Musuka G. Unlocking the potential of telehealth in Africa for HIV: opportunities, challenges, and pathways to equitable healthcare delivery. Frontiers in Digital Health. 2024;6:1278223.
95. Agbeyangi AO, Lukose JM, editors. Telemedicine Adoption and Prospects in Sub-Sahara Africa: A Systematic Review with a Focus on South Africa, Kenya, and Nigeria. Healthcare; 2025: MDPI.
96. Ivanova O, Wambua S, Mwaisaka J, Bossier T, Thiongo M, Michielsen K, et al. Evaluation of the ELIMIKA pilot project: improving ART adherence among HIV positive youth using an eHealth intervention in Mombasa, Kenya. African journal of reproductive health. 2019;23(1):100-10.
97. Haberer J, Baijuka R, Tumuhairwe J, Tindimwebwa E, Tinkamanyire J, Tuhanamagyezi E, et al. Implementation of electronic adherence monitors and associated interventions for routine HIV antiretroviral therapy in Uganda: promising findings. Front Digit Health. 2022; 4: 899643.
98. Haberer JE, Kahane J, Kigozi I, Emenyonu N, Hunt P, Martin J, et al. Real-time adherence monitoring for HIV antiretroviral therapy. AIDS and Behavior. 2010;14:1340-6.
99. Haberer JE, Kiwanuka J, Nansera D, Muzoora C, Hunt PW, So J, et al. Realtime adherence monitoring of antiretroviral therapy among HIV-infected adults and children in rural Uganda. Aids. 2013;27(13):2166-8.
100. Holst C, Isabwe G, Sukums F, Ngowi H, Kajuna F, Radovanović D. Development of digital health messages for rural populations in Tanzania: multi-and interdisciplinary approach. JMIR Mhealth Uhealth. 2021; 9 (9): e25558.

101. Ostermann J, Njau B, Masaki M, Mtuy T, Itemba D, Hobbie A, et al. Feasibility, acceptability, and potential cost-effectiveness of a novel mobile phone intervention to promote human immunodeficiency virus testing within social networks in Tanzania. Sexually transmitted diseases. 2022;49(11):778-81.
102. HIVgov. HIV Care Continuum 2025 [Available from: https://www.hiv.gov/federal-response/other-topics/hiv-aids-care-continuum.
103. Holst C, Isabwe GMN, Sukums F, Ngowi H, Kajuna F, Radovanović D, et al. Development of digital health messages for rural populations in Tanzania: multi-and interdisciplinary approach. JMIR mHealth and uHealth. 2021;9(9):e25558.
104. Theonest NO, Ngowi K, Kussaga ER, Lyimo A, Kuchaka D, Kiwelu I, et al. Status and future prospects for mobile phone-enabled diagnostics in Tanzania. PLOS Digital Health. 2024;3(8):e0000565.
105. Hyuha GM, Sawe HR, Kilindimo S, Mussa RY, Gulamhussein MA, Rwegoshora SS, et al. Feasibility and efficacy of text messaging to promote care among trauma patients screened for HIV at an urban emergency department in Tanzania. International Journal of Emergency Medicine. 2021;14(1):72.
106. Tanzania T. My Wangu Chatbot 2025 [Available from: https://techforward.or.tz/project/mywangu/.
107. ICAP. ICAP in Tanzania Provides Key and Vulnerable Populations with HIV Self-Testing Kits and Condoms Via Digital Vending Machines 2024 [Available from: https://icap.columbia.edu/news-events/icap-in-tanzania-provides-key-and-vulnerable-populations-with-hiv-self-testing-kits-and-condoms-via-easily-accessible-digital-vending-machines/.
108. depo A. Enhencing health care Accessibility 2025 [Available from: https://afyadepot.co.tz/?v=73bb4387b307.
109. Chikusi H. Machine learning model for prediction and visualization of HIV index testing in Northern Tanzania: NM-AIST; 2022.
110. Mahler H, Searle S, Plotkin M, Kulindwa Y, Greenberg S, Mlanga E, et al. Covering the last kilometer: using GIS to scale-up voluntary medical male circumcision services in Iringa and Njombe Regions, Tanzania. Global Health: Science and Practice. 2015;3(3):503-15.
111. USAID. Using Geospatial Analysis to Improve Resource Allocation for HIV Programs in Iringa Region, Tanzania. 2014.
112. Boniface S, Lwilla A, Mahiga H, Pamba D, Geisenberger O, France J, et al. Xpert HIV-1 qual point-of-care testing for HIV early infant diagnosis in Tanzania: experiences and perceptions of health care workers in a 2016 study. AIDS Research and Therapy. 2024;21(1):33.
113. Bull S, Thomas DS, Nyanza EC, Ngallaba SE. Tanzania Health Information Technology (T-HIT) System: Pilot test of a tablet-based system to improve prevention of mother-to-child transmission of HIV. JMIR mHealth and uHealth. 2018;6(1):e16.
114. Mhando F, Mushy SE, Nyankomo M, Haraka F, Maokola W, Masunga Z, et al. 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. BMC health services research. 2024;24(1):1084.
115. Kway A, Sabi I, Olomi W, Mcharo RD, Sanga E, William W, et al. HIV testing and linkage to care—A case of a mobile diagnostic and counseling service in Mbeya, Tanzania; a quantitative study. PLOS Global Public Health. 2022;2(8):e0000448.

116. Mhando F, Olughu K, Nyankomo M, Ngocho JS, Teri I, Mbita G, et al. Men's Willingness to Receive Text Messages and Talk with an HIV counselor from the National HIV Hotline in Tanzania for Support with Linkage to Care Following HIV self-testing. medRxiv. 2024.
117. Vu L, Tun W, Apicella L, Casalini C, Makyao N, Tsang S, et al. Community-based antiretroviral therapy (ART) delivery for female sex workers in Tanzania: intervention model and baseline findings. AIDS care. 2020;32(6):729-34.
118. Dillip A, Sarkar N, Grietens K, Liana J, Kimatta S, Hofmann R, et al. Towards A Digitally-Enabled, Community-Based Responsive Health System in Tanzania: A Formative Study for the Afya-Tek Digitised Health Initiative. AIJR Abstracts. 2021:22.
119. MSH. Developing an electronic medical record system in Tanzania 2024 [Available from: https://msh.org/resources/developing-an-electronic-medical-record-system-in-tanzania/.
120. MSH. Strengthening HIV Data and Use in Tanzania via a National Health Information Dashboard 2025 [Available from: https://msh.org/resources/strengthening-hiv-data-and-use-in-tanzania-via-a-national-health-information-dashboard/?utm_source=chatgpt.com.
121. Simba D, Sukums F, Kumalija C, Asiimwe SE, Pothepragada SK, Githendu PW. Perceived usefulness, competency, and associated factors in using district health information system data among district health managers in Tanzania: cross-sectional study. JMIR Formative Research. 2022;6(5):e29469.
122. Swai IU, Ten Bergen LL, Mtenga A, Maro R, Ngowi K, Mtesha B, et al. Developing contents for a digital adherence tool: a formative mixed-methods study among children and adolescents living with HIV in Tanzania. PLOS Digital Health. 2023;2(10):e0000232.
123. Sumari-de Boer IM, Ngowi KM, Swai IU, Masika LV, Maro RA, Mtenga AE, et al. Effect of a customized digital adherence tool on retention in care and adherence to antiretroviral treatment in breastfeeding women, children and adolescents living with HIV in Tanzania: a mixed-methods study followed by clinical trials. Trials. 2023;24(1):285.
124. Sumari-de Boer IM, Ngowi KM, Sonda TB, Pima FM, Masika LV, Sprangers MA, et al. Effect of digital adherence tools on adherence to antiretroviral treatment among adults living with HIV in Kilimanjaro, Tanzania: a randomized controlled trial. JAIDS Journal of Acquired Immune Deficiency Syndromes. 2021;87(5):1136-44.
125. Ngowi K, Pima F, Mmbaga BT, Aarnoutse RE, Reiss P, Nieuwkerk PT, et al. "I wish to continue receiving the reminder short messaging service": a mixed methods study on the acceptability of digital adherence tools among adults living with HIV on antiretroviral treatment in Tanzania. Patient preference and adherence. 2021:559-68.
126. Msosa TC, Swai I, Aarnoutse R, de Wit TFR, Ngowi K, Msefula C, et al. The effect of real-time medication monitoring-based digital adherence tools on adherence to antiretroviral therapy and viral suppression in people living with HIV: a systematic literature review and meta-analysis. JAIDS Journal of Acquired Immune Deficiency Syndromes. 2024;96(5):411-20.
127. Phillips AN, Cambiano V, Nakagawa F, Bansi-Matharu L, Sow PS, Ehrenkranz P, et al. Cost effectiveness of potential ART adherence monitoring interventions in Sub-Saharan Africa. PLoS One. 2016;11(12):e0167654.
128. Doctorpedia. Mobile Health vs. AIDS in Tanzania 2023 [Available from: https://patient.doctorpedia.com/channels/mobile-health-vs-tuberculosis-and-aids-in-tanzania/.
129. Mauka W, Mbotwa C, Moen K, Lichtwarck HO, Haaland I, Kazaura M, et al. Development of a mobile health application for HIV prevention among at-risk populations in urban settings in East Africa: a participatory design approach. JMIR Formative Research. 2021;5(10):e23204.

130. Mbotwa CH, Kazaura MR, Moen K, Lichtwarck HO, Leshabari MT, Metta E, et al. Effect of an mHealth intervention on retention in HIV pre-exposure prophylaxis services among female sex workers: Preliminary evidence of the use of the Jichunge app in Dar es Salaam, Tanzania. Digital Health. 2023;9:20552076231170507.
131. Mwanja EL, Mshenga MM, Alexander AP, Makuchilo MS, Kagya KM, Otladisa KS. Understanding the impact of the COVID-19 pandemic on HIV/AIDS care and management in Tanzania: challenges, adaptations and lessons learnt—a review. BMJ public health. 2024;2(2).
132. Duke. Telehealth to Reduce Suicidality and lmprove HIV Care Engagement in Tanzania 2021 [Available from: https://globalhealth.duke.edu/projects/telehealth-reduce-suicidality-and-lmprove-hiv-care-engagement-tanzania.
133. Fahey CA, Njau PF, Katabaro E, Mfaume RS, Ulenga N, Mwenda N, et al. Financial incentives to promote retention in care and viral suppression in adults with HIV initiating antiretroviral therapy in Tanzania: a three-arm randomised controlled trial. The Lancet HIV. 2020;7(11):e762-e71.
134. Packel L, Fahey C, Kalinjila A, Mnyippembe A, Njau P, McCoy SI. Preparing a financial incentive program to improve retention in HIV care and viral suppression for scale: using an implementation science framework to evaluate an mHealth system in Tanzania. Implementation science communications. 2021;2(1):109.
135. Mwatawala S, Sando D, Malele RS, Moshiro C, Senyael BR, Somi G, et al. Strengthening the appointment and tracking systems for patients on antiretroviral therapy in Tanzania: A optimizing adherence to ART as part of people-centered public health. International Journal of Person Centered Medicine. 2012;2(4):825-36.
136. Torokaa PR, Urio LJ, Mwakalobo A, Magesa AS, Allan JN, Osima DJ, et al. Evaluation of the Human Immunodeficiency Virus viral load surveillance system, national perspective in Tanzania: A descriptive cross-sectional study. Journal of Interventional Epidemiology and Public Health. 2025;8(3).
137. Mnzava D, Okuma J, Ndege R, Kimera N, Ntamatungiro A, Nyuri A, et al. Decentralization of viral load testing to improve HIV care and treatment cascade in rural Tanzania: observational study from the Kilombero and Ulanga Antiretroviral Cohort. BMC Infectious Diseases. 2023;23(1):222.
138. Moirana EL, Muro EP, Kiwelu IE, Kimaro J, Manongi R, Theilgaard Z, et al. Evaluation of HIV viral load turnaround time in Moshi, Tanzania. The Journal of Infection in Developing Countries. 2022;16(09):1500-5.
139. Geopoll. Mobile Penetration and Internet Usage in Tanzania 2014 [Available from: https://www.geopoll.com/blog/mobile-penetration-and-internet-usage-in-tanzania/.

ANNEXES

ANNEXURE 1: TABLES

Table 5: Terms used for literature search.

ISSUE TERM (OR)		FACTORS RELATED TERMS (OR)		GEOGRAPHICAL SCOPE TERMS
• Digital Health • eHealth • Telemedicine • Telehealth • mHealth • Digital technologies	AND	• HIV • AIDS • "HIV Continuum care" • "HIV Diagnosis" •	AND	• Tanzania • Zanzibar • Low-middle-income countries • Sub-Saharan Africa

Table 4: Summary of Digital Health Intervention:

NO.	Name of Intervention	Description	Study location/Users Target	HIV Continuum Addressed	Reported Outcomes	Challenges or Enablers
01.	mHealth & financial incentive system	mHealth and Financial incentive program to improve retention in HIV care and viral suppression for scale	Urban Tanzania	Retention, Viral Suppression	Improved retention & Virological Suppression	Acceptability of financial incentives

02.	mHealth reminders	Technology-driven incentives for HIV care and retention	Adults with HIV (Urban Tanzania)	retention	High retention	Integration into routine care
03.	Digital Appointment tracking system	Strengthening ART adherence through digital tracking systems	Urban Tanzania (Health Care workers)	Adherence	Better follow-up rates	Operational integration
04.	Decentralized viral load testing via digital platforms	Strengthening HIV care with decentralized, digital viral load testing systems	Kilombero & Ulanga (rural)	Viral Monitoring	Improved coverage	Infrastructure limitations
05.	Viral Load TAT evaluation system	Enhancing laboratory performance through viral load TAT evaluation tools	Moshi (urban)	Viral Monitoring	Reduced lab results turnaround time	Infrastructure limitations
06.	SMS + Peer navigation	Combining SMS reminders and peer navigation to strengthen HIV care	Urban area	Retention	Improved retention	Requires community support

07.	mHealth self-testing	Mobile health technology to promote HIV self-testing and follow-up	Adolescents, Urban areas	Diagnosis	Increased Testing uptake Feasible & empowering	Literacy dependency
08.	HIVST + Digital support	Digital platforms supporting HIV self-testing for improved diagnosis	Urban FSWs	Diagnosis	Empowerment in testing	Cultural stigma
09.	EMR systems for viral monitoring	Digital integration of viral load results within EMR platforms	Urban Tanzania	Viral monitoring/Suppression	Enhanced Strong performance	Infrastructure Limitation
10.	Counseling and ICT follow-up platforms	ICT-enabled counseling follow-up to improve HIV treatment adherence	Rural Tanzania	Adherence, Retention	Improved Retention and ART adherence	Digital Literacy Limited infrastructures
11.	Social media Platforms	Enhancing HIV testing uptake through social media platforms	Urban Tanzania	Diagnosis	Improved HIV Testing Uptake	Digital Literacy Limited infrastructures
12.	SMS HIV Campaigns	Development of digital health messages for rural	Rural, Tanzania	Diagnosis	Improved HIV Testing	Lack of Contextualization

		populations in Tanzania: multi-and interdisciplinary approach. JMIR mHealth and uHealth			Uptake	
13.	M-health systems	Status and future prospects for mobile phone-enabled diagnostics in Tanzania.	Urban and Rural	Diagnosis, Linkage to care, ART and Monitoring	Improved HIV Testing Uptake, linkage and ART Adherence	Digital Literacy Limited infrastructures Lack of Contextualization
14.	M-health systems	Feasibility and efficacy of text messaging to promote care among trauma patients screened for HIV at an urban emergency department in Tanzania.	Urban	Diagnosis, Linkage to care, ART and Monitoring		Lack of Contextualization
15.	M-health systems (My Wangu Chatbot)	My Wangu Chatbot	Urban	Diagnosis and Linkage to care	Improved engagement	Digital Literacy
16.	GIS	Using GIS to scale-up voluntary medical male circumcision services in Iringa and	Urban/Semi rural	Diagnosis		Digital Literacy Limited infrastructures

		Njombe Regions				
17.	Jichunge Mobile App	Mobile app supporting ART adherence and patient self-management	FSW, Dar es Salaam	Adherence & Retention	Better engagement	Cost of smartphones Infrastructures Limitations
18.	AfyaDepo web Platform	Web-based AfyaDepo system for HIV self-testing orders and virtual counseling	Urban Tanzania	Diagnosis	Reduced stigma	Rural inaccessibility
19.	ICAP Vending Machines	Digital HIV self-test kits dispensed via ICAP vending machines	Mwanza & Geita urban MSM, FSWs	Diagnosis Diagnosis & Linkage	Increased Testing Uptake High reach	Privacy concerns
20.	Duke Telehealth Pilot Project	Improving rural HIV care in Tanzania via teleconsultation technology	Rural Tanzania	Retention	High reach	Tech barrier in remote sites
21.	Wisepill Device Project	Improving HIV treatment outcomes with Wisepill adherence monitoring technology	Kilimanjaro Youth,	Adherence	Improved adherence	Cost & device maintenance

22.	Developing an electronic medical record system in Tanzani	Enhancing healthcare delivery in Tanzania through EMR system	Health care workers	Retention	Unified patient records	Training and electricity
23.	Xpert HIV-1 qual point-of-care testing for HIV early infant diagnosis	Xpert HIV-1 qual point-of-care testing for HIV early infant diagnosis in Tanzania: experiences and perceptions of health care workers		Diagnosis		Digital Literacy Limited infrastructures
24.	Information Technology (T-HIT) System: Pilot test of a tablet-based system to improve HIV care	Tanzania Health Information Technology (T-HIT) System: Pilot test of a tablet-based system to improve prevention of mother-to-child transmission of HIV	Urban Tanzania	Diagnosis, Viral Monitoring		Digital Literacy Limited infrastructures
25.	digital health intervention to improve linkage to care after Index HIV self-	Clients' and providers' perspectives in informing a digital health intervention to improve linkage to care after Index HIV	Urban and Semi-Rural	Linkage	Improved Linkage	Stigma Digital Literacy Limited infrastructures

	testing	self-testing in Hai and Moshi Districts				
26.	Mobile HIV Testing	HIV testing and linkage to care,A case of a mobile diagnostic and counseling service in Mbeya, Tanzania		Diagnosis		Digital Literacy Stigma Limited infrastructures
27.	Mobile health	Men's Willingness to Receive Text Messages and Talk with an HIV counselor from the National HIV Hotline in Tanzania for Support with Linkage to Care Following HIV self-testing		Linkage	Improved Linkage	Stigma
28.		Community-based antiretroviral therapy (ART) delivery for female sex workers in Tanzania: intervention model and baseline findings				

29.	Mobile health Apps	Towards A Digitally-Enabled, Community-Based Responsive Health System in Tanzania: A Formative Study for the Afya-Tek Digitised Health Initiative				
30.	EMR systems	Strengthening HIV Data and Use in Tanzania via a National Health Information Dashboard 2025		Retention	Improved Monitoring	Digital Literacy Limited infrastructures
31.	Using GIS to scale-up	Perceived usefulness, competency, and associated factors in using district health information system data among district health managers in Tanzania:				Digital Literacy Limited infrastructures Stigma
32.	Mobile health systems	Effect of a customized digital adherence tool on retention in				Digital Literacy Limited infrastructur

		care and adherence to antiretroviral treatment in breastfeeding women, children and adolescents living with HIV in Tanzania:				es

ANNEX X

KIT Institute (Masters or Short course) Participants
Declaration for Use of Generative AI (GenAI)

Please complete and submit this form as an annex on the last page of your assignment file; and not as a separate document.

Check the box that applies to your completion of this assignment:

☐ I confirm that **I have not used** any generative AI tools to complete this assignment.

☒ I confirm that **I have used** generative AI tool(s) in accordance with the **"Guidelines for the use of Generative AI for KIT Institute Master's and Short course participants".** Below, I have listed the GenAI tools used and for what specific purpose:

Generative AI tool used	Purpose of use
1.www.Perplexity.ai	used for expanding search ideas and brainstorming
2.Chatgpt	used to aid in summarizing information
...	