Healthcare workers' perspectives on the barriers and facilitators to digital health technology use to support symptomatic cancer diagnosis in South Africa and Zimbabwe: a qualitative study

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Table of Contents

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Abstract

Background: Despite improvements in early cancer diagnosis globally, morbidity and mortality in Southern Africa continue to rise. Challenges with funding, sociocultural beliefs, and healthcare access underlie the evolving cancer burden in the region. The increasing global use of digital health has the potential to expand healthcare access, particularly to remote communities, and expand support for healthcare workers (HCWs). However, there is limited research exploring the readiness to use digital health to support symptomatic cancer diagnosis in Southern Africa.

Objective: This study explored the barriers and facilitators of digital health use by HCWs to support the management of people presenting with symptoms of possible breast, cervical or colorectal cancer in South Africa (SA) and Zimbabwe.

Methods: We conducted semi-structured in-depth interviews (IDIs) with HCWs (n=56) across all levels of healthcare in SA and Zimbabwe who managed patients with symptoms of possible cancer. Conducted in English or local languages, interviews were audio-recorded, translated into English, and transcribed. Data were analyzed using framework analysis. To check the credibility of results, early findings were shared at four clinical advisory group workshops with 26 participants.

Results: Median age of IDI participants was 44 years, 38 (68%) were female, and most were nurses (n=34, 61%) or doctors (n=18, 32%). Four themes were developed: 1) the lack of reliable infrastructure (e.g., access to electronic devices, internet, and electricity) hindered technology use among HCWs; 2) the use of personal mobile devices increased digital health access at the expense of patient privacy and personal cost; 3) Information, workflow integration, and access: while digital health improved access to information, many tools were already in use, were poorly integrated into workflow, and use disrupted consultations; 4) Digital health is expanding whether we like it or not, describes a spectrum of attitudes toward digital health, ranging from enthusiasm to resistance but willingness to adapt to those completely against its use. Themes from the workshops were concordant with the IDI findings.

Conclusions: To capitalize on the potential benefits of digital health use among HCWs to improve early cancer diagnosis, infrastructural challenges must be addressed, tools designed to meet user needs and be integrated into clinical workflow. For the value of digital health to be realized in Southern Africa, as in many other resource-constrained settings, significant improvements

in development are required. In addition, where resources such as electricity are limited, its use for eHealth needs to be weighed against its use for other priorities such as operating ventilators. Furthermore, energy production in these regions is largely reliant on burning fossil fuels and use of eHealth tools risks contributing negatively to climate change. The findings of this study can be used to guide future digital health design or implementation strategies that are more contextually suitable. Clinical Trial: NA

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Authors

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Keywords

Africa; cancer; digital health; digital tool; early diagnosis; electronic health

Abstract

Background

Despite improvements in early cancer diagnosis globally, morbidity and mortality in Southern Africa continue to rise. Challenges with funding, sociocultural beliefs, and healthcare access underlie the evolving cancer burden in the region. The increasing global use of digital health has the potential to expand healthcare access, particularly to remote communities, and expand support for healthcare workers (HCWs). However, there is limited research exploring the readiness to use digital health to support symptomatic cancer diagnosis in Southern Africa.

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Results

Median age of IDI participants was 44 years, 38 (68%) were female, and most were nurses (n=34, 61%) or doctors (n=18, 32%). Four themes were developed: 1) *the lack of reliable infrastructure* (e.g., access to electronic devices, internet, and electricity) *hindered technology use among HCWs*; 2) *the use of personal mobile devices increased digital health access at the expense of patient privacy and personal cost*; 3) *Information, workflow integration, and access:* while digital health improved access to information, many tools were already in use, were poorly integrated into workflow, and use disrupted consultations; 4) *Digital health is expanding whether we like it or not,* describes a spectrum of attitudes toward digital health, ranging from enthusiasm to resistance but willingness to adapt to those completely against its use. Themes from the workshops were concordant with the IDI findings.

Conclusions

To capitalize on the potential benefits of digital health use among HCWs to improve early cancer diagnosis, infrastructural challenges must be addressed, tools designed to meet user needs and be integrated into clinical workflow. For the value of digital health to be realized in Southern Africa, as in many other resource-constrained settings, significant improvements in development are required. In addition, where resources such as electricity are limited, its use for eHealth needs to be weighed against its use for other priorities such as operating ventilators. Furthermore, energy production in these regions is largely reliant on burning fossil fuels and use of eHealth tools risks contributing negatively to climate change. The findings of this study can be used to guide future digital health design or implementation strategies that are more contextually suitable.

Introduction

Cancer is one of the leading causes of death globally, with the majority of the burden in low- and middle-income countries [1]. Breast and cervical cancers remain the leading causes of cancer-related mortality in Southern Africa [1] despite global advancements in screening, early diagnosis, and treatment. Cancer incidence in Southern Africa is rising [1, 3] owing to increased exposure to risk factors [4], an epidemiological shift to non-communicable diseases, and an aging population [5]. While health advancements have reduced breast- and cervical cancer mortality in high-income nations [3], the effectiveness and sustainability of similar strategies in Southern Africa are limited by funding, sociocultural beliefs and behaviors, and healthcare access [6]. The World Health Organization (WHO) highlighted screening and early diagnosis as the key approaches to enable cancer control. Where resources are insufficient to address both, early diagnostic capacity should be a priority [7]. Despite this, few studies explore opportunities for earlier detection in the region [2, 8] compared to extensive research on screening.

Digital health technology (DHT) use is rapidly rising in sub-Saharan Africa (SSA), where 43% of the population subscribed to mobile services in 2022 [9], and has the potential to increase healthcare access. Used interchangeably with DHTs, *eHealth* is defined as “the use of information and communications technology in support of health and health-related fields” and incorporates Electronic Health Records, health information systems, clinical support systems, and health education [10]. The benefit of eHealth is its potential to expand access to healthcare while minimizing cost, making it of interest in designing early cancer diagnostic approaches in low-resource settings. Many short-lived digital tools aiming to improve health outcomes in South Africa lack the evidence to support efficacy and feasibility [11], thus limiting potential for further investment and expansion. While the innovative and transformative capabilities of eHealth

to improve cancer health services are recognized, there is also a need to develop interventions that are underpinned by evidence-based design, and shown to be effective and feasible through reliable research and evaluation.

Mobile health (mHealth), a subset of *eHealth*, involves the use of mobile devices such as phones, and tablets for medical and public health practice. The advantages of mHealth include widespread access to devices [12], portability, and ease of connectivity to information, particularly for people in remote locations. Various forms of eHealth and mHealth interventions are available to the public/patients and healthcare workers (HCWs). Public/patient-facing DHTs are frequently in the form of mHealth and include short messaging services and mobile applications. eHealth is increasingly being adopted in healthcare to support administration, clinical management and HCW training and education [13].

This study aimed to explore the barriers and facilitators of DHT use by HCWs to support the management of people with symptoms of cancer in South Africa (SA) and Zimbabwe. This includes understanding contextual factors that could impact implementation and uptake of DHTs and user needs that should be considered for future DHT design or adaptation to existing tools.

Methods

Study design

A qualitative in-depth interview (IDI) study was conducted with HCWs managing patients with possible cancer symptoms. We also conducted workshops with clinicians to check the credibility of interview findings. The project was part of The African aWAreness of CANcer & Early Diagnosis program (AWACAN-ED) [14], which aims to advance awareness and early cancer diagnosis.

Study setting

This study was conducted in two regions of SA (The Western Cape and Eastern Cape Provinces) and two regions in Zimbabwe (Harare and Bulawayo, including their referral provinces) across all levels of healthcare. The countries were selected for variation in development and resources; SA represents a high- and Zimbabwe a middle-human development index (HDI) [15, 16]. Public healthcare in both countries consists of three tiers with increasingly specialized services. Primary-level facilities are clinics that provide basic health services usually during working hours, such as chronic care, antenatal services, and screening; they are the first point of contact for most patients with the healthcare system, and most clinical consultations are conducted by nurses. Secondary- and tertiary-level health facilities are hospitals that provide more specialized inpatient and outpatient services, including medical, surgical, and emergency services. Services offered at the secondary and tertiary levels vary across regions; cancer diagnostic and treatment services are usually managed at tertiary level. People presenting with possible symptoms of breast, cervical, or colorectal cancer usually present to primary care facilities and thereafter are referred to secondary or tertiary care for investigations (e.g., for colposcopy, mammography, biopsy, and colonoscopy) and treatment.

Sample

Potential participants were eligible for inclusion if they worked with patients presenting with symptoms of possible breast, cervical, or colorectal cancer. We used a matrix to purposively sample participants by regions, health facility

level, and job role.

Procedure

Facility managers or Heads of Department facilitated the identification of potential participants. Participants sometimes recommended other potential participants. Interested participants were asked to provide written consent prior to the interviews. Experienced qualitative researchers conducted interviews. Most interviews took place in a private setting at a health facility, while two took place virtually and lasted 30–90 minutes. Interviews were conducted in English or local languages (isiXhosa in SA and Ndebele or Shona in Zimbabwe) based on participant preferences. In one interview, three HCWs were present in addition to the main interviewee; questions were directed to and answered by the main interviewee, while the additional HCWs added details. This interview was counted as one participant. Interviews conducted in local languages were translated to English prior to transcription. Interviews were audio-recorded and transcribed verbatim using a professional transcription company. A sample of transcriptions was checked by interviewers (SM and MM) to ensure accuracy and completeness.

Interviews began with asking sociodemographic questions (age, job role, gender, education level, and years of experience). A semi-structured approach was used following a topic guide and aimed to explore (i) barriers and facilitators in the pathways to timely cancer diagnosis and (ii) perceptions of the barriers and facilitators of DHT use to support early cancer diagnosis (Appendix 1). This study focused on the analysis of part (ii) of the interview, aiming to scope infrastructural challenges, usability, and HCWs' attitudes toward DHT use. The interview guide adapted concepts from *The Technology Acceptability and Usability Survey* (TAUS), a survey developed to explore HCWs' perspectives of using an mHealth tool in Nigeria [17]. The authors of the TAUS synthesized literature on technology usability and acceptability globally to guide the development of a tool intended to be more suitable for low-resource settings and tested its validity through consultation with a panel of clinicians and researchers, before finalising its design.

Following interim analyses, four clinical advisory group workshops were conducted (two in each country) between March 18 and May 23, 2024. The participants were doctors and nurses working across all levels of care in SA and Zimbabwe. Preliminary findings were presented from the IDI as well as from a health facility audit and cross-sectional survey assessing the availability of services and infrastructure at the study sites. After presenting findings, a facilitator-led discussion using a question guide was conducted, focusing on (i) key challenges in the pathway to diagnosis for breast, cervical and colorectal cancer at each healthcare level, (ii) best practices for managing each cancer across healthcare levels, and (iii) requirements for DHT adoption to support symptomatic cancer diagnosis. Workshops were audio-recorded and transcribed, and transcription notes were recorded during the workshop.

Data analysis

We used the Framework Method to analyze the interview data, a codebook method broadly part of thematic analysis [18, 19]. The Framework Method uses an analytic framework to categorize and organize data using codes, and includes five stages after collection and transcription: (1) familiarization, (2) coding, (3) developing an analytical framework, (4) applying the framework, (5) charting data into the framework, and (6) interpreting the data [18]. Our conceptual framework incorporated ideas from the Sociotechnical Theory, which seeks to optimize social and technical factors in developing organizational systems by mapping the complex relationships between people, processes, and technological

systems [20].

After familiarization, a codebook was developed collaboratively by three coders (KDA, NT, and SM) guided by the analytical framework, and was adapted at different stages of analysis as we became more engaged with the data. Each interview transcript was indexed by two of the three coders using NVivo 14. We compared codes, highlighted disagreements, and refined the codebook through discussion, with support from SES and FMW. Final themes were developed by KDA to derive meaning from the data and answer the research question. The transcripts from the workshops were analyzed thematically by VS to categorize the content of the discussions and were then compared to the IDI findings.

Ethics

This study was part of a broader study protocol funded by the National Institute for Health and Care Research (NIHR133231) and was approved by (i) The University of Cape Town, Faculty of Health Sciences Human Research Ethics Committee (HREC Ref: 664/2021 and HREC 892/2023), (ii) The Joint Research Ethics Committee (JREC) at The University of Zimbabwe (JREC Ref: 363/2021), and (iii) the Medical Research Council, Zimbabwe (HREC Ref: MRCZ/A/2831).

Results

Participant characteristics

Fifty-six HCWs participated in IDIs, including 26 from SA and 30 from Zimbabwe, of which 24 (43%) worked in primary care and 32 (57%) worked in secondary or tertiary care (Table 1). The median age was 44 years (interquartile range [IQR]: 34–53 years), median time in their role was 6 years (IQR: 2–15 years), and most were female (n=38, 68%). Most participants (n=52, 93%) had a higher education degree (postgraduate degree, undergraduate degree, or diploma), three had Matric/O-levels (5%), and one had a certificate. Participants included 34 nurses (61%), 15 doctors (27%), 3 medical managers (5%), one health information officer, one clinical assistant, one data clerk and one receptionist.

Table 1: Distribution of interview participants across the four regions

Country	Region	Primary care	Secondary or Tertiary care	Total by region
South Africa	Western Cape	5	8	13
	Eastern Cape	7	6	13
Zimbabwe	Harare	9	9	18
	Bulawayo	3	9	12
Total		24	32	56

Definitions and current access to digital tools

We defined terms for concepts commonly identified in the data. “Digital tools” are mobile, computer or web-based applications [21] that can be used on electronic devices such as mobile phones, tablets or computers. Digital tools designed specifically for eHealth or have been adapted to be used for eHealth purposes are also referred to as DHTs. Digital tools and electronic devices were widely used in cancer healthcare services across the interviews and were more

evident and advanced in SA than in Zimbabwe, and at secondary or tertiary levels of care compared to primary care. We defined “personal devices” as electronic devices owned by the individual and “provided devices” as electronic devices purchased and owned by employing institutions. Participants used a range of digital tools on either personal- or provided devices, which we categorise into three groups (Table 2) based on their descriptions and published resources regarding specific tools. We refer to (i) “public-access tools” as digital tools available to the public on any device (personal or provided) connected to the internet (via Wi-Fi or cellular data) of which many were not designed for eHealth but can be adapted for eHealth purposes, (ii) “partially-restricted tools” were tools available on any device (personal or provided) connected to the internet but logins were restricted to sub-groups of HCWs such as doctors or administrative staff, and (iii) “restricted tools” were tools only accessible on hospital-based computers using a restricted login. Some HCWs were given “provided devices” with or without internet (Wi-Fi or cellular data) to use for work-related purposes. Provided devices were used to access “restricted tools” and “partially-restricted tools”; however, access to “public-access tools” on provided devices varied across cases. HCWs also used their personal mobile phones to access “public-access tools” and/or “partially-restricted” tools. The names of specific digital tools or DHTs have been *italicized*.

Table 2: Types of digital tools and DHTs used in healthcare described in in-depth interviews

Tool type	Description	Examples
Public-access tools	Anyone can download applications, create accounts and use the tools from anywhere and on any personal (or some provided) device connected to the internet (i.e. using Wi-Fi or cellular data) via mobile or web-based applications. Tools may or may not require payment for use. Tools were usually designed for a non-health related purposes but have been adapted for use in the healthcare setting.	*Jotform* [22] *Google calendar* [23] *Email* *WhatsApp* [24]
Partially-restricted tools	Tools that are available only to a specific sub-group of people or healthcare workers (e.g. admin staff, doctors or nurses) but can be accessed through any personal or provided device connected to the internet via mobile or web-based applications with a user login.	*National Health Laboratory Service* [25] *Vula Mobile* [26]
Restricted tools	Tools that are only available on devices provided by the local health services (e.g. facility-based computers) and have restricted access via a login and password. Internet access may or may not be required.	*Clinicom* [27] *Impilo* [28] *TriMed ePOC* [29]

Themes

Four themes were developed to demonstrate the barriers and facilitators of digital tool use among HCWs to support symptomatic cancer diagnosis in SA and Zimbabwe. All coders suggested quotes for inclusion, and by consensus with the wider team, quotes that best encompassed the meaning of the themes were selected (Boxes 1-4). Where possible, quotes were included from a spectrum of participants by regions, healthcare levels, and job roles to demonstrate similarities or contradictions across participants.

Theme 1: The lack of reliable infrastructure hindered digital tool use in healthcare

Most participants reported that the lack of reliable infrastructure hindered the use and expansion of digital tools both

through HCWs' ability to use them (Theme 1) and the impact it had on their attitudes towards them (Theme 4). This was particularly relevant to "restricted tools" on provided computers because many reported they were vulnerable to frequent power cuts, poor internet or network connectivity, and insufficient devices for the number of HCWs who needed them. Some HCWs from SA noted that challenges due to electricity cuts (referred to as "load-shedding") were partially solved by using generators; however, two participants noted that there were still brief interruptions in power supply during the changeover from electrical to generator energy that resulted in computers resetting and data loss. In Zimbabwe, generators were either unavailable or had limited power that was prioritized for essential services, such as for the use of ventilators and to operate theatre. Owing to the unstable power supply and HCWs' fear of losing data, many continued to use backup, paper-based systems alongside digital in both countries, and thus duplicated their work.

Box 1: Quotes for Theme 1

Quote	***Concept***
"Because the back-up system is not reliable. Firstly, when we lose electricity in this town, we lose network coverage. And when we lose electricity, sometimes the computers don't go on. Especially if the back-up doesn't kick in. So that impacts our work in a negative way". (Doctor, EC, SA) *"Yeah, it's okay but we need some power backup because at times there is no electricity. We can spend some 2-3 days without electricity so this will disrupt the workflow especially when you are using EHR [Electronic Health Records]." (Nurse in charge, Harare, ZM)*	*Lack of electricity and network/ internet connectivity*
"Well, you see because I have a backup book, it doesn't affect my work so much. You're stuffed if you're just on the computer. If you just electronically, it's going have quite a bit of an impact on you. But if you have some old school backup system, then you just revert back to that system." (Nurse, WC, SA) *"So, the problem is with loadshedding and often it's offline or there's something wrong and it needs an update or an upgrade. It's frustrating because you then have to go back to a manual system." (Medical Manager, WC, SA)* *"When internet is down now you go to manual and it takes time. It increases the patient's waiting time. For electricity at least we have the backup, but the backup is covering essential departments like suppose electricity goes out when the patient is on the table in theatre, or the patient is in ICU on a ventilator, so the generator should take over. …I think paper has served us well and even if we go technology, we are still supposed to promote this to fall back on." (Nurse, Bulawayo, ZM)* *"…the electrical infrastructure in the country is very poor. …when the system is down, I can't see anything and so that is a big draw back. If the whole system crushed, we would have a very big issue. … to be honest, we probably do not have adequate back up and so back up system redundancies, power back up, information back up. We do not have a cloud server. We do not have a hard drive." (Clinical assistant, Harare, ZM)*	*Duplication of work*

Theme 2: Use of personal mobile devices and public-access tools allowed for digital tool use in healthcare at the expense of patient privacy and personal cost

In SA, most participants reported using provided devices to access digital tools, compared to few in Zimbabwe.

Significant barriers to using provided devices including restricted access to the internet, being unable to use "public-access tools" such as *Google Calendar* [23], and having insufficient electronic devices. In contrast, using personal devices to access digital tools posed fewer restrictions, and most HCWs in both countries had access to a personal mobile device and used it for work. However, many noted that internet was not provided, and cellular data were unaffordable.

Many participants from SA and one in Zimbabwe highlighted that "public-access tools" gave them the autonomy to choose how to adapt them to the specific needs of their departments (such *Jotform* [22] and *Google Calendar* [23] to book appointments). Being publicly available, these tools also facilitated cross-department and inter-facility collaboration and communication without the needing approval from hospital management. While the accessibility of "public-access tools" was a major advantage, using these tools (particularly used on personal devices) raised concerns regarding protection of patient data. HCWs' frequently used *WhatsApp* [24] to communicate, and in some instances, photos and patients' personal details were shared between HCWs, despite a limited understanding of how the data were stored or protected. "Partially-restricted tools" brought about fewer data security flags as logins were still required and data not stored on devices. HCWs also appreciated that they could use "partially-restricted tools" to personal devices, particularly as hospital-based computers were unreliable or unavailable. Some HCWs drew strict boundaries on using their personal devices for work, whereas others highlighted it as the only access they had to some digital tools and accepted the personal financial cost.

In some areas, departmental leads took the initiative to use "public-access tools" in their daily practice to suit the needs of their departments. While these tools were acknowledged to play an important role in improving clinic efficiency or daily practice, having a single "champion" who oversaw the use of the tool meant its long-term sustainability was subject to their presence, even in the short-term when taking sick leave. Despite these challenges, accessibility of "partially-restricted" and "public-access" tools was a great benefit, compared to "restricted tools" which were governed by hospitals or region health departments and vulnerable to infrastructural barriers.

Box 2: Quotes for Theme 2

Quote	Concept
"But hence, I'm saying the network issues… You have to use your own network at some point to get your patient's results… if you need to call for anything you need to use your phone and your airtime." (Nurse, EC, SA)	Use of personal devices or data
"I use my personal device all the time. This [my mobile phone] is my office. …Often the computers are down, so we need to check blood results and stuff. We often use our [personal] phones. Often it's a bit faster because the internet and stuff is slow in the hospital." (Doctor, WC, SA)	
"Sometimes when I want to call maybe another department, when the phone is down, I can use my phone. My personal phone." (Nurse, Bulawayo, ZM)	
*"**Interviewer**: do you use any personally owned technological devices to support your clinical practice?* *"**Interviewee**: Yes, if you need to research on anything you use your phone because no one is giving you data, no one is giving you…" (Nurse, Bulawayo, ZM)*	
"Most people here if they are told to go and have a scan or x-ray done, the	

results will come on a disk so we will need a laptop to be able to access the content of that disk. We use our phones to take pictures... for example maybe we would have forgotten our laptops, we go to our fellow colleagues with our phones and open on their laptops then use our phones then return with pictures and attend to the patients or having patients' results being sent to our phones" (Nurse, Harare, ZM)	
"It's [mobile data] not really affordable as such, but it has become a need, a requirement- daily requirement. It's something that we have to accept that we need it." (Medical superintendent, Bulawayo, ZM) *"**Interviewer**: if you're using your personal, can you tell me more about how you go about using the internet and whether internet access is affordable for you.* ***Interviewee**: No, it's not affordable and some of the searches they are limited because I will be saving my data and also for something else. I can't just use it for clinical purposes, yet I have something to do at home. So, I will limit." (Nurse, Harare, ZM)*	Affordability
"Now the challenge there is that we have not instituted the whole privacy hyper. I do ask my patients beforehand, "Can I take a picture? Can I send it by WhatsApp?", but that's a very- has lots of holes. …I think there probably is going to be some regulation of that because abuse of that will come eventually. Most likely all patients will feel like they are not having confidentiality at some point." (Clinical assistant, Harare, ZM) *"That's what a lot of the doctors will do [use their personal devices], just out of sheer frustration. There are obviously issues of the POPI [Protection of Personal Information] Act and all of those things that become a problem, but for the patient's sake that's what they do. You'll compete with others [to use a computer] or go to another ward. You probably end up using your own device." (Medical Manager, WC, SA)*	Patient privacy
"I once introduced a booking system where we use a calendar for booking the patients but it didn't really materialise, it didn't really work out. I had to be there for it to work out but it ended up, because I left that unit, it just, they stopped using it after I left. So, I think attitude towards technology is also important. So, for it to work." (Doctor, EC, SA)	Champions

Theme 3: Information, workflow integration and access

In both countries, many HCWs noted multiple digital tools in use that all served different purposes, each with their own login details, and some restricted to certain cadres of staff. This lack of tool integration hindered workflow, and HCWs demonstrated frustration with the need to have multiple passwords. HCWs advocated for the integration of different systems with access using a single login on one application to provide all the information they needed about their patients. Many tools were designed to improve the efficiency of work and participants appreciated these functionalities, such as the use of an application to view X-Rays which had "restricted access" instead of fetching physical copies from the Radiology department, as well as the ease of access to patient information that was stored digitally compared to paper records, which could frequently get lost. However, insufficient devices or computers located in areas far away from consulting rooms disrupted workflow while they went to find available computers, diminishing the value of the tools.

Box 3.1: Quotes for Accessibility and workflow integration

Quote	***Concept***
"So, the problem with some of these databases and systems is that not everyone is allowed access." (Doctor, WC, SA) *"The availability of e-viewing devices in our institution is also limited…We have been provided with a computer. A single computer, which luckily sits in my office, in that whole gynae OPD [Out-patient Department]. But it's just a computer. There's no internet." (Doctor, EC, SA)* *"If you don't have enough computers, so sometimes you've got to compete and wait, the other guy has got to finish before you can start punching in your patient's stuff. …Often there's three or four EC [emergency centre] doctors working that's probably competing for one or two computers. That's definitely an obstacle." (Medical Manager, WC, SA)*	*Restricted access (logins and insufficient devices)*
"If there was one functional system that covered everything, a clinical working system. I don't actually care that I access it from my own phone, but one clinical system where I could access notes from [Hospital name], and they can access patient notes from [another Hospital name], that would be a huge step forward." (Doctor, WC, SA) *"That's probably one of the big problems is there's no uniform simple central one system that we can all use and it makes it easier of the patient." (Medical Manager, WC, SA)* *"But ideally if the systems were linked countrywide, it would have been easier, but I don't think they have that except this and even the ePOC- [Electronic point of care] the HIV treatment. That one also has an electronic system where if you have got your medication here, it's nationally linked." (Doctor, Bulawayo, ZM)* *"The only challenge is that it only shows here at [clinic name]. So, we wanted it to link with other clinics so that let's say we have referred someone to [clinic name], those at [clinic name] will immediately see that we have sent someone." (Nurse in charge, Harare, ZM)*	*Multiple tools with poor integration*
"Oh, it's quick. It makes things easier because you can see how well the patient has been taking treatment, and all that. You can see the viral loads. You can see everything about that patient. You can get all the information about where does she or he stays." (Data clerk, EC, SA) *"Oh, absolutely, definitely the benefits are that I can see the X-ray in any department that I am in." (Clinical assistant, Harare, ZM)* *"The benefits of using EHR [electronic health records] is at least the information is always there and the information is readily available, and it is also transmitted when it is supposed to be transmitted early." (Nurse, Harare, ZM)* *"For now, no, I quite enjoy it because you can just click, click, click, and then take… Because previously we had to take all the stickers and all the clients that we saw for the day just in case we have to go back for anything. So, it's one massive book missing. So, everything is just computerised and it's much better. I quite enjoy it because it's just much easier." (Nurse, WC, SA)* *"I think with the help of getting information. At the hospital we are not using but here we are using a*	*Easy access to information and improved efficiency with digital tool use*

system like Odoo [OnDemand Offer from OpenERP] system to capture clients' records. So, I think it lessens the work. Where you are writing four pages, you can just use it on a one-page system. So, it saves time. Then it's also efficient." (Nurse in charge, Harare, ZM) *"The benefits. I think time. It doesn't take much of your time plus storing data. Unlike paperwork, you may want it, but data will always be there. It's a very fast and convenient system." (Nurse in charge, Harare, ZM)*	

Specific to SA, some HCWs noted that tools used for referrals or appointments did not allow for instant engagement or immediate responses. *Vula* [26] is used in SA for communication between clinicians to discuss, refer patients, or book appointments. Some participants noted that responses were often received hours or days later, interrupting consultations; patients had to be sent home while awaiting feedback, and were unable to get hold of via telephone. Other tools allowed for instant bookings (for example *Jotform* [22], *Google Calendar* [23], and *Clinicom* [27]), and participants noted this as a huge advantage over other systems. Some tools were used consistently across regions, whereas others were specific to single departments or hospitals. The lack of uniformity created complexity as this required knowledge of the correct system for referral or appointments for every department, although one clinician took the time to provide feedback to referrers when they attempted to use the "wrong" route for referral.

Box 3.2: Quotes for Communication and uniformity

Quote	Concept
"I've taken it over because they had a book with stickers in. …It's all on a Google Calendar now. So, I can book a patient for a mammogram now. If you need a mammogram, I can book you one. … I can just go onto any computer, I can access my calendars. … So, it's a little bit better." (Doctor, WC, SA)	Immediate bookings
"When you refer someone, there's always a bit of a delay also on the day, because the person on the other side might be busy with other things. So, when he responds to accepting the patient and giving a fair date, it might be two or three hours down the line. That also causes a bit of waiting for the patients on our side. Often, we have to let the patient go home and say, look, give me your phone number, we'll call you back tomorrow, and that's another additional step in the process." (Medical Manager, WC, SA) *"It is not helpful to get back to someone [after a referral] the next day with a date or whatever. It needs to be an immediate response. …You're going to suck another half an hour of my life trying to find the patient again, get them to answer their phone and tell them what date they have to be at Urology. I don't have time for that. Or, maybe, they phone the patient, I don't know, and that doesn't sit well with me. So, the patient leaves me, and I don't know if it's sorted." (Doctor, WC, SA)*	Delayed bookings or responses
"Not everybody uses the same system, so you often have to phone the switchboard or somebody else to get the right place to go to, especially if it's not something that you deal with every day." (Medical Manager, WC, SA)	Lack of uniformity

Some participants in SA felt the tools were not designed to benefit patients, and they were being *"used to collect data"* (*Doctor, WC, SA*) because paper-based systems continued to be the primary method for documenting patient care. If tools had limited patient benefits and took additional time from consultation to complete, HCWs were reluctant to use them. In

comparison, tools that replaced paper systems entirely suffered from infrastructural challenges, and they frequently "switched back to manual" when electronic systems were down (Theme 1).

Box 3.3: Quotes for Tool value in practice

Quote	Concept
"I'm very sceptical of technology because it's just used to collect data with no benefit to the patient and that's not helpful." (Doctor, WC, SA)	Lack of patient benefit
"…there's quite a lot of information that you require from people [on Vula]. Sometimes you just feel, this is not necessary. But you can understand, on the other hand, that some people just refer anything. If people were allowed… So, there's got to be a way of asserting that this referral is the correct one. So, the more information they put in. So, it may be frustrating for them but this is the information you get." (Doctor, WC, SA) *"Your data capturing needs to be part of your daily routine otherwise people will not capture data. Forget about it… And that's why I stopped using REDCap…REDCap is a research tool. It's not an electronic patient record. It wasn't designed for that, so you can't do that with REDCap." (Doctor, WC, SA)*	Time consuming and requires effort to complete

Theme 4: Digital health is expanding whether we like it or not

Many HCWs were familiar with the use of digital tools in their day-to-day practice, and for some, their past negative experiences led to skepticism toward their use, particularly with regard to their reliability and feasibility in practice. The distrust in the reliability of digital tools stemmed from the unsuitable infrastructure for use (Theme 1), lack of training among staff, and wealth of other unresolved systemic issues that some were convinced would not improve with the use of digital tools. One participant in SA highlighted their skepticism in mobile health as the answer to *"reducing cervical cancer"* because they believed basic services and structural challenges underlying the poor cervical cancer outcomes needed to be resolved first, such as training and competence among HCWs.

Some HCWs acknowledged their own discomfort in using digital tools but recognized the inevitable trajectory of shifting to digital tool use in healthcare and accepted that they would need to adapt. Particularly evident among the older generation, some HCWs demonstrated a strong resistance to change, highlighting that they were too old to learn to use digital tools and electronic devices and felt it was the responsibility of the younger staff to learn, teach others, and facilitate wider adoption within the health system. Others also highlighted the need to include training to use digital tools and better support for troubleshooting as part of further tool integration and adoption. Training is discussed in more detail in a parallel paper.

Box 4: Quotes for Theme 4

Quote	Concept
"*There's quite a bit of resistance with electronic apps. Not just with me. I mean, I am not comfortable with it, but I wouldn't be resistant to it." (Nurse, EC, SA)* *"I think, it's fear. Fear of the unknown. But, I think, once the younger people get the hang of it. And change, people don't like change." (Nurse, WC, SA)*	Resistance to change and digital tool use
"So, when people are forced to, it is frustrating, and some people still don't get it but I think it's possible, especially if we get more and more of the younger generation." (Doctor, WC, SA)	Technology use among younger

	generation
"How comfortable, meaning, do I have the skill? Yes, I have the skill. But how comfortable am I in terms of, do I believe that these online mobile will reduce cervical cancer? I'm not convinced. Single-handedly, I'm not convinced," (Doctor, EC, SA). *"Everyone, when they said [Hospital name] now will pioneer with maternity they said let's go paperless tomorrow and we just warned, it's not as easy as that because we need to see how functioning it is and in parallel with the paper. We can't just go paperless." (Nurse, Bulawayo, ZM)*	Scepticism towards digital tool use in healthcare (reliability and feasibility)

Credibility checking

A total of 26 doctors and nurses (12 in SA and 14 in Zimbabwe) from all levels of care participated in the clinical advisory group workshops across both countries. Themes and recommendations derived from the workshops (Appendix 2) were concordant with the IDI findings and no additional themes were generated.

Discussion

This study explores HCWs' experiences of using DHT and the requirements for future adoption and expansion. While many previous studies explored HCWs' experiences of DHT generally [30] and for cervical cancer screening in SSA [31], few quality studies explore DHT use to support symptomatic cancer diagnosis. This study adds important insights to the limited body of literature and offers recommendations for design or adaptation of DHTs to support symptomatic cancer diagnosis in Southern Africa (Box 5).

Our findings demonstrate DHTs are used in a variety of clinical settings. However, there were widespread reports of infrastructural challenges hindering DHT use, which may have fuelled the observed skepticism about the potential it has to improve cancer outcomes. In a systematic review of barriers and facilitators to DHT use among HCWs globally [30], infrastructural challenges were similarly highlighted as a key barrier. With SA and Zimbabwe having fewer resources than the countries in the review, the investment required to prepare Southern Africa for DHT expansion will be greater than other regions globally. The poor infrastructure and distrust in DHT reliability led to parallel use of paper-based systems, and thus additional effort it required to use DHTs may have outweighed the potential efficiency value. Similarly, HCWs skepticism and the perception of usefulness were noted as barriers in other studies [30], although there was no mention of duplicated paper-based systems. Nevertheless, several participants recognised the adoption of DHT use as inevitable and were open to accepting the changes needed, and many expected the younger and more tech-savvy staff to facilitate the transition into the digital era.

Many HCWs adopted "public-access" tools such as *WhatsApp* [24] to develop informal solutions to the structural challenges they experienced, which required use of personal devices and data, at a personal financial cost and to patient privacy. Personal device use was commonly seen in other studies among HCWs attempting to tackle systemic gaps in healthcare services [32, 33]. While personal devices benefit from being more accessible, advocating for their use risks shifting the cost burden from health systems to HCWs [34]. Personal device use also makes standardisation of practice challenging and the informal pathways may disrupt or replace formal systems [32]. Interoperability, the access to- and sharing of health information between clinicians, healthcare organisations and providers, is a key principle of digital

health [35]. With HCWs using “public-access” tools, not governed by formal systems, information may only be accessible on individuals’ personal devices, therefore disabling continuity of care and the ability to use the information for auditing and quality improvement. Use of “restricted tools” also comes with its challenges. Relying on low-resourced facilities to provide electronic devices could mean there is never enough momentum to rollout a new digital intervention nor evaluate its impact. Future DHT designs should aim to ease flexibility of access, such as the devices they can be used on, while keeping data security a priority, and ensuring interoperability. This may mean adopting some aspects of “partially-restricted tools”, such as accessibility on personal devices, better data security through login-access limitations, and the ability to share information between different health actors or systems. The ethical and legal challenges of data security when HCWs use personal devices for work has been highlighted in previous studies [30, 32], although solutions were not discussed and requires further exploration, and stronger local and international guidance and policy. In our study, HCWs note DHTs caused a disruption to workflow and consultations. Other studies similarly showed that HCWs receiving phone calls can disruptive and was seen as unprofessional by patients [36], however, little is known about how this may play out when HCWs use mobile phone applications, and warrants further exploration.

There is growing debate about the impact eHealth use could have on climate change. The value it has in tackling climate change lies in the reduced use of transport from virtual services, such as telemedicine replacing face-to-face consultations, and electronic record keeping and communication such as prescriptions and referrals that reduce the need for paper-based systems [37]. However, eHealth can also contribute negatively through the production of electronic waste and increased consumption of electricity [38], which in many low-resource settings are reliant on burning fossil fuels, potentially mitigating the value eHealth has in reducing emissions [37]. Furthermore, in SA and Zimbabwe, electricity is limited, and use is prioritised for essential systems such as operating theatres and ventilators, among many others. While a switch to renewable energy production could create an adequate and sustainable electricity supply, this requires major investment and development extending beyond the health sector [39].

In interviews, HCWs noted that internet access was limited. Future DHT interventions should explore the possibility of no- or low data usage applications, or those that can be used offline and uploaded retrospectively. Mobile data is exceptionally expensive in SSA, with Zimbabwe having the most costly data globally (43.75 USD/gigabyte[GB]) [40], while other countries in the region have strikingly lower data costs despite similar HDIs, for example, Malawi (0.39 USD/GB) and Mozambique (0.78 USD/GB) [40]. Governments in SA and Zimbabwe should consider strategies to reduce the excessive cost, provide free or subsidised internet and invest in infrastructure to improve access. DHTs have the potential to improve healthcare access to remote communities, however, those in more resource limited and rural areas often lack internet and electricity [34]. Unless these issues are addressed, eHealth could inadvertently worsen health inequities. The United Nations Development Programme recommend guidance on DHT use and human rights, highlighting strategies to promote inclusive digital transformation and minimise the risk of exacerbating health inequalities [39], such as promoting open-access DHTs and facilitating infrastructural development.

Prior to developing eHealth interventions for early cancer detection, the availability of resources for the next steps in the cancer pathway should be assessed. SA has mostly free or subsidised healthcare services in the public sector [41] but in Zimbabwe, a significant burden of costs fall on patients [42, 43]. Without improving access to services in next steps in the cancer pathway, such as for investigation, diagnosis and treatment, DHT interventions to improve early detection may be futile and ethically questionable. There is already an overwhelming number of DHTs in use, and policymakers should consider better integration or adaptation of existing tools to streamline current practices before embarking on new developments.

Box 5: Recommendations for future digital health tool development and implementation

Digital tool and implementation specific recommendations

- Flexible accessibility– e.g. “partially-restricted” tools
- Interoperability – access to information by different actors (HCWs, providers, auditors)
- Single tool to access all patient information or tool integration across multiple tools
- Single login for all tools
- Usable with limited or no internet connection
- Adheres to local/national health data security recommendations
- Training to use digital tools and support for troubleshooting
- Desirable tool functions – immediate bookings, user autonomy, easy access to information, communication across departments
- Tool replaces paper system and has adequate back-up system (i.e. no duplication)
- Tool use for patient care as the primary aim and data capture as the secondary aim
- Tool should improve efficiency of work and minimise additional time from consultations
- Easy to use – accessible with limited digital proficiency

Infrastructural recommendations

- Uniformity in systems used across healthcare facilities and levels within regions, supported using guidelines to identify clear pathways for referral and/or digital tool use
- Involvement of higher managerial levels to oversee use and sustainability
- Use of “tool champions” with contingency plans for staff changes
- IT support for ongoing maintenance and sustainability

Strengths and limitations

The study’s involvement of a diverse sample from two countries with differing HDIs, and the triangulation of IDI findings in workshops, strengthens its credibility in reflecting the views of its participants. Data analysed from IDIs in Zimbabwe had less depth than SA. This could partly be explained by the interviews in Zimbabwe being conducted mostly in local languages and led to loss of depth and misinterpretation of meaning during translation. As a result, the study highlighted stronger patterns and drew more conclusions from the South African context than Zimbabwean.

Conclusion

DHT use has the potential to improve early cancer diagnosis in Southern Africa and expand access to care. However, to capitalise on its potential benefits, future interventions or adaptions to existing tools need to consider addressing infrastructural challenges, design tools to suit the user needs and be well integrated into workflow. The need for essential resources to adopt DHTs, including electricity and water, in low-resourced areas should be weighed against the need in competing priority areas such as operating theatre, particularly as the long-term resource availability is threatened by global warming. As energy production in these regions is largely reliant on fossil fuels, eHealth risks impacting the climate negatively. The findings of this study can be used to guide DHT development or adaptation, and design of more contextually suitable implementation strategies.

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Data availability

The data related to the preparation of this study can be made available on request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Abbreviations

AWACAN-ED: The African aWAreness of CANcer & Early Diagnosis
DHT: digital health technology
EC: Eastern Cape
eHealth: electronic health
EHR: electronic health records
GB: gigabyte
HCWs: healthcare workers
HDI: Human Development Index
IDIs: in-depth interviews
IQR: interquartile range
mHealth: mobile health
NHLS: National Health Laboratory Service
PHC: primary healthcare
SA: South Africa
SMS: short-messaging services
SSA: sub-Saharan Africa
TAUS: Technology Acceptability and Usability Survey
UNDP: United Nations Development Programme
USD United States dollar
WC: Western Cape
WHO: World Health Organization
ZM: Zimbabwe

Supplementary Files

Multimedia Appendixes

Interview guide.
URL: http://asset.jmir.pub/assets/59d34a2ad2861f96cbac99ec1b9eebaa.docx

Findings from clinical advisory group workshops.
URL: http://asset.jmir.pub/assets/e92fbadc583c7e16b2e4077ef5165e94.docx