ADDIS ABABA UNIVERSITY

DIGITAL HEALTH INTERVENTIONS FOR CLINICAL CARE AND TREATMENT OF TUBERCULOSIS AND HIV: CAPACITY AND READINESS ASSESSMENT OF HEALTHCARE FACILITIES IN ADDIS ABABA, ETHIOPIA

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This is to certify that the thesis prepared by Emnet Getachew, titled “Digital health interventions for clinical care and treatment of tuberculosis and HIV: Capacity and readiness assessment of healthcare facilities in Addis Ababa, Ethiopia” and submitted to the Center for Innovative Drug Development and Therapeutic Trials for Africa (CDT-Africa), College of Health Sciences, Addis Ababa University; in partial fulfillment for the requirement of master of science degree in clinical trials, compiles with the regulations of the University and meets the accepted standards originality and quality.

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DECLARATION

I, the undersigned, declare that this thesis (research work) entitled "Digital health interventions for clinical care and treatment of tuberculosis and HIV: Capacity and readiness assessment of healthcare facilities in Addis Ababa, Ethiopia" is my original work, has not been presented for a degree in any other University and that all sources of materials used for the thesis have been acknowledged.

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ABBREVIATIONS AND ACRONYMS

AIDS- Acquired Immunodeficiency Syndrome

ART- Anti Retroviral Therapy

DHA- Digital Health Activities

DHIs- Digital Health Interventions

DHILC-Digital Health Innovation and Learning Center

DOT- Directly Observed Therapy

HCPs- Healthcare Providers

HEWs- Health Extension Workers

HIV- Human Immuno-deficiency Virus

HSTP- Health Sectors Transformation Plan

IDT- Integrated Device Technology

LISs- Laboratory Information Systems

LMICs- Low and Middle-Income Countries

MDR- Multi-Drug Resistant TB

MERM- Medication Event Reminder Monitoring

RDT- Rapid Diagnostic Test

SCT- Social Cognitive Theory

SDGs- Sustainable Development Goals

SMS- Short Message Service

SUS- System Usability Scale

SSA- Sub-Saharan Africa

TB- Tuberculosis

TPB- Theory of Planned Behavior

TRA- Theory of Reasoned Action

UTAUT- Unified Theory of Acceptance and Use of Technology

WHO- World Health Organization

ABSTRACT

Background: Digital Health Interventions (DHIs) such as electronic health (eHealth) and mobile health (mHealth) are emerging as promising technologies to advance clinical care and treatment. However, many of these breakthroughs have not reached the people most in need to tackle the rising burden of diseases such as Tuberculosis (TB) and Human Immunodeficiency Virus (HIV). People living in low-income countries are at high risk of many health conditions than those living in other regions while having the least access to such technologies. There is a high level of concern that low-income countries lack the infrastructure and human resource capacity needed to effectively adopt, implement, and scale up DHIs. Being one of the top 30 high TB and HIV burden countries globally, Ethiopia exerts efforts to meet the global targets to End TB by 2035 and End HIV/AIDS by 2030. DHIs could transform TB and HIV clinical care and treatment services in Ethiopia. However, the country needs an in-depth assessment of the healthcare system's capacity and readiness to absorb and implement DHIs.

Objective: This study aimed to assess the capacity and readiness of healthcare facilities to adopt and implement DHIs for TB and HIV care and treatment.

Method: This study was a multi-center, facility-based, mixed-method, cross-sectional study. The study included 14 government healthcare facilities: 10 health centers and four hospitals with high TB/HIV clients load in Addis Ababa, Ethiopia. The participants were healthcare providers who provide TB and HIV clinical care and treatment services in the study facilities. With a purposive sampling method, two healthcare providers have participated from each included site. Using a questionnaire framed by the Technology Readiness and Acceptance Model, data were collected from the participants that assessed their experience using digital health technologies and the potential readiness of their healthcare facilities to implement DHIs. Using a tool framed by the unified theory of acceptance and use of technology (UTAUT) model, data were collected from participants who hold a solid prior experience of using DHIs to understand further the level of acceptability of such digital health technologies. A multiple linear regression model to determine the relationship between dependent and independent variables. Cronbach's alpha test was performed to evaluate the internal consistency and reliability. Using an adapted checklist, the healthcare facilities were assessed to investigate their infrastructure and human resource capacity to adopt and implement DHIs.

Result: There were 76 healthcare providers actively engaged in HIV/TB clinical care services in the selected 14 study sites, of whom 60 met the inclusion criteria and participated in this study. sixty-two percent of the participants were working in HIV clinics, 37% of them had more than 10 years of working experience, 65% of them held a minimum of BSc degree, 60% were female, and 42% were aged between 31-40 years.

According to the responses, 80% of the healthcare providers had the experience of using DHIs to facilitate their healthcare delivery. Most of them had internet access and computers in their facilities. Seventy-five percent of the participants found the technologies advantageous than the traditional system and the majority preferred to use the DHIs in their healthcare facility. The major factors that influence healthcare providers' willingness to use different technologies were educational level (β= .097, t= 3.784, p= .006), age (β= -.227, t= -1.757, p= .027), work experience (β= -.366, t= -2.855, p= .016).

Respondents who had experience using digital adherence technology for TB felt that remote monitoring of medication adherence benefits both patients and providers. Similarly, respondents who had experience using smart care technology for HIV felt that the technology helps to retrieve patients' data easily and simplify their work. The strongest facilitator of their acceptance and the use of the digital adherence technology were perceptions of positive performance expectancy (i.e., perceived usefulness).

According to *Cronbach's alpha test,* all factors were greater than 0.7, and such values suggest a high level of internal consistency and reliability of related items. The majority of respondents reported the absence of regulatory policy and guidelines as the major gap to adopt and use DHTs in their facilities. The correlation between technological readiness and organizational cultural readiness was considered to being significant ($r = 0.8$).

Thirty-one percent of the healthcare facilities had prior needs assessments made to make their sites ready for new DHIs. The data showed that 57.1% of facilities had skilled staff on payroll for maintaining computers and other dysfunctions related to technologies. The average number of computers in each facility was about 20. most of the healthcare providers used Wi-Fi while 42.9% of them used both Wi-Fi and broadband internet. Of the 14 facilities, 35.7% had the plan to establish a functional Local Area Network for interconnectivity to give better services.

Conclusion: The present data confirm that many public healthcare facilities in Addis Ababa have already begun implementing various DHIs/e-Health systems for TB/HIV services and the level of acceptability of these technologies by healthcare providers was noticeably good. Thus, there is an excellent opportunity for DHIs to be integrated into the healthcare system in tertiary health facilities in Ethiopia with appropriate training and education. However, most of the available digital health technologies in the facilities were utilized without reliable DHIs/eHealth regulatory policy in place. Thus, there is a critical need for DHIs/e-Health regulatory policies and some improvement is needed in DHIs/e-Health strategic planning (core readiness). There should be a prior need assessment and proper training given to healthcare providers to properly adopt and implement new DHIs in healthcare facilities.

Keywords: Digital Health, eHealth, technology, Tuberculosis (TB), Human Immunodeficiency Virus (HIV), Healthcare Providers.

1. INTRODUCTION

1.1. Background

1.1.1. Burden of TB

As the World Health Organization, WHO (2019) reports, an estimated 10 million new cases, and 1.5 million tuberculosis-related deaths occurred in 2018. Geographically, most TB cases in 2018 in the WHO regions were notified that 44% in South East Asia, 24% in Africa, and 18% in Western Pacific (1-3).

As compared with other WHO regions, Sub-Saharan Africa (SSA) carried an enormous burden of TB. Out of 30 high TB burden countries, 16 of them were found in SSA. In this region, the government-funded 52% for universal health coverage and social protection for TB and 54% for the TB program from the required budget (2, 3). Ethiopia is the third in Africa among 22 high-burden countries for TB, TB/HIV, and Multi-Drug-Resistant Tuberculosis (MDR-TB) in 2018 (1, 4, 5). In connection with this, an estimated 165,000 cases of TB incidents had been recently reported in Ethiopia (5).

1.1.2. The burden of HIV/AIDS

Despite significant advancements in antiretroviral therapy (ART), HIV/AIDS remains a public health problem globally (6, 7). Currently, 36 million people living with HIV, 2 million new cases, and more than 39 million deaths are recorded (6). The aspiration 95-95-95 goal set of UNAIDS aims to globally diagnose 95% of people living with HIV, provide treatment to 95% of diagnosed people, and achieve viral suppression in 95% of people on treatment by 2030 (6).

In Eastern and Southern Africa, 20.7 million people were living with HIV/AIDS. In 2019, 730,000 new cases and 300,000 deaths were reported in Africa (8). UNAIDS 2018 report shows, 690,000 people were living with HIV 23,000 new cases and 11,000 people died in Ethiopia. High clusters of HIV cases were consistently observed in Addis Ababa and neighboring areas of Afar, Tigray, Amhara regional states, and central Oromia (9).

1.1.3. The burden of TB/HIV Co-Infection

Tuberculosis and HIV/AIDS are the major public health problems in many parts of the world particularly in resource-limited countries like Ethiopia. According to WHO 2019 report, globally around 9% of TB patients were living with HIV. The highest proportion of TB/HIV co-infection is seen in Africa (31% on average), with some regions having co-infection rates higher than 50% (1, 10). It was estimated that 44% of people living with HIV and TB were unaware of their HIV co-infection and therefore not receiving the necessary care (1, 7). Although some studies have been conducted on the prevalence and associated factors of TB /HIV co-infection in Ethiopia, there was no comprehensive data on the magnitude and risk factors at a national and regional level (11).

1.1.4. Digital Health Interventions (DHIs)

Digital health interventions (DHIs) can be defined as the use of digital, mobile, and wireless technologies to support the health systems and to achieve health objectives. Digital health describes the general use of information and communication technologies (ICT) for health and comprises both mobile health (mHealth) and electronic health(eHealth) (12, 13). World Health Organization recommended that countries should consistently strive for the implementation of DHIs for TB and HIV programs. DHIs, improve patient care to support adherence, efficient handling of medical records, surveillance, monitoring to improve notification, follow-up, drug-safety monitoring, program management, laboratory management, drug procurement, and eLearning to enhance patient education and professional development (14).

A digital health intervention has been applied within various countries and contexts and found to be strengthening health systems even though its implementation is not uniform throughout those countries (15). The excusion of digital health interventions is made possible by several factors. These factors include the availability of trained and qualified staff, good perception of Healthcare Providers (HCPs) and their willingness to use the system, adequate infrastructure, conducive health systems as well as health policies in the country (15).

Ethiopia's health system has been one of the poor technologically supported sectors for decades. Even though the country covers 9% of the African population, it accounts for only 1% of African internet access (16). Ethiopian Ministry of Health (MOH) and its partners issued the mHealth framework in 2011GC. The country also adopted eHealth strategies to improve the healthcare delivery system and their application which have brought promising outcomes (16).

According to the digital 2020 report, the number of internet users in Ethiopia was 21.14 million in January 2020. This number increased by 534 thousand (+2.6%) between 2019 and 2020. Internet access in Ethiopia stood at 19% in January 2020. Mobile connections in the country were 46.75 million in January 2020 which was equivalent to 41% of the total population. It increased by 7.2 million (+18%) between January 2019 and January 2020. Nevertheless, the current internet use by healthcare providers was not yet supported by enough evidence. Therefore, this situation required conducting an assessment on the current trained of the technology utilization by healthcare providers.

Recently, MOH launched the Digital Health Innovation and Learning Center (DHILC), the first of its kind in Addis Ababa in August 2020(17). The DHILC is supposed to be a place where health professionals can design and validate digital health tools, synthesize and promote best practices, and scale up innovations(17).

1.2. Statement of the problem

WHO, UNAIDS, and their partners have a strategy to end TB by 2035 and HIV by 2030. The vision of the strategies is to make the world free of TB with no deaths and suffering due to TB disease and reduce the burden of HIV. A radical reduction in TB/HIV, incidence and mortality will be highly required in achieving such goals. The development and success of DHI applications in TB/HIV clinics for treatment initiation as well as patient follow-up can support improving healthcare management in the sector (7, 12, 18).

Therefore, every country needs to support its health systems through the provision of different technologies. Implementation of those technologies would facilitate the detection of new cases with highly automated and rapid diagnostic tools, proper and consistent follow-up of patients, data surveillance and monitoring, electronically supported training, and others (7, 12, 18). Moreover, the integration of digital health intervention has great promise and potential to improve the usability of technologies, access to health education, and open new frontiers in renovating health systems deficiencies in Africa (19).

Ethiopia has been working on the Sustainable Development Goals (SDGs) and launched a five years' ambitious Health Sector Transformation Plan (HSTP) to address major diseases of public

health including TB and HIV(4). To achieve End TB Strategy, 95-95-95 goal, SDGs, and HSTP targeting at fighting against TB and HIV; the health providers and the health systems need to ensure appropriate implementation of digital health technologies. These technologies will most likely enable and facilitate access to TB/HIV therapy, enhanced treatment adherence, support effective communication among different healthcare providers in the health systems (20-22).

Ethiopia launched the first Digital Health Innovation and Learning Center (DHILC) in 2020 which will be the potential to be an integral part of the health system and strengthen the usability of technologies in the health sector (17). Currently, the use of digital health intervention among patients attending health care facilities in Ethiopia is increasing from time to time.

However, the magnitude of current technology utilization and acceptability of DHIs by healthcare providers and the possibilities of adopting new technologies and scaling up in the existing system among different facilities is not well assessed (23, 24). Besides, there is an existing gap of evidence on the capacity and readiness of different health facilities to adopt and implement new DHIs in Ethiopia.

Moreover, the strengths and weaknesses of an existing system to implement DHIs and its practicability, possibility, and adequacy of the necessary infrastructure were not yet sufficiently studied. There is also a gap in knowing the opportunities and threats in the present natural environment to implement different digital health technologies in health systems i.e. both in public health centers and the hospital context.

Therefore, this situation necessitates conducting different researches to discover the utilization, efficiency, and acceptability of digital health interventions among HCPs to ensure good treatment outcomes and halt transmission of TB and HIV. Moreover, researches are also needed to assess the institutional capacities and readiness of different health sectors to ensure effective adoption, implementation, and scaling-up digital health interventions in the country in general and in Addis Ababa health facilities in particular.

1.3. The rationale of the Study

Measuring the overall treatment success of TB/HIV care should be evaluated from different angles such as the ability to make good patient-patient or provider-patient communication, a timely diagnosis, proper treatment initiation, and follow-up of drug adherence. Proper implementation of DHIs would enable all the benefits mentioned-above for the health sectors to achieve the intended goals globally and nationally. In addition, DHIs also facilitate good communication between different healthcare workers. It is known that the number of health professionals is limited in Low- and Middle-Income Countries (LMIC) like Ethiopia. Therefore, introducing such technologies in the system benefits the patients and healthcare providers.

Thus, we have to assess the extent to which the end TB strategy and 95-95-95 goal of HIV succeeded from the side of HCPs by creating favorable and technologically aided working environments. These would likely ensure timely diagnosis, patient data management and surveillance, monitoring of treatment completion, and finally the desired treatment outcome. It is also thought that the success of innovative public health strategies ought to be assessed from the perspective of HCPs. This is since the objective and the purpose of technology should be clear enough to collaborate with all stockholders including HCPs. This would have a considerable value to establish potential innovative technologies to fight the global TB/HIV burden.

It is known that digital health technologies assist remote monitoring and faster delivery of medical care (25). This would become a game-changer to decrease health care professionals' workload and increase their job satisfaction. Even if, recently several innovative technologies were developed in the health system, rapid adoption and acceptance of them may not be fully guaranteed. The perception and acceptance to adopt those technologies are more likely dependent on the diverse settings like socio-cultural, economic setting, and the country's health care policy and system. The acceptability may also be affected by the presence or absence of other options and prior experience of using such technologies.

The main challenge to integrate and implement DHIs into the health system is the lack of information to make evidence-based decisions. A large-scale capacity and readiness research is needed to ensure its implementation and deployment in the country (26). Acceptability of technology by healthcare providers is one of the indicators of health facility readiness to adopt and implement DHIs. In addition to the above reasons, research is required to influence global financial

mechanisms and the local government to recognize the potential value of digital health interventions and make necessary decisions (13, 26).

Localize understanding of how theoretically promised new technology works within a specific local context is significant to conclude context-sensitive implementation and scale-up the programs in a wide range. The theoretical basis for this study is that healthcare workers' perspectives and the health facilities' capacity and readiness are critical in determining the extent and success of the implementation of the DHIs. Assessing the perspective of HCPs plays a significant role in improving the healthcare system since they are experts with the capacity to judge the extent of improvement or lack of it in the management of the DHIs (21).

This study is expected to assess the current technology utilization by HCPs, infrastructure, human resources, capacity, and readiness of health facilities to the implementation of the DHIs as routine care from the health care provider's perspective. This knowledge would be helpful to guide policymakers to decide by incorporating various digital technologies in the existing health environment in different health facilities in Addis Ababa. The study also aims to get insight into how HCPs would utilize, accept, and perceive the DHIs in TB/HIV clinics. The study also intends to get suggestions and inputs on how implementing the new technologies to be acceptable by the concerned individuals and at the community level.

The study is investigated possibilities of designing proper and alternative digital health interventions through a patient-centered approach using the current infrastructure, human resources, and health systems. This study is also helpful to ensure to what extent health facilities were technologically supported and whether they were adequately implemented in connection with TB/HIV care in Addis Ababa public health centers and hospitals. Consequently, the result would generate additional knowledge. It would contribute to strategic planning to make an evidence-based decision to incorporate newly introduced DHIs in routine health systems.

2. LITERATURE REVIEW

2.1. An Overview of Digital Health Interventions (DHIs)

DHIs can be defined as the use of digital devices, mobile and wireless technologies to support the achievement of health goals (13, 27). Similarly, World Health Organization also defines digital health intervention (DHI) as a discrete functionality of digital technology that is applied to attain health objectives. Therefore, Digital health intervention indicates the general use of necessary information and communication technologies (ICT) for health and it consists of both mobile health (mHealth) and electronic health (eHealth) (12, 13).

The World Health Organization (WHO), the European Respiratory Society (ERS), UNAIDS, and other partners have programs for action towards the End TB Strategy and 95-95-95 goal for HIV which seeks digital health solutions (28, 29). Thus, Digital technologies are key tools to attain those goals more effectively and efficiently (30). In resource-constrained countries, implementing digital or electronic health on a large scale to introduce new diagnostics and novel medicines is promising and potential to advance the health system.

Here below, there is an example of common digital health products and their potential support to different components of the End TB Strategy on the three pillars of the strategy (15). These include: video (virtually) observed therapy (VOT); Medication Event Reminder Monitoring (MERM); electronic learning (eLearning); and Short Message Service (SMS).

Pillar and Components

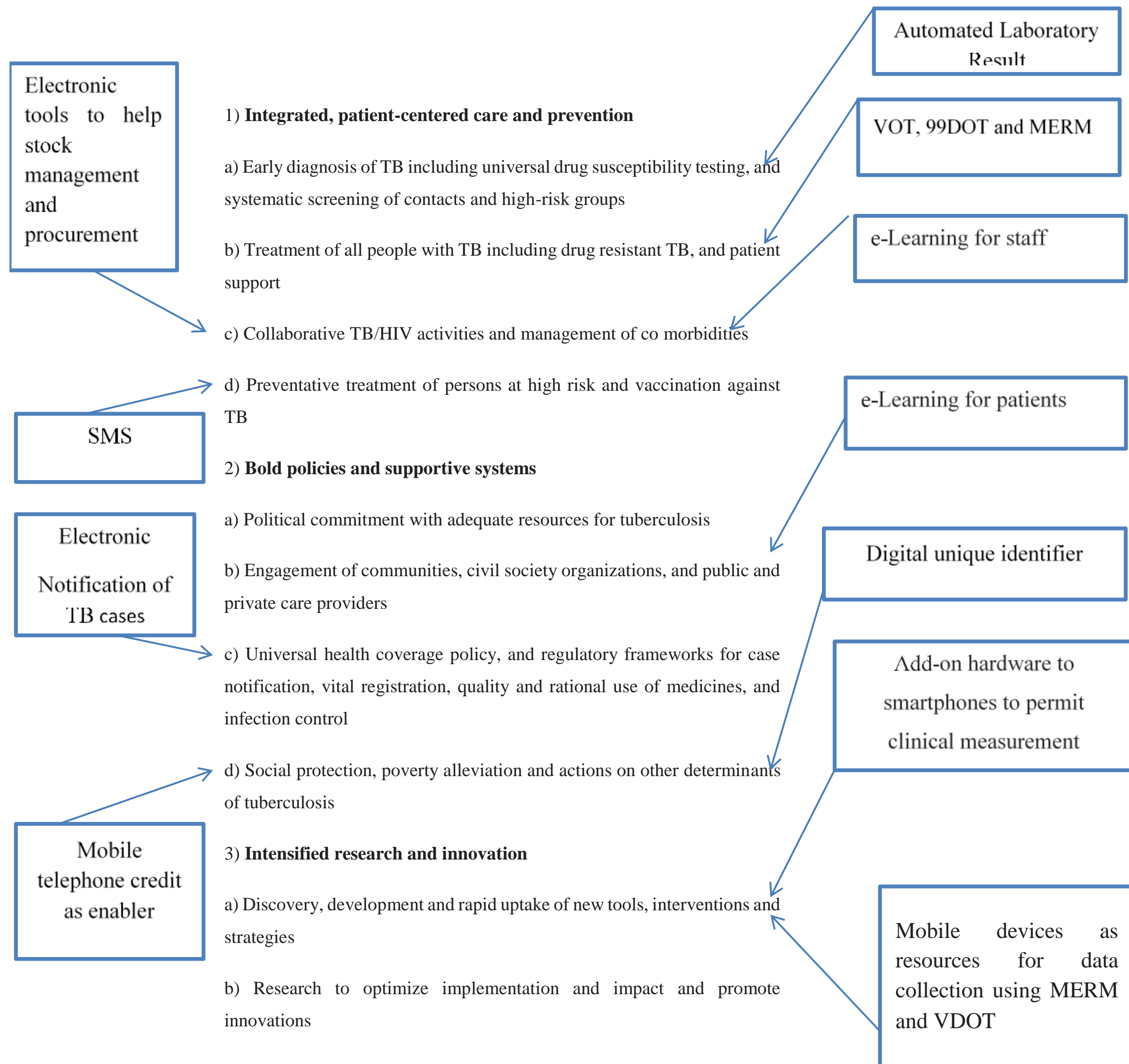

Figure 1 Examples of common digital health products and their potential contribution to different components of END TB Strategy (15)

Therefore, countries need to introduce new and various innovations such as digital health to support patient care, surveillance, program management, training, and communication. Implementation of such interventions on a large scale and comprising them with innovation is essential to advance new technologies over time and to bring a considerable impact on the health system (18, 29, 30). To make the processes more effective and efficient, incorporating them with potential artificial intelligence into new software is very crucial.

Users can get benefits from the enabling pattern software of artificial intelligence for tasks ranging from reading radiographs to adverse event monitoring. Artificial intelligence is also able to personalize a patient's care plan or customize training materials through vast datasets (30). Based on the report of studies and projections of experts, artificial intelligence and machine learning are likely the best tools to revolutionize the management of TB/HIV & other global public health problems (29, 30).

As recent data revealed in low- and middle-income countries, access to the internet and affordable mobile devices is becoming increasingly widespread (18, 30). This would be a good opportunity to introduce new technologies for the health system of resource-constrained countries. In the past two years, WHO and its partners identified a set of priority electronic and mobile health products and concepts as advantageously positioned to have a considerable and high impact on various domains of TB/HIV care and prevention (30).

As a recently used device, digital health interventions are applied within a country context and a health system environment, and their implementation is realized and possible by several factors (12). These factors include: (i) the health domain area and associated content;(ii) the digital intervention itself: functionality provided by it; (iii) the hardware, software, and communication channels for delivering the digital health interventions; and mediated within the existing health system (iv) a foundational layer of the Information Communication Technology (ICT) and enabling environment. These would be characterized by the country infrastructure, end-users including HCPs and patients, leadership and governance, strategy and investment, legislation and policy compliance, workforce, standards and interoperability, and common services and other applications (12).

Digital health interventions are intended to integrate with and fit into overall digital health architecture. The digital health architecture provides an overview or blueprint to illustrate how various digital applications both the software and related functionalities would interact with each other within a given context(12). To implement DHIs in the existing healthcare system, investigating the already existing projects/investments in the country is essential.

Furthermore, decision-making can also be supported by DHIs in the health system so that technology provides necessary data to utilize by health professionals. According to WHO, there are four classifications based on DHIs being used to help the health system needs:1)for clients (patients)-DHIs support several patients in targeted client communication, untargeted client communication, client to client communication, personal health tracking, citizen-based reporting, on-demand information service to clients and client's financial transactions. 2) DHIs for Healthcare providers include client identification and registration, client health records, healthcare provider decision support, telemedicine, healthcare provider communication, referral coordination, health work planning, and scheduling, healthcare provider training, prescription, and medication management, laboratory and diagnostic imaging.3) DHIs also support the management of the health system by guiding human resource management, supply chain management, public health event notification, civil registration and vital statistics, health financing, equipment and asset management and facility management and 4) Data service: this includes data collection, management, and use, data coding, location mapping and data exchange and interoperability(26).

The use of digital technologies for health systems has become an important field of practice for employing routine and innovative forms of information and communications technology (ICT) to address the health needs of the large society (12). The major challenge to incorporate and implement DHIs into the health system is the lack of adequate information to make an evidence-based decision. To make sure its usability, acceptability, and possibilities of adopting new technology, large-scale feasibility and acceptability research is needed (13, 26). Furthermore, the global financial mechanism and the government to recognize the potential value of digital health interventions, evidence-based information should be provided(13, 26).

The evidence that sheds light on DHIs has the potential to explain the ecosystem: social, political, economic, legal, and ethical context that helps digital health implementation and scale-up its deployment (31). Knowledge generated from researches and studies would enhance the

accessibility of DHIs, boost accountability, promote transparency, and have the capacity to strengthening all aspects of health systems (31).

2.2. Categories of DHIs and potential applications

Each Digital Health Intervention is classified into 1 of only 4 categories for the sake of simplifying the analysis. However, the possibility of overlap in technological function must be seriously considered. In other words, some digital technologies no longer have a single function or are targeting a single user but instead, they have multi-functionality and can target different types of users (14, 15, 32). For example, for analysis, GeneXpert MTB/RIF was considered under the category of patient care. Nonetheless, at the same time, it could serve as a tool for the surveillance of drug resistance and as program management by providing diagnostic results at the right time (32).

2.2.1. Patient Care

The potential for DHI is to improve treatment adherence and patient treatment outcomes are promising technologies especially in LMICs. The following are some of DHIs that have been used in different settings globally to ensure medication adherence and good treatment outcome. Each type of technology has its advantage and disadvantage. Therefore, prior assessment of its advantage and the possibility of incorporating the technology within the existing health infrastructure and the system is very crucial.

2.2.2. SMS

One of real-time adherences monitoring is integrated with Short Message Service (SMS) reminders. It has become a commonly accepted and largely relay on perceived utility as well as practicable intervention in resource-limited countries. In recent years, the value of the mobile phone in low and middle-income countries especially in sub-Saharan countries has facilitated public health programs including medication adherence of patients, and allowed proper follow-up and monitoring by health care providers (33, 34).

SMS reminders triggered by late or missed doses detected by real-time adherence monitors had revealed to advance the overall anti-retroviral and TB treatment adherence in China, Uganda, and Peru but did not significantly improve adherence in South Africa and Pakistan though it had fewer

sustained adherence lapses (22, 35). One review also reported that using mobile (cell-phone) had no substantial effect on treatment outcome and drug adherence (36).

2.2.3. Video-Assisted Directly Observed Therapy (VDOT)

The other technology to help medication adherence is the smartphone which is used to monitor the medication intake via video, VDOT. While utilizing this technology, participants used their smartphones to record videos of themselves at the time of taking each medication. Then uploaded videos were observed by Directly Observed Therapy (DOT) workers by the means of a secure website to document whether they complete their medication accordingly (37-39).

Some studies reported that VDOT was found to be highly acceptable, potentially efficient, feasible, and cost-effective than traditional DOT as reported by both TB patients and health care providers in both high and low resource settings. VDOT is also believed to save money and decrease the burden on patients and health care providers (36, 37, 40). On the other hand, Some other studies reported that the VDOT system requires professional expertise to check all medication intakes daily and lack of availability of smart-phone in the rural areas and claimed that this aspect of technology restricts its usability in Low and Middle-Income Countries, LMIC (38).

2.2.4. 99DOTs

This approach works by wrapping each blister pack of medication with a custom paper envelope which is sealed shut by the care provider. Every day patients dispense drugs through perforated flaps on the back of the envelope and reveal a hidden phone number. They use their registered mobile phone (may not be a smartphone) to place a toll-free call to that phone number and the computer responds to the phone and says" thank you and hangs up". In simple interaction, HCPs can track the caller ID of the patients along with the sequence of unpredictable numbers that they call overtime to have high confidence that the pills are in their hands and likely taken. If a patient doesn't call in on a given day, an automated reminder will be sent to the patients and also an automated alert to care providers to ensure that follow up with targeted counseling and get back on treatment (41-44).

One study stated that some patients involved with 99DOTS but others did not. This might be due to various obstacles to the acceptance and use of 99DOTS. Consequently, this could potentially be mitigated through better rollout and implementation of the technology. It might include progresses

in 99DOTS counseling (for patients) or training (for HCPs) and better anticipation of changes in workload for HCPs (41). On the other hand, a different study reported that 99DOTS was an effective approach for successful TB/HIV medication adherence, thereby increasing compliance to TB/HIV treatment. It would be helpful for easy access of treatment to patients from remote areas, increase notification from private practitioners, and supports differentiated cares to be taken (43).

2.2.5. Medication Event Reminder Monitor (MERM)

Medication Event Reminder Monitor (MERM) devices are new digital technologies that record measure treatment adherence, store medication, and offer alerts at the time treatment is taken or missed in a resource-constrained setting (45). These devices help to enable health facilities to deliver treatment for TB/HIV patients in the community, while closely monitoring adherence (45). Nevertheless, having contributed considerably to the knowledge of medication-taking behavior in different clinical settings, electronic treatment monitor technologies are not able to record whether the patient ingested the medication or what dosage was taken (46).

Earlier pilot studies of similar devices under-taken in Uganda, China, South Africa, and Canada were found to be effective in increasing medication adherence and high acceptability by patients and HCPs(45, 47). Likewise, a study in Morocco reported that pillbox (MERM) was found to be a successful program to minimize the number of visits to health facilities by patients particularly in the intensive phase (48).

On the other hand, it was realized that the type of device selected and how it was utilized may not be optimal to ensure medication adherence and prevent adherence errors (47). Besides, large-scale implementation of a study conducted in China and Tanzania indicated that some patients refused to use the device and shifted to be monitored by DOT. In Vietnam, only about half of the patients used the device as intended and the time in which the device had opened and the time of drug ingested was different time-elapse due to their concern on the portability of the device (45, 46).

2.2.6. Fingerprinting for Patient Identification

Monitoring, evaluation, and data integrity in resource-constrained settings may restrain the continuity of care due to a lack of unique Patient identification (49). One study found that digital fingerprinting was feasible and acceptable for individual identification, but problems

implementing the hardware and software lead to a high failure rate. Although HCPs found fingerprinting to be acceptable in principle, their aim to use the technology was tempered by perceptions that it was inconsistent and of questionable value (49).

2.2.7. Program Management

TB/HIV programs and systems in the facilities face some challenges of measuring the impact and effect of ICT on program management and building an evidence base around it. The determinants of successful harmonization and program management are multi-factorial (15). Indicators can, however, be recognized to characterize the achievement of certain elements of program management. One such example is the impact of digital laboratory information systems (LISs) on the accuracy and turnaround time of test results or outcomes. Diagnostic tests are essential parts of many public health interventions, guiding the detection of markers of disease and response to therapy. They have an imperative role in ensuring proper therapy and avoiding unnecessary treatment and waste (14). Different studies focused on the performance of diagnostics as a domain of particular importance in modern TB/HIV care within the program management function.

According to the WHO, one of the greatest difficulties to the control and management of drug-resistant TB (DR-TB) is insufficient laboratory capacity and capability to diagnose resistance in *Mycobacterium tuberculosis* strains in a timely and cost-effective manner (50). It is known that dependable and timely information is of paramount importance for the proper functioning of several processes in the TB laboratory, for the management of patient results data, and for the generation of indicators for program management. This suggests that countries need to consider the adoption and implementation of different real-time and rapid diagnostic tools. In the current time, the use of new diagnostic tests is increasing dramatically, including in resource-limited countries (15, 51, 52).

Currently, different technologies, most remarkably the Hain MTBDR Plus line probe assay and the GeneXpert MTB/RIF assay are being used globally to diagnose new TB cases and screen for the most widespread and prevalent mutations associated with resistance (53). Those technologies are robust, rapid diagnostic methods that have been adapted to TB. They have also been utilized to test clinical specimens directly which considerably shortens and simplifies the turnaround time for the identification of drug resistance in TB patients(53).

2.2.8. Surveillance and Monitoring

The aspect of DHIs in surveillance and monitoring would help the health sector with advanced and better technologies to display notification of TB/HIV cases from diverse areas of the country. The digital application also enables drug safety monitoring for active TB and HIV. The digital dashboard is being utilized as indicators and epidemiological trends for TB/HIV (15). This assists the system by improving the understanding and use of surveillance data to make a decision and access key summary indicators on TB/HIV and associated health risks. The digital dashboard will offer snapshots and graphical displays through which health care providers and public health officials can interact when they wish to know about the impact of TB/HIV program efforts and background epidemiological trends, such as the clustering of cases (15, 25).

Continuous and systematic gathering, analysis, and interpretation of health-related data for planning, implementation, and evaluation of public health practices can be conducted by public health surveillance (15). It is one of the principal pillars of any efficient public health system and an important tool for health action. Effective surveillance will be needed to support the End TB strategy and achieve the 95-95-95 goal against HIV in the coming years (15). Predominantly, measuring and monitoring the effectiveness of efforts to tackle the TB/HIV burden plays a significant role in controlling and reducing delays in diagnosis and care (15).

The other side of surveillance and monitoring is drug safety monitoring, detecting and responding to TB/HIV outbreaks and interfere with the chain of transmission; planning for managing resources for TB/HIV medicines. It is important to plan, implement, and evaluate programs and public policy to prevent TB/HIV and thereby identifying gaps in knowledge (15). Implementing key activities of surveillance system remain challenging in many countries due to different factors. For instance, lack of access to health services or poor diagnostic skills results in the under-diagnosis or misdiagnosis of TB. Consequently, inaccurate reporting anad under-reporting of TB/HIV cases significantly impact disease control. Countries also face challenges such as inconsistent follow-up by healthcare workers; insufficient use of the WHO standardized TB and HIV case definitions and reporting parameters (15, 25).

2.2.9. Diagnostic Device Connectivity

WHO has recommended a series of rapid diagnostic tests (RDTs) since 2010 that enable rapid detection of drug-resistant strains and yield enormous volumes of data. Correspondingly, most high-burden countries have adopted connectivity solutions that allow linking of diagnostics, real-time capture, and shared repository of these test results (51). Using connectivity and scaling-up the laboratory devices can generate laboratory information for surveillance in the field of TB/HIV.

Connecting microscopy to a database was not possible during the past years. After 2010, GeneXpert has enabled the synchronization of all data into the database after getting the test results(54). Consequently, both HCPs and data services personnel could benefit from the use of rapid diagnostic technologies so that TB surveillance tools can be used to manage the health system (14, 15, 32).

Responding to the demand for connectivity, using Xpert MTB/RIF assay has become a widely accepted technology (51, 55). The experience related to the utilization of these systems enables the monitoring of wide laboratory networks. This infers the need for a more global and comprehensive approach to diagnostic connectivity. In addition to facilitating the reporting of test results, the flow of digital information allows the sharing of data generated in program settings. When the information becomes easily accessible, data would in turn be used to improve patient care, disease surveillance, and drug discovery (51, 55).

The connectivity platform allows a more accurate and reliable real-time estimation of transmitted RR-TB proportions in a population. The combined approach will automate the analysis of shared RDT results and their interpretation into clinical and public health information (55). This would in turn initiate a timely outbreak response and appropriate investigation of suspected cases based on epidemiologic linking that would prevent further spread of TB (55).

2.2.10. e-Learning

e-Learning is a method of using electronic media and devices as a tool of teaching and learning. It denotes all or part of the educational model for advancing access to training. It simplifies communication, interaction, and adoption of new ways of understanding and developing learning (14, 15).e-Learning techniques range from provision of conventional learning as a mixed approach to delivering teaching entirely online. Irrespective of the technology applied, learning remains its central element (14, 15).

The digital eLearning devices aim to educate patients and their families about TB/HIV care and other associated conditions- such as proper diet and smoking cessation which can influence treatment outcomes. Patients and their families demand information after the diagnosis of TB/HIV result being available. There might be some questions about the disease and its implications on lifestyle, the type of treatment to be taken, and kind of support they need, and the responsible person in charge of providing the support. e-Learning can have a substantial role in accomplishing such a demand. A message which is clear and easy to understand is imperative to make a better-informed decision when considering treatment options (14, 15).

New interventions for TB prevention, diagnosis, and treatment are anticipated in the coming years(14). These comprise the large-scale introduction of innovative diagnostics and medicines as well as new methods for addressing upstream factors of TB in line with the End TB Strategy. There are also different new digital adherence technologies to support drug adherence among TB patients. Health care providers ought to have new knowledge, skills and make themselves familiar with these innovations for effective delivery of care(14). e-Learning is internet-based, self-directed learning tool and an important accessory to provide timely training for HCPs on the care of TB, HIV, and associated risks.

There are limited numbers of Published researches that compare the outcomes of traditional methods with e-Learning for obtaining knowledge. Conversely, there is a growing literature that supports the potential benefits of web-based training and the use of multi-media techniques (15).

2.3. Barriers to adopting DHIs in low and middle-income countries

Even though global health organizations such as the WHO, and their partners have been encouraging the development and adoption of scalable DHIs, their impact and sustainability are still uncertain in LMICs (56). For the poor implementation of DHIs, the following factors are identified by WHO: Conflict between health-care priorities, unmaintained operating costs, inability to consistently measure clinical effectiveness, lack of harmonized health-care policy and governance models to support DHIs initiatives, lack of knowledge on the possible application of DHIs and public health outcomes, lack of IT infrastructure to support DHI programs, patient literacy, privacy, and cultural issues (15, 56).

2.4. Digital Health Interventions in Africa

Adoption and implementation of digital health hold great potentials and opportunities in strengthening and transforming health systems across Africa. Digitization of health systems brings advancement and implications on preventive and curative healthcare and medical services delivery in the continent. It needs strong political leadership commitment and investment from the government side, the public and private stakeholders as well. All these contribute to advancing digital health benefits and supporting the value of an integrated digital health ecosystem approach, technologies, and tools in Africa (19).

Due to the rapidly growing economies of the world, Africa has widely utilized digital health and medical paradigm shift in health systems. By utilizing digital health, re-engineering, and innovative transformation, effective care service delivery has been provided to its populations in need. Even more, numerous industrial opportunities make Africa an attractive investment environment. This has significant implications on drive strategic growth and profits, social cohesion, well-being, regional and global economic prosperity (19). In African, the digitalization of health databases and electronic records can solve the existing health systems challenges and issues by providing effective, affordable, and timely given medicine and make health care devices accessible (19).

Africa needs several innovative strategies such as digital health interventions to accomplish universal health coverage ambition (52). Digital health has several advantages. For instance, it advances the safety and quality of healthcare services; enhances access to health care services basically for those in hard-to-reach areas, better knowledge for health workers and communities through eLearning. It also facilitates access to the cost-effective and efficient health services delivery to the public which addresses economic and environmental determinants of health. All the above benefits could contribute to the attainment of universal health coverage and fighting against global epidemics such as TB and HIV (52).

The pooled papers from different implementation research projects in Africa, Asia, Latin America, and the Middle East confirmed that digital technologies improve and save lives in low- and middle-income countries. The story emerging from these studies is also comprised that digital health can be used to strengthen upward and downward accountability (27).

However, poor coordination of projects, weak health systems, lack of knowledge about digital health, and poor infrastructure challenge the implementation of digital health in Africa. This includes poor internet connectivity, unstable power supply and lack of interoperability of the numerous digital health systems are some of the problems (52).

2.5. Digital Health Interventions in Ethiopia

The health system of Ethiopia was thought of as one of the poorly technologically supported systems for decades. To improve the health system, Ethiopia issued them Health and eHealth frameworks by the Ethiopian Ministry of Health and its partnersin2011GC (16). This technology has been supporting the health system and contributes to enhancing healthcare delivery especially those undertaken by Extension Health Workers (EHWs).

In 2015, Ethiopia launched its Health System Transformation Plan (HSTP) to build on its considerable gains in advancing health outcomes in the country (16). The basis of the plan is to promote and advance the digitization of the methods and practices used to collect, analyze, present, and disseminate information pertinent to the health system.

In 2016 United Nations launched Sustainable Development Goals (SDGs), following this Ethiopia has adopted SDGs to address major diseases of public health including TB/HIV (4). To achieve WHO's End TB Strategy, 95/95/95 goal, and SDGs; the health providers and the health system need to be sure of proper implementation of DHIs in the health sector. In supporting the program, in December 2019 the U.S. Agency for International Development (USAID) in partnership with Ethiopia's Ministry of Health declared the launch of a new Digital Health Activity (DHA). Currently, Ethiopia's health sector is also ready to attain the country's health information revolution roadmap. DHA is doing this through three major objectives (17).

Digitization: digitize, integrate, and scale-up possible solutions of digital health. These comprise regulatory information systems, electronic medical records, health management information systems, human resource information systems, and community health information systems.

Data Use: culture of proper data utilization to make decisions about health planning, performance management, and delivery.

Governance: To enable the adoption of best practices and policies in data use, data system architecture, and IT infrastructure by government agencies and implementing organizations (17).

Recently, the Ethiopian Ministry of Health (MOH) commenced the Digital Health Innovation and Learning Center (DHILC), the first of its kind in Addis Ababa in August, 2020. The DHILC is believed to be a place where health professionals will be able to design and validate digital health tools, synthesize and promote best practices, and scale-up innovations(17). The center is supposed to play a remarkable role, particularly in developing and implementing data in the health sector. It has the ambition to support the use of digital technology to improve health service delivery and to be a place where sustainable implementation and support capacities are going to be built to ensure government ownership of the systems (17).

Despite the political will to have effective DHI programs, one study conducted in Ethiopia in 2018 reported seven significant barriers that hamper the support of a sustainable health IT infrastructure for national public health initiatives (56). According to the study, poor access to electric power, the limited number of healthcare workers and lack of eHealth literacy, data governance and standardized technology conformance, telecommunication connectivity and adaptability of technology infrastructure, mobile phone availability and cost, prohibitive service management costs to maintain mobile health software and hardware and lack of information technology human resource constraints were identified as a bottleneck to adopt and implement DHIs in Ethiopia (56).

The mobile subscription rate of the country accounted only 8% which was 4-6 times lower than Uganda (30%), Tanzania (31%), Rwanda (36%), and Kenya (51%) (56). Besides, the overall mobile phone access was found to be 56% of these, 88% of urban and 47% of rural households. The cost of mobile phones was also relatively higher at the household level in Ethiopia as compared with other African countries (56). In addition to the cost of mobile phones, poor mobile networks and short battery life are some bottlenecks to use mobile phones in the country (56). According to 2016 Ethiopian Demographic and Health Survey (EDHS), only 20.8% of the total population gets electric city (56). Even though 90% of extension healthcare workers had a mobile phone in the rural part of Ethiopia, only 23% of them have consistent access to charging stations (56).

Comparing to the total population of the country, the number of healthcare providers was limited in Ethiopia compared to other African countries (16). Technology acceptability by healthcare works was also found to be minimal in the rural part of Ethiopia. Although the working language in Ethiopia is English, studies reported that health extension workers had relatively poor English proficiency and usually preferred the local language during the utilization of different technologies (56, 57). Furthermore, in Ethiopia, the integrated enterprise architecture governance body or regulatory system that confirms compliance to HMIS interoperability standards of the new e-health system is comparatively poor (24, 56). Therefore, the right addressing of the above-mentioned constraints would require deep investigation of human resources available in terms of their number and quality is vital to support the very complex health information management efforts. These can also facilitate the utilization and the progress of adoption of new DHIs including mHealth or related ICT solutions (24, 56).

3. THEORETICAL FRAMEWORK

3.1. Technology Adoption Readiness Model

Today, there are many eHealth, digital health, or technology readiness assessment models/frameworks used in the healthcare sector and many of them assess a specific dimension in the healthcare environment and use different methodologies (54). This makes reaching some standard frameworks problematic. Technology readiness refers to the preparedness of healthcare institutions or communities for the anticipated change brought about by programs related to ICT (54, 58).

Organizational readiness for change is considered an important precursor to the successful implementation of complex changes in healthcare settings. In planning for digital health implementation, a needs assessment is the first critical step towards building an effective and sustainable program (54, 59). The ultimate objective of all stakeholders in the healthcare delivery system is, to keep people healthy, prevent chronic illnesses that consume a large fraction of our healthcare budget, and use medical interventions appropriately (54). These can only be achieved by the early involvement of all healthcare participants leading to the development of medical intervention products with compelling value propositions from all stakeholders. This involvement would have a direct impact on their behavioral intention to accept and use the system effectively.

The implementation of technology is complex and requires adept and adaptability to make it work. The adept could be the understanding of the context of the need for such systems(54, 59). The existence of policies at the government and organizational levels to address common issues such as licensing, liability, and reimbursement is also critical to the adoption and use of technology by healthcare providers (54).

In a report by one systematic review, 29% of the reviewed papers considered assessing technology acceptance as a crucial way to determine the healthcare organizations' overall readiness (54). Many studies relating to user acceptance have recommended an understanding of issues, which have the potential to affect users before implementation (54, 60).

3.2. Unified Theory of Acceptance and Use of Technology (UTAUT) framework

The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed to assess user acceptability of new innovative technology according to Venkatesh et al. (41, 61).UTAUT incorporated eight theories: the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the motivational model, the Theory of Planned Behavior (TPB), Integrated Device Technology (IDT), a model combining the TAM and TPB, the model of PC utilization and Social Cognitive Theory (SCT). With experimental investigation, Venkatesh et al. narrated that performance expectancy, effort expectancy, social influence, and facilitating conditions are the major factors influencing user acceptability of a given technology (41, 61).

Out of the above factors, performance expectancy most likely measures the usefulness and having relative advantage(61). Effort expectancy can be interpreted as perceived ease of use or complexity. Social influence is concerned with assessing the acceptance of the technology within specific cultural and social norms. Facilitating Conditions more likely refers to the users that they have the resources and knowledge required to use the technology. Thus, users need to bear the costs of using technology and require being equipped with the necessary knowledge to operate accordingly (41, 61).

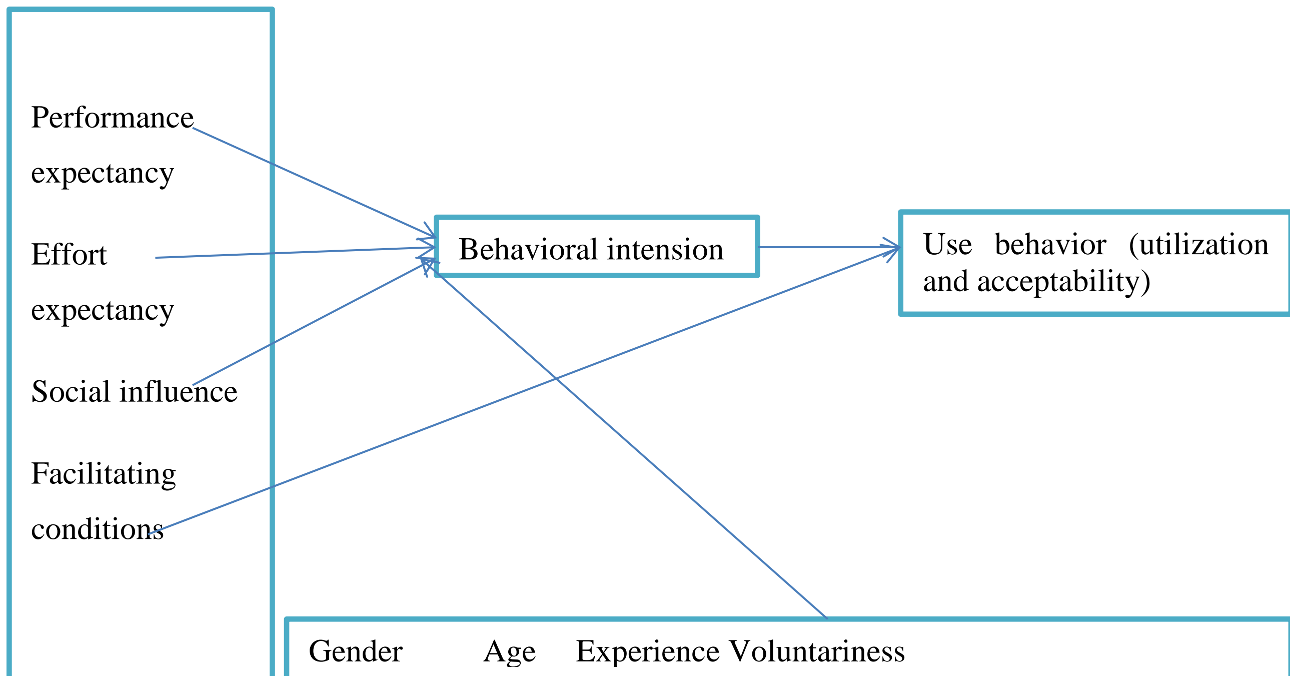

Figure 2.Framework of UTAUT model (41, 61)

4. RESEARCH QUESTIONS

1. What is the current status of technology utilization by healthcare providers?
2. What are the acceptability and perceptions of healthcare providers towards using DHIs?

3. What is the readiness of health institutions in terms of infrastructures and human resources to adopt and implement new DHIs for TB and HIV care services?

5. RESEARCH OBJECTIVES

5.1. General Objective

To assess the capacity and readiness of healthcare facilities in terms of the infrastructure and human resources to adapt and implement DHIs for TB and HIV care and treatment services in Addis Ababa from January to March 2021.

5.2. Specific Objectives

- To investigate the current status of technology utilization by healthcare providers.
- To explore providers' acceptability and perception of handling and using the DHIs.
- To assess the existing infrastructure and human resource readiness to adopt and implement any new DHIs.

6. METHODS

6.1. Study Setting

The study was conducted in Addis Ababa, the capital city of Ethiopia. The statistics show that the population number increases from time to time and Addis Ababa is much crowded than ever. Therefore, the people of the city are highly vulnerable to TB transmission during transportation and other social activities that put them at high risk. Studies also indicated that Addis Ababa is one of the Ethiopian cities with a large number of patients with HIV (9).

There are a total of 94 health centers found in 10 sub-cities of the capital city. Of these, 10 public health centers with high TB/HIV patient flow from each sub-city one health center was selected as indicated in the below table.

Table 1 Included Public Health Centers from Each Sub-city

No.	Name of Health Center	Sub-city
1	Addis Raey Health Center	Addis ketema

2	Akaki Health Center	Akaki kality
3	Kebena Health Center	Arada
4	Goro Health Center	Bole
5	Adisu Gebeya Health Center	Gulele
6	Kazanchis Health Center	Kirkos
7	Alem Bank Health Center	Kolfe
8	Teklehaymanot Health	Lideta
9	Woreda 02 Health Center	Nifasilk lafto
10	Woreda 13 Health Center	Yeka

Under the administration of Addis Ababa Health Bureau, there are 6 governmental hospitals of which 4 of them were identified as being having high TB/HIV patient flow. Accordingly, we took these hospitals as samples for the study purpose i.e., Dagmawi Menelik Referral Hospital, Zewditu Memorial Hospital, Ras Desta Damtew Memorial Hospital, and Yekatit 12 Hospital.

6.2. Study Design

A facility-based mixed-method cross-sectional study was conducted in public health centers and governmental hospitals in Addis Ababa to investigate the capacity and readiness of these facilities to incorporate various DHIs. The study was combined semi-structured interviews and a self-administered questionnaire in a mixed-methods study design. The study was conducted between January and March 2021 in Addis Ababa, Ethiopia.

6.3. Source and study populations

Source population: TB/HIV care providers from all sampled healthcare facilities of Addis Ababa were the source population for the study.

Study Population: all TB/HIV care providers working in the selected healthcare facilities were considered as the study population.

6.4. Eligibility criteria

6.4.1. Inclusion criteria

- Healthcare professionals willing to provide informed consent.

- Professionals working in selected TB and HIV clinics at the time of data collection.

6.4.2. Exclusion criteria

- Working experience on TB/HIV care for less than 6 months

6.5. Sample size determination

The sample size was based on the purpose of the study and the availability of healthcare providers in each healthcare facility. As result healthcare workers were interviewed and requested to fill self-administrated questionnaires based on purposive sampling. In the purposive sampling technique, predefined criteria were used to determine the selection of participants based on the requirements of the study objectives. Participants were selected for both questionnaires and interviews within the study sites of 10 public health centers and 4 hospitals using purposive sampling. Accordingly, fourteen sites were sampled as part of a larger evaluation with a high TB/HIV patients load. This incorporating all health workers meeting inclusion criteria at each site for the interview and to fill the prepared questionnaires.

According to the information gathered, in health centers on average there were 8 healthcare providers working in TB/HIV clinics in health centers and an average of 13 HCPs in hospitals. Total healthcare providers who were assigned in 10 health centers and 4 hospitals were found to be 76 in number. Of these, 60 HCPs met the inclusion criteria and were included in this study which covered 80% of the total healthcare workers from the selected healthcare facilities.

6.6. Data collection

Data was gathered from healthcare workers using adopted questionnaires and semi-structured interview questions based on the adapted UTAUT model. Interview questions were used to investigate the relative advantages and simplicity of DHIs, social acceptance, and enabling factors to utilize technologies using the model. The acceptability of technology was asked only for those HCPs who held solid prior experiences of using DHIs in their healthcare delivery or if they were involved in any technology utilization-related research or study in the earlier time.

Current technology utilization, personal perception, and acceptability of the technology in selected health facilities were investigated through interviews using a set of interview guide questions that were responded by participants.

Key inputs were collected using self-administrated adopted questionnaires to gather quantitative data. The questionnaire was aimed to assess facilities' capacity readiness to adopt and implement new technology. The questionnaire was constructed by using 6 themes including: (1) core readiness (CR); (2) Organizational cultural readiness (OCR); (3) Operational resource readiness (ORR); (4) Technological readiness (TR); (5) Value proposition readiness (VPR); and (6) Regulatory and policy readiness (RPR) (54, 58, 62). the questionnaires were filled by a person who was entitled to a managerial position in each department i.e., HIV and TB clinics to assess facility readiness.

A checklist was also prepared based on the adopted Technology Infrastructure Checklist to evaluate the infrastructure and human resource capacity of included healthcare institutions (54, 63). The checklist aimed to investigate the existing infrastructure and human resources to estimate the possibilities of adopting new technologies in those sectors. The checklist was filled by making an observational evaluation and if any additional information was needed, health information managers were asked for further clarification.

Health workers usually work in very busy clinics, therefore; the researchers used available empty office spaces to ensure their privacy and to manage their time.. The interview was lasted for about 20 to 30 minutes and was conducted in Amharic or English depending on the interests of the respondents or the participants. The audio recording was later transcribed and translated to produce de-identified English-language transcripts.

6.7. Epistemological approach

The epistemological approach for this study was assembled in an interpretive or constructionist paradigm (64). The interpretive paradigm is supposed that people construct their understanding of fact from their varied personal experiences. According to this thought during interviews, participants were needed to draw meaning concerning how the introduction of the new technology changed their practice and impacted the lives of their patients. This particular approach was mainly used to assess the experience and knowledge of healthcare providers towards DHIs.

6.8. Operational definition and measurements

Capacity- For this study, the word capacity infers the current technology utilization by healthcare providers and the overall availability of the infrastructure and human resources to ensure proper utilization of digital health technology.

Facility- In this study, a facility refers to any healthcare institution health centers or hospitals providing TB and HIV care and treatment services.

HCPs- For this study HCPs refers to those healthcare workers working in TB or HIV clinics.

TB/HIV- Refers to tuberculosis and HIV/AIDS cases or TB and HIV co-infection. We were using these two words together to imply either the disease condition in co-infection form or when there are commonalities between the two diseases as separate disease conditions.

Technology- For this study, the word technology is defined as any kind of electronic or internet-based device used in healthcare facilities. It may range from a basic mobile phone to complex artificial intelligence which can perform reading radiographs, adverse event monitoring, and customize training materials.

Use behavior- For this study, the phrase "user behavior" is used to describe the level of utilization and acceptability of technology by healthcare providers in selected healthcare institutions.

6.9. Data Processing and Management

Any physical records (e.g., informed consent forms and paper-based questionnaires) were safeguarded in a locked personal cabinet, and interview recordings and transcripts were also be stored on a coded password-protected computer to ensure the confidentiality of participants' data. One-quarter of English language transcripts were randomly chosen and were assessed against the original audio recordings for the correctness and completeness of the gathered data to verify translation accuracy.

6.10. Data analysis

The questionnaires and checklist were treated quantitatively but most interview questions were analyzed qualitatively using a thematic approach. Quantitative data were analyzed using SPSS

computer software, version 20. All readiness assessment variables have 5 point Likert scale values. Depending on the type of questions, two possible different answers were analyzed accordingly. One type of the responses on the Likert scale was “No never considered, No but have considered, Yes in progress, Yes nearly completed, and Yes in place.” For such type of questions, all positive answers included “Yes” type of responses were added together to analyze the result positively. The other questions were similarly answered in the Likert scale in the other form to be analyzed and conclude. It denotes that “Strongly disagree, Disagree, Neutral, Agree and Strongly agree”. Respondents who replied with “ Strongly agree” and “Agree” were considered as positive responses and their responses were added to make the analysis. From the data analyzed, it can be concluded that a higher score indicates better preparedness for DHIs implementation.

Categorical data were expressed as frequencies and percentages. After the interviews were conducted, the responses of the respondents were written down and documented. Then, qualitative data were manually coded by two investigators, and a thematic approach to analyze the data were utilized. The transcription procedure was followed by coding the transcripts. Consequently, the descriptive codes were documented, and analytic codes were established. Afterward, key themes were identified and recognized. A codebook comprising both descriptive and analytic codes that related themes was utilized to guide the progress of the study, discussion and conclusion were forwarded accordingly. Regarding statistical analysis, we used Multiple Regression to assess the influence of age, sex, work experience, educational level, and department either TB or HIV clinic influence their inclination towards technology utilization and we had also conducted correlation analysis to assess any significant relationship between the composite variables, a Pearson product-momentum correlation (Pearson r) was conducted.

To confirm the reliability, the researchers reviewed transcripts of respondents to endorse the content captured whether they used accurate quotes in the course of reporting. And this study was carried out in light of the COREQ guidelines for the reporting of qualitative data (65).

The UTAUT comprises multiple constructs from prior literature on technology acceptance into a single framework (acceptability of DHIs). Three of these constructs- effort expectancy, performance expectancy, and social influences are essential to comprehend the behavioral intention of individuals to utilize technology. Performance expectancy refers to the perceived helpfulness and comparative benefit of technology to HCPs and the health system in general. For

instance, it may refer to the level to which it is assumed to improve the quality of care they can deliver or the work efficiency of HCPs. Effort expectancy denotes the easiness of the technology to operate. This may refer to the effort needed to use the technology or how easy it is to utilize and deliver routine care. For example, if it enables to identify the online adherence to monitoring drug adherence of patients by HCPs. Social influences mention how the perception of other individuals comprising other HCPs in their work atmosphere and their patients affect HCPs acceptance and utilization of the technology (41, 61).

Data from a range of contexts show that performance expectancy often has the most substantial influence on behavioral purpose to utilize a technology (41, 45). On the other hand, facilitating situations, the fourth construct in the UTAUT, directly influence individuals' actual utilization of a novel technology. Facilitating circumstances include the underlying infrastructure such as human resources, power supply, internet connection, and others to enable the use of new technology (45, 61).

For HCPs, we interpreted this to hold factors such as the quality of the institutional infrastructure that exists to assist individuals to utilize such technology. This includes the quality of training they earned before the placement of the technology and infrastructure given by the health organization to certify the proper functionality of the technologies and if any higher-level support related to the technology was offered at the time of the deployment procedure (41).

6.11. Data quality assurance

Data quality assurance includes the validity and reliability of data. Validity is the accuracy of measurement to which data truthfully represent a concept. Researchers use a validity test to ensure both dependent and independent variables have been measured accurately. Accordingly, for this particular research, the validity of the data was verified by using important statistical tools. The reliability and internal consistency of each factor in the modified data collection instrument assessed using Cronbach's Alpha. The value 0.7 was used as a cut point to decide the validity and reliability. Values that are greater than 0.7 suggest that a high level of internal consistency and reliability of related items.

A pre-test of the study questionnaires was conducted at selected health facilities on 10% of the estimated sample size to check clarity and to make essential amendments to the questionnaire before its actual use. The training was provided to the data collectors to avoid hypothetical bias and to confirm appropriate categorization and coding of questionnaires. The study Supervisor and the Principal Investigator verified the collected data thoroughly for completeness each day.

6.12. Ethical Considerations

The following procedures were taken to ensure ethical issues in line with the purpose of the study. Approval was obtained from the Scientific and Ethics Review Committee of the Center for Innovative Drug Development and Therapeutic Trials for Africa (CDT-Africa), College of Health Sciences, Addis Ababa University, and the Ethics Committee of Addis Ababa Health bureau. An official letter was also sent to each health facility to get permission to undertake the study accordingly.

Each participant was given a clear explanation of the purpose and importance of the study, by providing an information sheet, and written informed consent was obtained from all participants before they were included in the study. During the consent process, the participants were informed that personal identifiers were omitted to ensure their privacy and confidentiality. The study units' culture, language, beliefs, and values were considerably respected and participants were asked permission for digital recording of the interview sessions. The study participants were also be informed that the study process had no intention to harm them and there was the possibility to withdraw from the study at any time.

7. RESULT

7.1. Digital technology utilization status of healthcare providers

7.1.1. SocioDemographic characteristics

As indicated in the table 2, 60% of participants were females. 42% of them were between 31-40 years old, 65% hold a BSc degree, 62% were working in an HIV clinic and 36.7% had more than 10 years of working experience (Table 2).

Table 2 Socio-demographic Characteristics

	No.	%
Total	60	100
Gender		
Male	24	40
Female	36	60
Age		
18-30	16	26.7
31-40	25	41.7
41-50	15	25
Above 51	4	6.7
Educational Level		
College diploma	10	16.7
BSc	39	65
MSc	11	18.3
Department		
TB Room	23	38.3
HIV Room	37	61.7
Work Experience		
Less than 1 year	2	3.3
2-5	16	26.7
6-9	20	33.3
Above 10	22	36.7

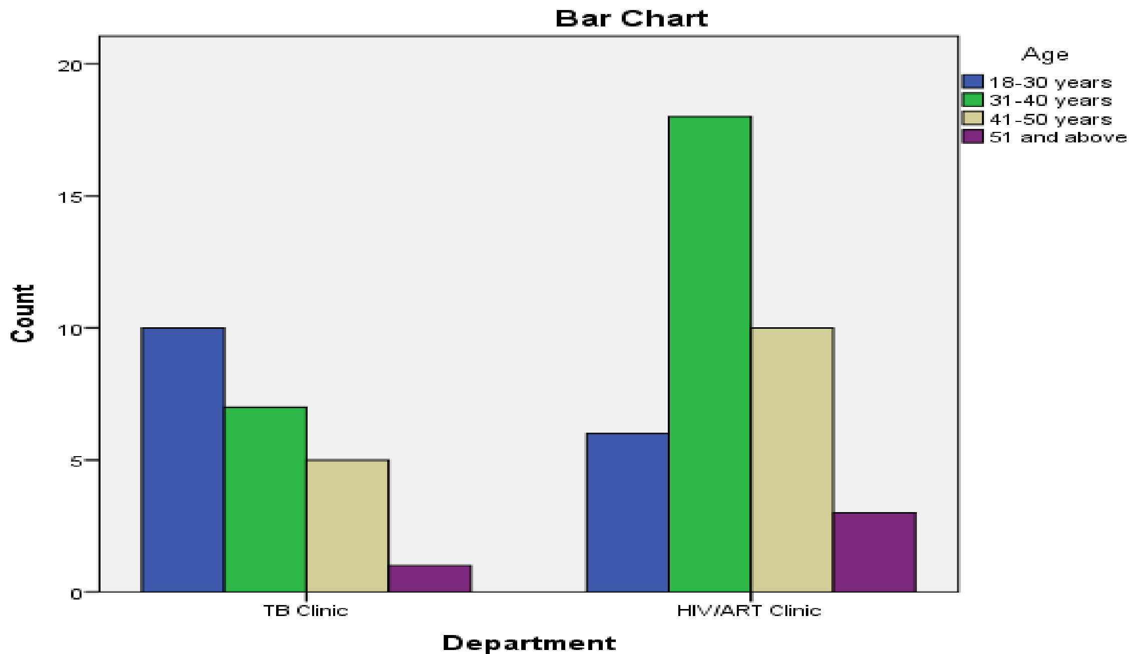

Figure 3 Age and department of the Respondent

7.1.2. Technology utilization

Based on the responses of the respondents as shown in Table 3, 80% of healthcare providers have been using DH technologies in their respective facilities. The healthcare providers from HIV clinics utilized a smart care system to keep patient data electronically, report the data to the concerned bodies and retrieve the data whenever they think it is necessary. The healthcare providers had been given some type of training to use such technology appropriately. Still, only 26% of them were satisfied with the training given to them. The majority of the healthcare provides responding that the training provided was not enough to use the technology properly.

Table 3 Responses of Leading Questions by the Respondents

	Leading Questions	Percent of Cases
	HCPs heard of DHIs	48.3%
	HCPs with smartphone	85.0%
	Willingness to use various technologies in the facility	90%
	computer access in the healthcare facility	55.0%
	HCPs having different online training	11.7%
	Experience using EMR	61.7%
Q1[a]	Experience in using any other technologies for TB/HIV patients	80.0%
	The relative advantage of technology	75.0%
	The simplicity of the technology	70.0%
	Related training that would help to implement such technology	68.3%
	Adequacy of the training	26.7%
	Favorable environment or infrastructure	43.3%
	Challenges to use DHIs in the facility?	86.7%
	Opportunities in the facility to adopt new DHIs?	81.7%

According to the data obtained from the respective respondents, the TB care providers in selected hospitals were less familiar with technology utilization than the rest of the 10 selected health centers. Tb care providers likely became one part of a pilot study using Digital Adherence Technology (DAT). For that study, they had been using the internet (Wi-Fi) and computers to follow the drug adherence of their patients. In using this new technology, the healthcare providers of those health facilities had been provided pertinent training.

Among the respondents, 43% confirmed that they had a favorable working environment to utilize the new technologies in their respective facilities. In addition to this, the majority of the respondents, 82% endorsed the presence of several opportunities in the health facilities to properly implement digital health interventions in both health centers and public hospitals under the study.

7.2. Acceptability and Perception Using DHIs

One central element to the acceptance of DHIs is the conservation of care providers' time and improvement of health care service delivery, including improving system speed and quality of documentation.

Figure 4. UTAUT model for the assessment of acceptability and perception of using DHIs

At the time of data collection, it was observed that only one hospital of TB clinic tried to implement a new system among the selected hospitals. the new system helped them to record patient's data and connected digitally with different departments such as laboratory technicians and pharmacists. Likewise, the other three hospitals had also planned to implement such technologies but were not executed yet. It was evidenced that a pilot study had been conducted in selected 10 health centers to use a digital adherence technology. The healthcare providers working in TB clinics were also assessed their perception and acceptability towards the digital adherence technology. Similarly, the perception and acceptability of HIV caregivers' towards smart care were assessed accordingly.

The strongest facilitator of their acceptance and the use of the digital adherence technology were perceptions of positive performance expectancy (i.e., perceived usefulness). In particular, most HCPs felt that remote monitoring of medication adherence had some benefits for both patients and HCPs. During the pilot implementation of the technology, TB patients were generally dispensed 15 days of medications in the device. Patients who visited the clinic only pick up medications every 15 days, which were previously required daily which their visit likely substantially reduced. It was evidenced that the assumption of remote monitoring of adherence minimized the need for more frequent in-person monitoring. Most HCPs felt that patients benefited considerably from this reduction in required clinic visits. HCPs in the HIV clinic also described how smart care facilitated their works since they could easily retrieve patients' data from the record so that patients' follow-up became easier. Thus, this situation also likely enhanced their job satisfaction as well.

The following are examples that was taken directly from the interviews of the care givers of health facilities under the study :-

I. Performance Expectancy

1. “We can retrieve patient data from electronically recorded documents easily as compared with manual work documentation; besides the systems do have numerous advantages that simplify service delivery and decision-making process”. HCPs from HIV clinic.

2. “I think smart care has made our work much easier. Before there were a lot of missing data of the patients but currently any important information can be easily accessed by the care providers”. HCPs from HIV clinic.

3. “The digital adherence technology reduced the workload and increased our job satisfaction which allows us to dedicate more time to other important tasks”. HCPs from TB clinic.

4. “Previously we were supposed to give therapy daily [i.e., DOT]. But now, the patients come [to the clinic] every 15 days so that our work pressure has been reduced consequently”. HCPs from TB clinic.

5. “With this new technology, I could not be sure whether they have taken the medication or not thus I prefer DOT”. HCPs from TB clinic.

II. Effort Expectancy

6. “We took two weeks training on how to use the smart care and consequently it likely becomes effortless to work with”. HCPs from HIV clinic.

7. “I found the drug adherence technology is easy to use. I haven’t yet faced any difficulties so far .” HCPs from TB clinic.

8. “With a simple orientation I was given, I found the task was tough for I have no previous experience using such technologies but currently I can use the device more efficiently after sometimes of exposure.” HCPs from TB clinic.

III. Social Norm

9. “Patients now need not travel long distances spending their money and time to collect their drugs every day. Most of our TB patients come from distant villages. Now, they feel comfortable with being supported by these technologies.” HCPs from TB clinic.

10. “Previously most patients come to the clinic with lost cards and it had been difficult to manage such issues but currently since the patient’s card number is registered electronically as a result of this the problem is being solved. Therefore, the patients are happy with the new technology”. HCPs from HIV clinic.

11. “The good thing about the digital adherence technology is that it does not carry any messages on TB [on the outside of the box], so there is no stigma attached to it. This helps the patients to carry it freely”. HCPs from TB clinic.

IV. Facilitating Conditions

12. “Here in our offices, we have enough computers so we can perform our work more easily than before”. HCPs from HIV clinic.

13. “Even if there is Wi-Fi access in the health facility, the signal is a bit weak to work with it efficiently”. HCPs from TB clinic.

14. “We had two weeks of training on smart care to implement it; besides, the management members are very supportive. There are also enough number computers, Wi-Fi access, and generator; so this would facilitate our work”. HCPs from HIV clinic.

15. “In our room, there are no computers and the one that we had used previously is not yet maintained; so we have borrowed some computers from another room and this makes our works very difficult for there is a very minimum number of computers to use in the health facility.” HCPs from TB clinic.

7.3. Willingness to use various DH technologies

Table 4 model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.436a	.540	.515	.461	.590	2.536	5	54	.030

a. Predictors: (Constant), Work Experience, Department, Educational Level, Sex, Age

b. Dependent Variable: willingness to use the technology

R2 for the overall model was 54% with an adjusted R2 of 51%, a large size effect is reported by the model.

Table 5 ANOVA Table

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	2.697	4	.539	15.536	.030[b]
1	Residual	11.486	54	.213		
	Total	14.183	59			

a. Dependent Variable: willingness to use the technology

b. Predictors: (Constant), Work Experience, Department , Educational Level, Sex , Age

The overall model was significant to predict care providers' willingness to use various technologies in their facility: F (4, 54) = 15.536), p = 0.03 as shown by the ANOVA table

Table 6 Table of Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	1.611	.346		4.655	.000					
Education	.080	.102	.097	3.784	.006	.152	.106	.096	.974	1.027
Sex	.055	.127	.055	.433	.666	.056	.059	.053	.916	1.092
Department	.056	.073	.100	.767	.085	-.051	.104	.094	.875	1.143
Age	-.227	.129	-.227	-1.757	.027	-.199	-.233	-.215	.896	1.116
Experience	-.203	.071	-.366	-2.855	.0 16	-.362	-.362	-.350	.913	1.095

a. Dependent Variable: willingness to use the technology

This study was also conducted to determine if various factors can influence healthcare providers' willingness to use different technologies. It was hypothesized that their sex, educational level, their department either TB or HIV clinic, age, work experience will predict their willingness towards the use of technologies. Multiple regression analysis was used to test this analysis. Results show that 51% of the variance can be accounted for by the five predictors, collectively, $F (4, 54) = 15.536)$, $p = 0.03$. Looking at the unique individual contribution of the predictors, the result shows that educational level (β= .097, t= 3.784, p= .006), age (β= -.227, t= -1.757, p= .027), Work Experience (β= -.366, t= -2.855, p= .016). Furthermore, the result also reveals that work experience and the age of healthcare providers negatively influence their willingness. Nevertheless, as the educational level of the healthcare providers increasing, their willingness to use the technology is

also increasing. But, other variables do not contribute to HCPs' inclination towards technology utilization.

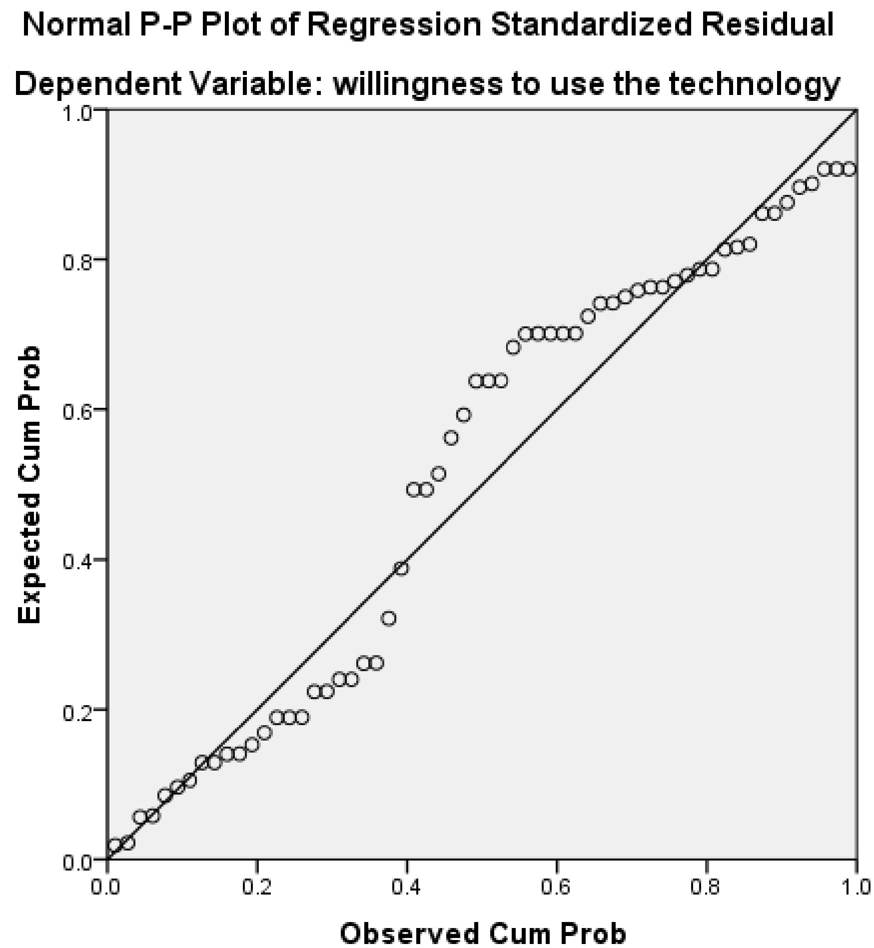

Figure 5 Probability Plot of Regression Standardized Residual

7.4. Facility readiness to adopt and implement New DHIs

Table 7. Result from the Checklist to Investigate of Facilities' infrastructure and human resource capacity

Description	Frequency	Percent
Personnel (professional IT staffs)	14	100
Are hardware & software required for healthcare deliveries readily available?	9	64.3
The dedicated annual budget for improving IT	14	100
Is there any external consultant for installation and maintenance?	8	57.1
Is there establish inputs from leadership/management for sustaining the system?	9	64.3
Any currently delivered services using technology?	14	100
Any multi-user system (connectivity among HCPs, laboratory, and others)	2	14.9
Is there a procedure to secure patients' confidentiality?	14	100
Are governmental and institutional policies are in place to promote and manage the use of DHIs?	7	50

Table 8. Computer Skills of HCPs

Computer skill of HCPs	Frequency	Percent
Fundamental (typing & using mouse)	8	13.3
Basic computing and application	16	26.7
Intermediate computing & application	34	56.7
Advanced computing and application	2	3.3
Total	**60**	**100.0**

According to Tables 7 and 8, all selected healthcare facilities have a dedicated annual budget, a procedure to secure patients' confidentiality, and are currently delivering services using technology. On the other hand, only two facilities are implemented a multi-use system (connectivity among HCPs, laboratory, and others). Only 21% of them had governmental and

institutional policies to use DHIs. Regarding the computer skills of the care providers, the majority of care providers had intermediate computing and application skill.

Table 9 Result from Checklist on the Infrastructure and Human Resource

Description		Frequency	Percent
Staff with computing skills	Data entry	2	14.3
	Database mgmt.	4	28.6
	Having all skills	8	57.1
	Total	**14**	**100**
How does your office manage computing equipment maintenance?	Outsource whenever necessary	4	28.6
	Using skills of staff on payroll	8	57.1
	No Maintenance or irregular	2	14.3
	Total	**14**	**100**
Number of computers	Below 20	4	28.6
	Above 20	10	71.4
	Total	14	100
Internet access	Wi-Fi	8	57.1
	Both Wi-Fi and cable	6	42.9
	Total	**14**	**100**
Do you have a functional Local Area Network (LAN) for interconnectivity?	NO	5	35.7
	Yes	4	28.6
	plan to establish	5	35.7
	Total	**14**	**100**
How do you ensure security for computing equipment?	Using the resident guard/police	14	100

Data of the respondents showed that 57% of facilities had skilled staff on payroll for maintaining computers and other dysfunctions related to technologies. We observed the average number of computers in each facility during data collection, it was about 20 from sampled healthcare. The majority, 71% of facilities had more than 20 computers. However, for TB and HIV clinics the average numbers of computers were found to be not more than 10. Most of the HCPs used Wi-Fi for service provision, but 43% were using Wi-Fi and broadband internet (cable). 36% of facilities had a plan to establish a functional Local Area Network (LAN) for interconnectivity to give better services.

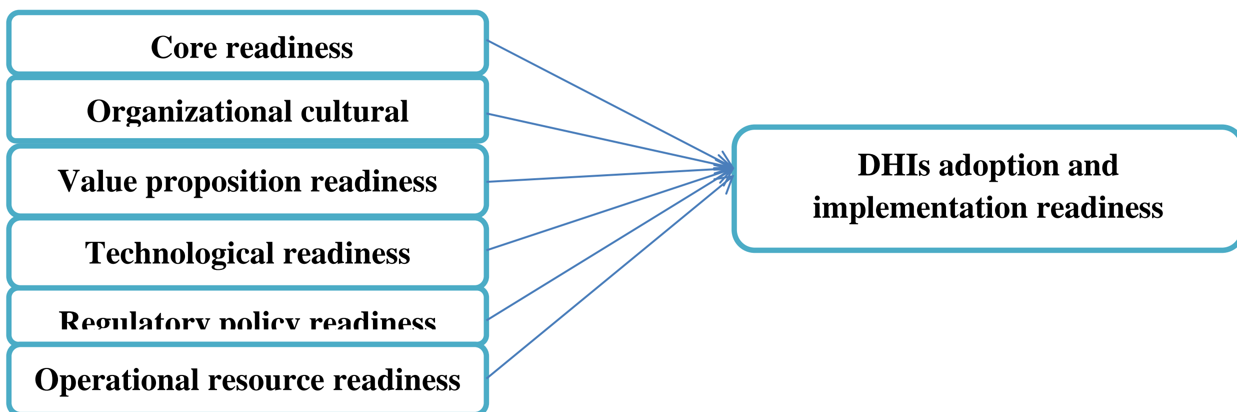

Figure 6 DHIs Adoption and Implementation Readiness model

Reliability Tests

Cronbach's alpha values for the factors: core readiness and organizational cultural readiness were 0.803 and 0.813, respectively. For value proposition readiness, technological readiness, Regulatory policy readiness, and Operational resource readiness, the Cronbach's alpha value was found to be 0.837, 0.880, 0.905, and 0.871, respectively. Such values suggest a strong interrelatedness between measuring items.

Core Readiness

Core readiness assessments are meant to guide development efforts by providing benchmarks for comparison and appraising progress. Digital health interventions readiness process based on an objective assessment leads to sound strategies that can offer a path for transfiguring good

intentions into planned action that brings real change to people's lives. Using this theme, we had assessed the strategic planning of the facility. Surprisingly, only 32% of the respondents replied positive responses regarding their need assessment plan on DHIs.

Table 10. Core Readiness table

Core Readiness		Frequency	Percent
The facility has conducted prior need assessment on the DHIs for serving the population	No never considered	12	42.9
	No, but have considered	7	25
	Yes, in progress	7	25
	Yes, nearly completed	2	7.1
	Total	28	100
There is a plan in our facility to adopt different technologies based on the assessment	No never considered	12	42.9
	No, but have considered	6	21.4
	Yes, in progress	8	28.6
	Yes, nearly completed	2	7.1
	Total	**28**	**100**
Staffs with relevant knowledge/skills are available.	Strongly disagree	6	21.4
	Disagree	12	42.9
	Neural	4	14.3
	Agree	5	17.9
	Strongly agree	1	3.6
	Total	**28**	**100**
Evidence on the practical effectiveness of DHIs and lessons learned has been drawn	No never considered	13	46.4
	No, but have considered	5	17.9
	Yes, in progress	8	28.6
	Yes, nearly completed	2	7.1
	Total	**28**	**100**

Organizational Cultural Readiness

As shown in the table 11, 82% of the given health facilities identified other interested health facilities collaborators and stakeholders. Based on this, ICAP and AHF (AIDS Healthcare Fund)

were found to be stakeholders in collaborating and facilitating the technology utilization by HCPs. These institutions mainly focused on HIV clinics, provided computers and different training for the facilities, and HCPs. Fifty eight percent of respondents believed that their management or leadership had supported DHIs initiative.

Table 11. Organizational Cultural Readiness

Organizational Cultural Readiness		**Frequency**	**Percent**
End users have been part of the process of planning	No never considered	14	50
	No, but have considered	9	32.1
	Yes, rarely participated	1	3.6
	Yes, participated	4	14.3
	Total	**28**	**100**
There are plans for creating awareness	No never considered	15	53.6
	No, but have considered	7	25
	Yes, in-process/progress	3	10.7
	Yes, occasionally done	2	7.1
	Yes, in place	1	3.6
	Total	**28**	**100**
There are measures in place to collect and evaluate feedback from users	Strongly disagree	16	57.1
	Disagree	4	14.3
	Neural	4	14.3
	Agree	1	3.6
	Strongly agree	3	10.7
	Total	**28**	**100**
The facility has identified other interested health facilities collaborators.	Strongly disagree	1	3.6
	Disagree	4	14.3
	Neural	5	17.9
	Agree	7	25
	Strongly agree	11	39.3
	Total	**28**	**100**
The DHIs initiative has been supported by management leadership	Strongly disagree	5	17.9
	Disagree	4	14.3
	Neural	2	9.8

	Agree	10	33
	Strongly agree	7	25
	Total	**28**	**100**

Value Proposition Readiness

Based on the information provided in the table 12, 68% of the respondents believed that DHIs support the care delivery mission of their respective facility. Furthermore, 93% responded that there was a system or Processes to assure patients' safety and confidentiality. On the other hand, only 39% of respondents reported that care providers in the facilities were licensed/being licensed/trained to provide care through DHIs.

Table 12. Value proposition readiness

Value proposition readiness		Frequency	Percent
The DHIs support the care delivery mission of your facility	Strongly disagree	3	10.7
	Disagree	3	10.7
	Neural	3	10.7
	Agree	8	28.6
	Strongly agree	11	39.3
	Total	**28**	**100**
All care providers have been licensed/being licensed/trained to provide care through DHIs.	Strongly disagree	4	14.3
	Disagree	12	42.9
	Neural	1	3.6
	Agree	2	7.1
	Strongly agree	9	32.1
	Total	**28**	**100**
Processes to assure patients safety and confidence are in place/being developed or in progress	Strongly disagree	0	0
	Disagree	1	3.6
	Neural	1	3.6
	Agree	9	32.1
	Strongly agree	17	60.7
	Total	**28**	**100**
Methods of improving services delivered through DHIs are being examined	No, never considered	4	14.3

	No, but have considered	4	14.3
	Yes, in progress	4	14.3
	Yes, nearly completed	6	21.4
	Yes, in place	10	35.7
	Total	**28**	**100**

Technological Readiness

From the sampled healthcare facilities, 49% of the respondents identified the medical requirements that have met the standards for properly implementing the DHIs in health facilities. Similarly, 46% confirmed that the facilities had examined the DHIs implemented in the context of workflow in their respective facilities.

Table 13. Technological Readiness

Technological Readiness		Frequency	Percent
Your facility has identified the medical requirements that have to be met using the DHIs.	No never considered	5	17.9
	No, but have considered	9	32.1
	Yes, in progress	7	25
	Yes, nearly completed	6	21.4
	Yes, in place	1	3.6
	Total	**28**	**100**
The practical viability of the DHIs has been considered, such as user-friendliness of the system for both patients/providers.	No never considered	7	25
	No, but have considered	4	14.3
	Yes, in progress	10	35.7
	Yes, nearly completed	4	14.3
	Yes, in place	3	10.7
	Total	**28**	**100**
A training session for end-users on using the e-Health technology is in place.	No never considered	12	42.9
	No, but have considered	8	28.6
	Yes, in progress	5	17.9
	Yes, nearly completed	3	10.7
	Total	**28**	**100**

The facility has examined the DHIs to be implemented in the context of the workflow.	No never considered	10	35.7
	No, but have considered	5	17.9
	Yes, in progress	5	17.9
	Yes, nearly completed	6	21.4
	Yes, in place	2	7.1
	Total	**28**	**100**

Regulatory Policy Readiness

According to the below table, the majority of the respondents, 61%, ensuring the absence of guidelines in using technology in their respective healthcare facilities. Participants blamed and critiqued the lack of any Digital Health policy document, which they understand was hampering the ability of responsible agencies to conduct and coordinate the activities of various existing silos of digital health-related projects in the facilities. However, 75% of respondents confirmed the presence of electronic data protection measures for patients in their facilities.

Table 14. Regulatory Policy Readiness

Regulatory Policy Readiness		Frequency	Percent
There is an available guideline on the use of technology	No never considered	12	42.9
	No, but have considered	5	17.9
	Yes, on process/ in progress	6	21.4
	Yes, nearly completed	3	10.7
	Yes, in place	2	7.1
	Total	**28**	**100**
There are regulations permitting the use of technology	No never considered	13	46.4
	No, but have considered	3	10.7
	Yes, on process/ in progress	6	21.4
	Yes, nearly completed	3	10.7
	Yes, in place	3	10.7
	Total	**28**	**100**
Patient electronic data protection measures are in place	No never considered	2	7.1
	No, but have considered	5	17.9
	Yes, on process/in progress	8	28.6
	Yes, nearly completed	7	25
	Yes, in place	6	21.4
	Total	**28**	**100**
Issues of liability in the use of the technology have been determined	No never considered	8	28.6

	No, but have considered	5	17.9
	Yes, in progress/on process	4	14.3
	Yes, nearly completed	6	21.4
	Yes, in place	5	17.9
	Total	**28**	**100**

Operational Resource Readiness

The process of ensuring the availability of relevant tools for DHIs usage for both care providers and care receivers/patients had been identified only by 39% of the respondents of healthcare facilities. However, 79% of respondents confirmed an excellent collaboration with IT staff to implement DHIs in the facility. Overall, most of the respondents believed that more needs to be done for IT to be fully recognized as an essential tool to improve the quality of healthcare delivery.

Table 15. Operational Resource Readiness

Operational Resource Readiness		Frequency	Percent
Relevant tools for DHIs usage for both care providers and care receivers/patients have been identified	No never considered	11	39.3
	No, but have considered	6	21.4
	Yes, in progress	6	21.4
	Yes, nearly completed	3	10.7
	Yes, in place	2	7.1
	Total	**28**	**100**
There is a good collaboration with IT staffs in order to implement DHIs in the facility	Strongly disagree	1	3.6
	Disagree	2	7.1
	Neural	3	10.7
	Agree	9	32.1
	Strongly agree	13	46.5
	Total	**28**	**100**
There are enough skills to successfully implement the DHIs system in their settings	Strongly disagree	6	21.4
	Disagree	10	35.7
	Neural	5	17.9
	Agree	4	14.3
	Strongly agree	3	10.7
	Total	**28**	**100**
Individual and collective roles have	No never considered	1	3.6

been identified	No, but have considered	6	21.4
	Yes, in progress	3	10.7
	Yes, nearly completed	9	32.1
	Yes, in place	9	32.1
	Total	**28**	**100**

Digital Health Interventions Readiness

The majority, i.e., 75%, believed that there were legitimate reasons to introduce a computer-based system in their unit. 93% of them responded that they need new tools to improve the way they workaround. However, only 25% of respondents approved that their respective facility is ready to adopt and implement digital health interventions (DHIs) to advance healthcare delivery.

Table 16 Digital Health Interventions Readiness

Digital Health Interventions Readiness		Frequency	Percent
I believe there are legitimate reasons for us to introduce a computer-based system in our unit.	Strongly Disagree	1	3.6
	Disagree	3	10.7
	Neutral	3	10.7
	Agree	10	35.7
	strongly Agree	11	39.3
	Total	**28**	**100**
We need new tools to improve the way we work around here.	Disagree	1	3.6
	Neutral	1	3.6
	Agree	9	32.1
	strongly Agree	17	60.7
	Total	**28**	**100**
I think that staff in our unit will benefit from the use of DHIs .	Disagree	2	7.1
	Neutral	1	3.6
	Agree	16	57.1
	strongly Agree	9	32.1
	Total	**28**	**100**
The deployment of DHIs will contribute to our unit's overall performance.	Disagree	2	7.1
	Agree	5	17.9
	strongly Agree	21	75
	Total	**28**	**100**

I can say the facility is ready to adopt and implement digital health interventions (DHIs) to advance healthcare delivery			
	Strongly Disagree	1	3.6
	Disagree	6	21.4
	Neutral	5	17.9
	Agree	9	32.1
	strongly Agree	7	25
	Total	**28**	**100**

7.5. Correlation analysis

A Pearson product-momentum correlation (Pearson r) was conducted to assess any significant relationship between the composite variables. The Pearson correlation coefficient quantifies the strength of a linear association between two variables and is denoted by *r (54, 66)*. The variables were being measured on a ratio scale, which is a prerequisite for using Pearson correlation. The Pearson product-moment correlation coefficient is a dimensionless index, which is invariant to linear transformations of either variable (67).

Table 17 Correlations analysis

		Core readiness	Organizational cultural readiness	Value proposition readiness	Technological readiness	Regulatory policy readiness	Operational resource readiness
Core readiness	Pearson Correlation	1	.550**	.397*	.543**	.401*	.465*
Organizational cultural readiness	Pearson Correlation	.550**	1	.404**	.801**	.538**	.486**
Value proposition readiness	Pearson Correlation	.397*	.404**	1	.528**	.419*	.514**
Technological readiness	Pearson Correlation	.543**	.801**	.528**	1	.630**	.675**
Regulatory policy readiness	Pearson Correlation	.401*	.538**	.419*	.630**	1	.576**
Operational resource readiness	Pearson Correlation	.465*	.486**	.514**	.675**	.576**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

As shown in Table 17, all variables demonstrated a positive relationship, i.e., r values were all positive in the range of 0.4** to 0.8** and $p < 0.05$ for all, suggesting the contribution of these composite variables towards the assessment of *DHIs* adoption readiness of selected healthcare facilities, as a dependable construct. The *r*-value, the correlation between Technological Readiness and Operational Resource Readiness was 0.8. According to a study conducted in Ghana, to have a significant relationship between variables, the r-value should have been at 0.8 (54). As a result, the correlation between Technological Readiness and Organizational cultural Readiness was significant in this analysis.

8. DISCUSSION

Many have argued that digital health holds the promise of enhanced efficiency and quality in healthcare. A facilitating factor for adopting and successfully implementing digital health is the acceptance and readiness of healthcare providers (68, 69).

In this study, we assessed the current technology utilization by healthcare providers, the level of acceptance and perception towards the technology, and the overall readiness of the sampled healthcare facilities to adopt and implement different new technologies. Accordingly, we have tried to present the findings of the results obtained from the data as follows.

8.1 Current Technology Utilization

Among the respondents, 80% of them have ever used different technologies in their respective healthcare facilities to support healthcare delivery. This finding is similar to other studies conducted in a similar settings in Ghana (54).

In general, according to the respondents, the internet access of the healthcare facilities was found to be 100%. However, this data had some discrepancies regarding internet access among healthcare workers. Thus, HIV care providers had more access to the internet relative to HCPs working in TB clinics. On the other hand, few Participants in this study confirmed that they used the Internet for regular medical/professional updates. This result is comparable with other studies conducted in northern Ethiopia (70). A possible reason was that the poor computer hardware and slow Internet connection at the selected healthcare facilities. More than half the participants in this study were willing to take certified web-based courses, similar to result of online surveys among health professionals done in other country (64).

Most of the healthcare providers included in the study had better access to computers at their respective healthcare facilities. This finding is essential since better access to such technology among HCPs working in healthcare facilities advances their healthcare service. Lack of access to technology, mainly to computers, is assumed to be a significant barrier to adopting ICTs in their respective workplaces, which is similar to another study (68). Besides, our study found that healthcare providers with access to computers believed that they would benefit from implementing

a digital health system. As a result, they would gain the necessary skills to implement such a system of technology in more innovative ways.

Previous studies conducted among healthcare providers in some primary care practices found that providers who used computers often were more eager regarding the technology. Besides, providers who already have been using computers believed that they could adapt to newly implemented technologies (24, 28, 64). Another study conducted in London showed that the current ICT utilization among HCPs acts as a facilitator for the acceptance and use of eHealth technologies (68). Those HCPs, who utilize computers at the center daily, believed that they had the necessary skills for the implementation of such a system compared to those who never used the computers at the center. This is in line with the findings of this study.

Some other studies found that the deficit of basic and refresher training on computers and eHealth among health professionals is the possible hindrance factor for utilizing digital health interventions that might lead to undesirable patient health outcomes (59, 71). According to the current study and other similar studies, health professionals who had ever trained for the digital health interventions were more likely to be willing to use the digital health interventions than their counterparts, as supported by previous studies (59, 64, 71). This is also in line with the existing fact that training can change the knowledge, attitude, and skills of health professionals on computer systems and increase commitment to using digital health interventions. Thus, before the actual launching of such a program, it is mandatory to assess the current level of knowledge, acceptance, and utilization habits of those HCPs in the facilities.

8.2 Acceptability and Perception of Handling and Using DHIs

Drawing from the UTAUT model, we found that a digital adherence monitoring intervention by TB care providers and smart-care is widely acceptable for supporting HIV care delivery in the selected healthcare facilities. The study confirmed that the critical factor for acceptability appeared to be perceived usefulness; for TB caregivers. Although the electronic adherence monitor was only initially intended to monitor adherence, it was also beneficial in creating a sense of being "cared for" and a sense of fear of "being caught" not adhering (72, 73). Both of which inspired participants to take the medications to maintain their ongoing relationships with the study staff, and this finding is in line with the other previous studies (41, 45).

For HIV care providers, the key factor for acceptability also appeared to be perceived usefulness; care providers could retrieve any patient-related data, including patients' card, date of appointment, CD4 count, viral load, and other pertinent information. Timely and reliable health information is the groundwork of health systems action. Information and communication technology initiatives such as Smart-Care help electronically keep documents and enhance the decision-making process (35, 59). However, it is sometimes unavailable as required because of poor managerial priority, budget allocation, and support. The current study enlightened this managerial support, guidelines, and access to strong signal internet was independent determinants for acceptability and utilization of the system. This result is similar to that of a previous study conducted another study in Ethiopia (59). This might be explained by the fact that more resources, including working manuals, would be allocated to the implementation when managerial support is in place. Undoubtedly health professionals become motivated and eager to use the technology. The computer expertise of health providers influences the readiness to accept information systems in healthcare. This is supported by other studies that affirm computer expertise directly influences respondents' perceptions of computer-based systems (62, 69).

The result from regression analysis indicated that healthcare providers' age and work experience had a negative impact or indirect relationship with their willingness to utilize the technologies. However, the educational level had a positive relationship. This result is also similar to the finding from another study conducted in Northern Ghana (69).

Several studies have indicated a positive relationship between the level of knowledge on digital health interventions and willingness to use them. The present study, as a result, identified that health professionals who had good knowledge on digital health intervention and who had a higher educational level were more likely willing to use the DHIs system as compared to those with inadequate knowledge and low educational level (34, 59, 64, 71). This might be because health professionals with sound knowledge tend to accept the advantage of technology and are more likely to use the DHIs willingly. This is supported by the study in Ethiopia conducted in the Amhara region Bahir Dar city (59).

8.3 Readiness of healthcare facilities to adopt and implement New DHIs

Based on our assessment, all healthcare facilities had professional IT staff and a dedicated annual budget to improve the IT department. Currently, all of them are delivering services using different technologies and had a procedure to protect/keep patients' confidentiality. In one or another way, the sampled health facilities used different technologies to simplify their care, providing services to their patients. These findings also align with another study conducted in Uganda (62).

Healthcare providers with good computer skills or comfortable using computers were more likely to express their readiness for DHIs implementation. Likewise, those with previous knowledge of DHIs were more likely to adopt the system in their respective facilities (67-69, 74). According to this study, 57% of care providers had intermediate computing and application skill, and 27% had basic computer skills.

Studies in other developing countries reported that poor computer skill was highly associated with the non-readiness of health professionals to implement DHIs. Given the low computer skill of healthcare providers in developing countries, the findings re-enforced the need for pre-implementation preparations to begin with adequate training of health providers on basic computer literacy and interoperability functionalities of DHIs (62, 68, 69).

This study found that the state of ICT infrastructure in selected healthcare facilities is comparable with other facilities in developing countries. Accordingly, there is a need to focus on the management of the sector to properly use ICT and improve the quality of the healthcare delivery system. Many obstacles affect digital health adoption in developing countries as part of routine health care delivery. Differing among countries, other challenges include sustainable funding, availability and adequacy of qualified HCPs, a low rate of Internet penetration and low bandwidth, lack of acceptable global standards and privacy, confidentiality and security concerns, lack of healthcare policies, and a unique patient identifier (58, 73). This finding is also well remarked by the current study.

In developing countries, there is comparatively poor technological infrastructure and fewer digital health systems installed in healthcare institutions. The focus is on basic health data collection, basic ICT infrastructure such as connectivity, and healthcare access (58, 62). Perhaps the most challenging question to answer, however, is "*when will digital health become part of the standard*

of care"? The future of digital health will depend on human factors, economics, and technology (62).

In the current study, most care providers mentioned their readiness to use different technologies over the traditional method. They had mentioned the availability of internet access (Wi-Fi and broadband internet), the readiness of generators during light interruption, and accessibility of computers as a good opportunity to implement different technologies in the future. On the contrary, the poor signal strength, lack of maintenance, and in some facilities lack of availability of a sufficient number of computers and above all absence of adequate spaces were mentioned by most of the respondents as challenges to implement digital health interventions in their facilities. As a barrier, HCPs also mentioned inadequate training sessions to implement technologies as envisioned appropriately. However, the willingness of care providers to use technologies and support from leadership/ managerial areas had been mentioned as facilitating and enabling factors for better implementation of the technology. This finding is aligned with other studies conducted in other resource constraint settings (66).

In digital innovation, networking was the groundbreaking technology that modified the landscape for the use of ICT. A computer alone is no longer the central feature of computer-based systems. Instead, it is the node on the network (45, 54). DHIs, require the use of computers in the form of HCPs digital assistance, electronic health records, computerized care providers' order entry systems by HCPs, patients, hospitals, laboratories, x-ray facilities, and all other stakeholders. This study also reveals that readily available high bandwidth can offer multimedia content, providing healthcare providers with a rich digital health experience (58, 62, 73). The lack of appropriate tools and computer utilities to access relevant and quality healthcare information deprives developing nations of realizing the networked world's full potential. The assessment of existing network capacity also involves healthcare providers' perception of the reliability and stability of Internet access. Without a proper Local Area Network (LAN) and Internet facility, inter-organizational and intra- organizational communication is impossible. The LAN is the backbone of any information system (67). According to the current study, only 1 facility established LAN and from the rest healthcare facilities, only 36% of them had a plan to establish, which is relatively poor comparing with other studies undertaken in Uganda and Saudi Arabia (62, 67).

8.3.1 Core Readiness

There is a need for DHIs needs assessment or planning to allocate resources and create internal accountability and work productivity efficiently. Need assessment offers evidence and a framework on which the planning of the organization is based. Unfortunately, most DHIs are carried out without prior performing needs assessment with the end-users and healthcare providers (54, 75). In our study, a need assessment on digital health intervention was only in 32%, similar to the previous study in Ghana and another study in a similar setting (54, 66). A comprehensive needs assessment on the application and importance of the DHIs and the services to be delivered is inevitable when a healthcare facility is poised for a successful DHIs implementation (59). It is an approach that supports people to make justifiable and informed decisions that bring about the desired results, which include exclusive health characteristics and needs of the beneficiary population. It can identify instances of effective DHIs used in comparable conditions. Prior researchers found that a comprehensive assessment will involve a permutation of methods that allow the organization to 'see the whole picture while engaging multiple approaches to form an effective and consistent assessment (62, 66).

8.3.2 Organizational Cultural Readiness

In this research study, organizational cultural readiness of healthcare facilities in stakeholders' commitment and change management demonstrated a high level of connotation with DHIs readiness. Coordination with concerned stakeholders is an essential factor that impacts readiness for digital health implementation (68). It comprises an organization's experiences, philosophy, expectations, and standards that guide members' behavior. It is expressed in members' self-image, inner workings, collaborations with the outside world, and future expectations (54, 62). In our study, most healthcare facilities identified different stakeholders who provide various supports and training. 58% of participants believe management and leadership support and are committed to implementing these digital health systems in their respective facilities, and this finding is comparable with another study in Lebanon (68).

8.3. 3 Value Proposition

The ultimate objective of healthcare facilities is to keep people healthy, protect them from chronic illnesses; that consume a significant fraction of our health care expenditures, and use medical interventions appropriately (67, 74). These can only be accomplished by the early involvement of all healthcare providers, leading to developing medical intervention products with persuasive value propositions from all stakeholders. The involvement of healthcare providers or end-users (patients) in system development also directly impacts their behavioral intention to effectively accept and use the system. However, in this particular study, it was found that prior involvement of end-users/patients in the system development is relatively low comparing to other studies (62, 68)

Healthcare providers, administrators, patients, and sponsors such as governmental or non-governmental agencies all have convincing reasons to keep the digital health intervention alive. For instance, in the case of DHIs adoption, patients would experience improved healthcare accessibility, quality, and safety. For healthcare administrators, the implementation of DHIs should provide them with better financial containment and better management of other resources. For providers, clinical effectiveness and job satisfaction will be of great importance. Lastly, for sponsors such as non-governmental agencies, the overall efficiency of the entire healthcare system will also be of great importance. As many organizations move informatics from theory into practice and realize its value, they will transform incompetent processes and improve care for all (62, 66).

In this study, most the healthcare facilities examined methods of improving services delivered through DHIs, and around 67% of healthcare providers believed that DHIs support the healthcare delivery mission of their facilities. Furthermore, the majority HCPs confirmed that the presence of procedures to keep patients' privacy and confidentiality at the time of technology utilization. This finding aligns with other findings of studies conducted in similar settings (54, 62, 68).

8.3.4 Technological Readiness

The success of technology cannot be only assessed based on how complex it is, but how simply it would be applicable and related with social life and to what extent it provides value on human life. While the importance of information technology in reducing rising healthcare costs and improving service quality is progressively recognized, significant challenges remain in how it is executed

(62). The application of IT systems is multifaceted and needs adept and adaptability to make it work. The adept could understand the systems, the selection of the most suitable systems that will offer value to consumers and remain sustainable. Numerous factors have been learned as imperative variables in defining the successful implementation of DHIs (58). ‘Infrastructural arrangements,’ however, play a central role, and it becomes tremendously important in the setting of developing countries (54).

Key technological categories are needed to support the successful execution of DHI systems. These key technology categories are recognized as Network, Hardware, Related Software, and Healthcare providers’ past IT experience. Technological readiness requires these technological categories to function reliably and adequately when necessary and should be located at the convenient reach of healthcare providers (62). In this study, it was found that around 64% of healthcare facilities had software and hardware devices to support the implementation process. and this finding is also comparable with other studies conducted in similar settings (68, 69).

8.3.5 Regulations and Policy Readiness

An absence or inadequacy of legislation and policies and liability concerns may impede the implementation of DHIs systems at the organizational and health professional level. This appears to be the condition in selected healthcare facilities found in Addis Ababa when it comes to adopting new DHIs systems. 60% of respondents confirm the absence of regulation and policy concerning the use of technologies in their respective facilities. The existence of policies at the government and organizational levels to address common issues such as licensing, liability, and reimbursement is compulsory to the adoption and proper use of digital Health by HCPs (54, 58).

As with many technology readiness assessments, in this readiness assessment study, it was essential to explore the readiness of healthcare institutions in the context of DHIs regulations and policy as a central component; as a substantial part of the state of technology in selected healthcare facilities in Addis Ababa. Almost all participants emphasized the gaps in the existing DHIs policies and recommended the crucial need for such policies if public hospitals and health centers, for that matter, were to succeed in adopting and implementing DHIs into the mainstream healthcare

environment. This finding is similar to another study conducted in other resource-constrained settings (54, 66).

8.3.6 Operational Resource Readiness

Be it in hospitals or health centers, DHI is a valuable tool for improving healthcare delivery to needy people. As DHIs essentially use the ICT platform, it requires resources ranging from finance to dedicated and skilled staffing to deliver on its promises accordingly (54, 58). In this study, all selected healthcare facilities had IT personnel in their respective facilities. Operational resources in the DHIs process represent the non-technological resources (62). According to data organized in this research, these resources were identified as finance and workforce availability. Our study realized that most HCPs have a good collaboration with IT staff; this facilitates the current technology utilization and future implementation of digital interventions.

On the other hand, there appeared to be a general lack of recognition for the potential of IT to be used to improve healthcare delivery services. The majority of respondents also believed that the relevant skills were out there in the workforce. Still, there was no employment structure for hiring and retaining personnel with the requisite skills. That was found to be a significant challenge, and the finding aligns with other studies in Ghana (54). IT's role is currently getting substantial attention due to past successes with DHIs related implementations.

8. CONCLUSION AND RECOMMENDATIONS

This research study aimed to explore and understand the current utilization status of DHIs/e-Health among TB and HIV care providers working in some selected governmental healthcare facilities in Addis Ababa. The results suggested that most healthcare providers working in TB and HIV clinics had been acquainted with using different technologies to support their healthcare delivery services in their respective health organizations.

The study identified several factors impeding DHIs utilization in selected public health facilities. These hampering factors need to be overcome and solved if health care facilities want to achieve their envisioned objectives. Notably, among these factors weak internet signal, a limited number of functional computers, insufficient refreshment training, and lack of guidance at the facility level can be mentioned as some of the hindering factors. Therefore, it would be wise and recommendable for the management and government to invest more time and money into reassuring the necessary health service supporting infrastructure. Availing an adequate and well-skilled workforce in the health facilities and providing these health institutions with well-organized infrastructure would enable them to adequately implement digital health technologies.

Future efforts should focus on optimized user training to overcome the challenges, cost-effectiveness studies, and the monitoring aspect of the device without accompanying interventions. The acceptability of technology used by HCPs is a critical factor in the sustainability and scalability of any DHIs to implement in the future. Measuring and establishing acceptability is a critical part of evaluation from the inception of any DHIs pilot project with ambitions to scale-up and sustainability.

As similar to many developing countries, there is insufficient technology infrastructure in selected healthcare facilities in Addis Ababa, Ethiopia. Thus, there would not be any meaningful development without effective and efficient telecommunication systems being in place. Thus, long-term outcomes are typically determined by factors such as the presence and reliability of sophisticated equipment and the availability of technical human resources to operate and maintain such equipment. There is also a need for ample funding to finance ordinary operating expenses, maintenance costs, and frequent upgrades that seem to be a fundamental feature of ICT systems.

Regarding the strategical readiness, factors capable of impeding DHIs adoption in selected healthcare facilities outweigh those promoting it. This implies that more significant improvements are vital to realizing a broader and more successful adoption of DHIs in public healthcare facilities. Results from this study suggest that the role of technological readiness, both internal and external, in the context of available IT infrastructure and software/hardware availability/affordability is paramount. The burden of responsibility of implementing new DHIs lies on individual healthcare facilities and higher administrative bodies. Therefore, it is better to ensure adequate and reliable IT infrastructure for the intended DHIs project is in place before proceeding with any advanced decisions by all the concerned bodies.

Furthermore, the readiness of public healthcare facilities to implement successful strategies is tied to the availability of operational resource readiness, including necessary funding and well-trained health informatics and IT workforce. While technology infrastructure establishes a platform on which DHIs can be built, there should be an assignment of committed and capable IT workforce who have adequate knowledge and skills required to implement it properly.

This study also found that organizational culture plays a critical role in the success of DHIs adoption readiness. It is, therefore, recommended that healthcare organizations should assess the necessary change in line with management principles and employees' or stakeholders' engagement.

Thus, public healthcare facilities intending to implement DHIs must continue developing strategies and plans that reflect their current need for such adoption and implementation of technologies to realize the maximum possible benefit from it to deliver health services for the needy people.

This study was conducted in selected governmental healthcare facilities in Addis Ababa. Therefore, a replication or transfer of the result of this study to other parts of Ethiopia, particularly for the rural areas and the private healthcare sector, should consider the potential differences resulting from varying cultural, socioeconomic, and infrastructural since healthcare is a much-institutionalized industry.

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10. ANNEX

Annex I: Information sheet and consent form

Title of the project:

Digital Health Interventions for Clinical Care and Treatment of Tuberculosis and HIV: Capacity and Readiness Assessment of Healthcare Facilities in Addis Ababa

Introduction:

The study will take place from January to March 2021. This form contains some details about the purpose of this study, a description of the involvement required and your rights as a participant.

Purpose of the study:

The purpose of this study is to comprehend current utilization and acceptability of digital health by healthcare providers and the overall capacity and readiness of health facilities found in Addis Ababa, Ethiopia.

The importance of this study is to get understanding on how HCPs perceived usefulness of digital health interventions in order to advance the health delivery and assess the capacity readiness of existing infrastructure to introduce a new technology.

Study procedures:

If you agree to be part of the study, we will have a one to one interview which will take 20 to 30 minutes and you will also be requested to fill in a self-administered questionnaire which will take about 10 to 15 minutes.

You are free to ask questions or raise concerns any time about the nature of the study or the methods we are using. The interview will be audio taped in order to accurately capture your perceptions in your own words. The tapes will only be used for the purpose of this study and deleted after the completion of the study. If you feel inconvenience with the recorder, you can ask to be turned off at any time. You also have the right to withdraw from the study at any time. At the time you choose to withdraw from the study, all information you provide (including records) will be deleted.

Though direct quotes from you may be used in the paper, your name and other identifying information will be omitted.

If you have any questions about the study, you can use the following contact address: +251911886883 and +251118787311.

Consent form:

I acknowledge that I have read and understand the above information. I am aware that I can discontinue my participation in the study any time and the study will not harm me in anyway. By signing this consent form I confirm that I (fill your full name) ______________________ agree to be part of the study.

Signature _______________Date______________

አባሪ 1: - የመረጃ ወረቀት እና የስምምነት ቅጽ ለጥናት ተሳታፊዎች

የፕሮጀክቱ ርዕስ-

የዲጂታል ጤና ጣልቃ ገብነቶች- ተቀባይነት እና የአቅም ዝግጁነት ምዘና- ለሳንባ ነቀርሳ እና ለኤችአይቪ ህሙማን ጤና እንክብካቤ እና አያያዝ- በ አዲስ አበባ የጤና ተቋማት

መግቢያ

ጥናቱ የሚካሄደው ከጥር እስከ መጋቢት 2021 ነው። ይህ ቅፅ ስለዚህ ጥናት የተወሰኑ የዓላማ ዝርዝሮችን፣ ከእርስዎ ስለሚፈለጉት የተሳትፎ መግለጫችዎ እና እንደተሳታፊ መብቶችዎን አካቷል።

የ ጥናቱ ዓላማ

የዚህ ጥናት ዓላማ የዲጂታል ጤና አጠቃላይ ተቀባይነት በጤና ባለሞያዎች እና በአዲስ አበባ ውስጥ የሚገኙ የጤና ተቋማት የአቅም ዝግጁነትን ለመገንዘብ ነው።

የዚህ ጥናት አስፈላጊነት የጤና ባለሞያዎችን እይታ ለዲጂታል ጤና ጣልቃ-ገብነት የጤና አቅርቦትን ለማሳደግ ምን ያህል ጠቀሜታ እንዳላቸው እና አዲስ ቴክኖሎጂን ለማስተዋወቅ አሁን ያሉትን የመሰረተ ልማት አቅም ዝግጁነት ለመገምገም ነው።

የ ጥናቱ ሂደቶች

የጥናቱ አካል ለመሆን ከተስማሙ አንድ ለ አንድ ቃለ መጠይቅ እናደርግልዎታለን፣ይህም ከ 20 እስከ 30 ደቂቃ የሚወስድ ሲሆን ከ 10 እስከ 15 ደቂቃ ያህል የሚወስድ በራስዎ የሚተዳደር መጠይቅ እንዲሞሉ ይጠየቃሉ።

ስለጥናቱ ምንነት ወይም በምንጠቀምባቸው ዘዴዎች ላይ በማንኛውም ጊዜ ጥያቄዎችን ለመጠየቅ ወይም ስጋቶችን ለማንሳት ነፃነዎት።የራስዎን ቃላት እና ግንዛቤዎትን በትክክል ለመያዝ ቃለ-መጠይቁ በድምጽ የሚቀረጽ ይሆናል ። ቴፖቹ ለዚህ ጥናት ዓላማ ብቻ የሚውሉ እና ጥናቱ ከተጠናቀቀ በኋላ የሚሰረዙ ይሆናል ። በመዝጋቢው (ቴፖቹ) ላይ ምቾት የማይሰማዎት ከሆነ በማንኛውም ጊዜ እንዲዘጋ (እንዲቋረጥ) መጠየቅ ይችላሉ። እንዲሁም በማንኛውም ጊዜ ከጥናቱ የመውጣት መብት አለዎት። ከጥናቱ ለመገለል (ለማቋረጥ) በሚመርጡበት ጊዜ እርስዎ የሚሰጡት መረጃ ሁሉ (ቴፖችን ጨምሮ) ይሰረዛሉ።

ምንም እንኳን ከ እርስዎ ቀጥተኛ አባባሎች እና ንግግሮች በወረቀቱ (በጥናቱ) ውስጥ ጥቅም ላይ ሊውሉ ቢችሉም፣ የእርስዎ ስም እና ሌሎች የመታወቂያ መረጃዎች አይካተቱም።

ስለ ጥናቱ ማንኛውም ጥያቄ ካለዎት የሚከተለውን አድራሻ-+251911886883 እና +251118787311 መጠቀም ይችላሉ።

የፈቃድ ቅጽ

ከላይ የተጠቀሱትን መረጃዎች እንዳነበብኩ እና እንደተረዳሁ እውቅና እሰጣለሁ። በጥናቱ ውስጥ ተሳትፎዬን በማንኛውም ጊዜ ማቋረጥ እንደምችል አውቃለሁ እናም ጥናቱ በ ምንም መንገድ አይጎዳኝም። ይህንን የስምምነት ቅጽ በ መፈረም እኔ (ሙሉ ስምዎን)-- የጥናቱ አካል ለመሆን መስማማቴን አረጋግጣለሁ።

ፊርማ ---------------------------- ቀን -------------------------------

Annex II: Questionnaire

Socio Demographic Data of Respondents

Section I. Instruction: please circle the letter where you feel it appropriate

1. Sex a) Male b) Female

2. Age a) 18-30 years b) 31-40 years c) 41-50 years d) 51 and above

3. Educational Level a) College Diploma b) BSc c) MSc d) If others, Specify--

4. Department a) TB clinic b) HIV clinic c) if any other, specify…………..

5. Work Experience a) Less than1 year b) 2-5 years c) 6-9 years d) 10&above

Section II-Perception of HCPS on DHIs adoption readiness of their facilities

Instruction: With all the constructs and sub constructs below, please circle the appropriate corresponding number in the columns, which BEST matches your perception/understanding on the readiness of your institution to adopt and implement Digital Health Interventions (**DHIs**).

1 = No, never considered; 2 = No, but have considered; 3 = Yes, in progress; 4 = Yes, nearly completed; 5 = Yes, in place						
	A. Core readiness					
1	The facility has conducted prior need assessment on the DHIs for the serving population	1	2	3	4	5
2	There is a plan in our facility to adopt different technologies based on the assessment	1	2	3	4	5
3	Staffs with relevant knowledge/skills are available.	1	2	3	4	5
4	Evidence on the practical effectiveness of DHIs and lessons learned has been drawn	1	2	3	4	5
	B. **Organizational cultural readiness**					
5	End users have been part of the process of planning	1	2	3	4	5
6	There are plans for creating awareness	1	2	3	4	5
7	There are measures in place to collect and evaluate feedback from users	1	2	3	4	5
8	The facility has identified other interested health facilities collaborators.	1	2	3	4	5
9	The DHIs initiative has been supported by management leadership	1	2	3	4	5
	C. **Value proposition readiness**					
10	The DHIs support the care delivery mission of your facility	1	2	3	4	5
11	All care providers have been licensed/being licensed/trained to provide care through DHIs.	1	2	3	4	5

12	Processes to assure patients safety and confidence are in place/being developed or in progress	1	2	3	4	5
13	Methods of improving services delivered through DHIs are being examined	1	2	3	4	5
	D. **Technological readiness**					
14	Your facility has identified the medical requirements that have to be met using the DHIs.	1	2	3	4	5
15	The practical viability of the DHIs has been considered, such as user friendliness of the system for both patients/providers.	1	2	3	4	5
16	A training session for end-users on using the e-Health technology is in place.	1	2	3	4	5
17	The facility has examined the DHIs to be implemented in the context of workflow.	1	2	3	4	5
	E. **Regulatory policy readiness**					
18	There is available guideline on the use of technology	1	2	3	4	5
19	There are regulation permitting the use of technology	1	2	3	4	5
20	Patient electronic data protection measures are in place	1	2	3	4	5
21	Issues of liability in the use of the technology has been determined	1	2	3	4	5
	F. **Operational resource readiness**					
22	Relevant tools for DHIs usage for both care providers and care receivers/patients have been identified	1	2	3	4	5
23	There is a good collaboration with IT staffs in order implement DHIs in the facility	1	2	3	4	5
24	There are enough skills to successfully implement the DHIs system	1	2	3	4	5
25	Individual and collective roles have been identified	1	2	3	4	5
	G. **Digital Health Interventions/e-Health readiness**					
26	I believe there are legitimate reasons for us to introduce a computer-based system in our unit.	1	2	3	4	5
27	We definitely need new tools to improve the way we work around here.	1	2	3	4	5
28	I think that staff in our unit will benefit from the use of DHIs.	1	2	3	4	5
29	The deployment of DHIs will contribute to our unit's overall performance.	1	2	3	4	5
30	I can say the facility is ready to adopt and implement digital health interventions (DHIs) to advance healthcare delivery	1	2	3	4	5

Section III: Interview based questionnaire

No	signaling questions	Yes	No	Remark/comments
1	Have you ever heard of DHIs before? If yes, what is your understanding of DHIs?			
2	Do you have a smart phone? If yes, are you willing to use your personal cell phone to receive patient related data			
3	Do you have a computer in your facility to support your healthcare delivery? If yes, How often do you use a computer?			
4	Have you ever taken an online training?			
5	Do you have any experience using electronic medical records (EHR) systems?			
6	Have you ever acquainted with using any other technology for TB/HIV patients? If yes, mention some			
7	Have you seen the advantage of using such technology over the use of the traditional method?			
8	Was the technology easy or simple to use?			
9	Did you take any related training that would help you to implement technologies? If yes, how many times did you take it? Did you find it adequate to use the new technology?			
10	Is there a favorable environment or infrastructures that enable you to use the technology?			
11	Have you got any challenges to use DHIs in your institution/facility? If so, would you please mention some of them?			
12	Have you noticed any opportunities in your facility in order to adopt new DHIs? If yes, please mention some.			

Annex III: Interview guiding questions

1. How do you get the technology that you are currently using?

   ……………………………………………………………………………………….

2. What are some opportunities and challenges to implement and utilize digital health interventions in your facilities?

   ………………………………………………………………………………………….

3. What is the perception of your patients and other staffs in using the technology?

   ……………………………………………………………………………………….

4. How would you rate your computer skills on a scale of 1 to 5? 1= Basic computer skills (need help with internet and email or office applications), 5= Proficient (able to do advanced tasks such as database management or programming) Computer skills: circle your level from Basic to Proficient

   1 — 2 — 3 — 4 — 5

5. What is your general perception about using DHIs in your institution? What do you suggest to implement it properly?

Thank you!

Annex IV: Healthcare facility assessment checklist

Name of the health facility	
Checklist Date of Completion	
Person Completing Checklist	

<table>
<tr><th>No</th><th>Needed</th><th colspan="3">Yes</th><th>No</th></tr>
<tr><td>1</td><td>Personnel (professional IT staffs)</td><td colspan="3">If yes, number of staffs</td><td></td></tr>
<tr><td>2</td><td>If yes, please specify staff with any of the computing skills</td><td colspan="3">1. Data entry
2. Basic computer maintenance
3. Knowledge to troubleshoot LAN
4. Database administration
5. Open source usage
6. Open source administration</td><td></td></tr>
<tr><td>3</td><td>How does your office manage computing equipment maintenance?</td><td colspan="3">1. Call central office
2. Outsource whenever necessary
3. Have a contracted firm
4. Have a staff on payroll
5. No maintenance/irregular
6. Do not know
7. Other: specify</td><td></td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Computers</td><td rowspan="2">If yes, number of computers per clinic</td><td>For TB</td><td></td><td rowspan="2"></td></tr>
<tr><td>For HIV</td><td></td></tr>
<tr><td>5</td><td>Are hardware and software required for healthcare deliveries readily available?</td><td colspan="3"></td><td></td></tr>
<tr><td>6</td><td>Internet access</td><td>If yes, which type</td><td>DSL/cable
Wi-Fi
Mobile data</td><td></td><td></td></tr>
</table>

7	Do you have a functional Local Area Network (LAN) for interconnectivity?	If NO, do you have a plan to establish a LAN?		
8	Dedicated annual budget for improving IT			
9	Is there any external consultant for installation and maintenance?			
10	Is there establish inputs from leadership/management for sustaining the system?			
11	Any currently delivered services using technology	If yes, please mention some		
12	Any multi-use system (connectivity among HCPs, laboratory and others)			
13	Are governmental and institutional policies are in place to promote and manage use of DHIs?			
14	Is there a procedure to secure patients confidentiality?			
15	How do you ensure security for computing equipment?	1. Resident guard/police 2. Office burglar-proofed 3. All equipment is labeled 4. Ad hoc, still a challenge 5. Act of God 6. Other:		