

Digital Health Interventions for Early Cancer Detection and Referral Pathways in Sub- Saharan Africa: A Scoping Review

Chigbo Chisom Godswill

chizomgodswill@gmail.com

University of Port Harcourt

Omosivie Maduka

University of Port Harcourt

Temitope Olukomogbon

Institute of Human Virology

Nneoma Harris

GROW (Guyana Research and Outreach for Wellbeing)

Ayobami Ademola

Institute of Human Virology

Olushola Oyewande Tinuoye

Mountain Top University Ibafo Ogun State

Emeka Odiaka

Institute of Human Virology

Elima Jedy-Agba

Institute of Human Virology

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Abstract

Background

Cancer has been a leading contributor to death globally; it accounted for about 10 million deaths in 2020 alone, or about 1 in 6 deaths. While high-income nations have achieved major improvements in survival through early diagnostic pathways, organized screening initiatives, and advanced health information solutions, several low and middle-income countries continue to experience widening differences in outcomes. Sub-Saharan Africa (SSA) has witnessed an increase in digital innovation and mobile connectivity, which has established fresh opportunities to mitigate long-term health solution gaps through appropriate digital systems. However, implementation has occurred in isolated pilot projects with limited evidence synthesis on their efficiency, scalability, and scope within countries' health systems.

Aim

This scoping review aims to systematically map the digital health interventions' landscape that support, surveillance, early cancer detection and referral pathways across the SSA region, detailing the contexts of their implementation, and assessing factors that affect their scale-up and sustainability.

Methodology:

The systematic search was performed in Google Scholar, Scopus, and PubMed databases and complemented by grey literature. We identified 2047 records published from January 2010 to February 2025. After excluding 327 duplicates, 1720 titles/abstracts were screened with the PCC (Population, Concept, and Context) framework eligibility requirement and which 1582 records were removed. Furthermore, 138 full-text articles were retrieved and evaluated for eligibility. After the full-text screening, 108 studies were removed. Generally, 30 studies met the inclusion criteria and were involved in the final synthesis. They contained 18 peer reviewed articles and 12 eligible grey literature studies.

Result

Across the 18 peer-reviewed articles, most studies concentrated on cervical cancer prevention pathways, which reflected the VIA suitability, HPV DNA testing, and digital cervicography for remote supervision and task sharing in SSA. The major countries represented in the peer-reviewed studies included Kenya, Botswana, Tanzania, Madagascar, and Rwanda. Types of intervention clustered into the following: Mobile phone or SMS communication for outcome notification and screening uptake; Smartphone-based cervicography plus decision support for quality enhancement of VIA (Vertical Interconnect Access). c. Application of mHealth to support society health workers plus home-centred HPV testing pathways. d. Tele-triage or telepathology to fasten diagnostic confirmation plus referral. e. Smartphone tools for detection of early signs plus triage of suspicious lesions. On the other hand, grey literature majorly explained multi-country or national digital cancer data solution strengthening and evaluation of telehealth needs that are relevant to referral coordination, early detection, plus surveillance. These were frequent in Nigeria, Rwanda, and Zambia, and were helpful for mapping readiness of scale up, interoperability objectives, and implementation limitations instead of estimating effectiveness.

Conclusion

This review indicates that digital innovations are increasingly utilized to address significant gaps in the cancer care pathway, especially in screening support, communication, data management, and diagnostic linkage. Mobile communication measures, telepathology platforms, smartphone screening technologies, and initiatives on digital registry have shown promise in solidifying service delivery in poor settings. However, the evidence shows that most interventions are still program-level implementations or localized pilots, with little integration into countries' health systems.

Introduction

Cancer has been a leading contributor to death globally; there were close to 20 million new cases of cancer in the year 2022, alongside 9.7 million deaths from cancer [1]. According to the WHO (2025), in 2020, the most common causes of cancer death were lung (1.80 million deaths); colon and rectum (916 000 deaths); liver (830 000 deaths); stomach (769 000 deaths); and breast (685 000 deaths). Every year, up to 400 000 children develop cancer [2]. The most common cancers differ between nations, as cervical cancer is the most common across 23 countries [2]. While high income nations have achieved significant enhancements in survival via early diagnostic pathways, organised screening initiatives, and advanced health information solutions, several low-and middle-income (LMICs) countries continually observe widening differences in outcomes [3]. As noted by Dillner (2019), early detection is an effective approach in minimising cancer mortality, however, its success relies majorly on symptoms' timely identification, effective referral pathways, and organised surveillance systems [4]. Internationally, digital health technologies like telemedicine, mobile health applications, and electronic medical records are revolutionising how health solutions identify disease earlier, link patients to cancer care, and track outcomes [5]. These mechanisms and tools have allowed remote screening assistance in rural areas, quicker diagnostic consultations, and enhanced data-driven decision implementation [5].

In SSA, the cancer burden is growing rapidly largely due to an epidemiological transition, urbanization, and fast demographic growth [6]. The SSA region has one of the biggest case-fatality rates worldwide, with estimates showing about 70% of cancer cases diagnosed at late or advanced stages [6]. According to Day et al. (2025), shortages of trained/educated specialists, limited screening infrastructure, poor-quality cancer registries, and fragmented referral pathways contribute to delays that can extend from symptom recognition to definitive diagnosis by several months [7]. Egilsdóttir et al (2022) noted that patients in rural areas sometimes navigate several degrees of care with no coordinated monitoring, which results in loss to follow-up plus missed opportunities for cancer early treatment [8]. Similarly, the SSA region has witnessed an increase in digital innovation and mobile connectivity, which has established fresh opportunities to mitigate long-term health solution gaps via appropriate digital systems [9].

Governments, non-governmental organizations, and global health partners have, in the past decade, overseen various digital interventions designed to strengthen referral coordination and early cancer detection [10]. They include electronic referral monitoring systems, SMS awareness platforms, telepathology networks connecting peripheral infrastructures to urban specialists, plus digital cancer registries to enhance the accuracy of surveillance [11], [12]. In spite of these promising attempts, implementation has sometimes occurred in isolated pilot projects with limited evidence synthesis on their efficiency, scalability, and scope within countries' health systems. In this sense, this review aims to systematically map the digital health interventions' landscape that support referral pathways, early cancer detection, plus surveillance across the SSA region, explain the contexts of their implementation, and assess factors that affect their scale-up and sustainability. Also, the scoping review was guided by the central question of what digital health interventions have been implemented to solidify referral systems and early cancer detection in the SSA region, and what lessons they provide for adopting digital innovation into system-wide, resilient cancer control measures.

Review Objectives

1. Determine the kinds of digital health tools for supporting SSA early cancer detection and diagnostic pathways.
2. Explain the implementation contexts, settings, plus cancer types targeted by these interventions.
3. Assess the reported barriers and facilitators that influence implementation and scale-up.
4. Ascertain the evidence gaps and implications for transitioning digital cancer innovations from pilot stages to scale.

Methods

Study Protocol

This review followed the methodological guidance for evidence mapping and was reported based on the PRISMA-ScR. The protocol explained the eligibility requirements, review scope, and analytical strategy before the search. The Population-Concept-Context framework guided the review. It focused on digital health interventions, populations at risk of cancer, and referral, early detection, or surveillance in SSA.

Inclusion Requirement

In this review, the eligible sources included a digital health intervention that supports cancer detection, referral coordination, diagnostic pathways, or surveillance in one or more SSA nations. Also, important implementation reports and peer-reviewed articles published from 2010 to 2025 were included in the review. Studies that focused mainly on treatment, performed outside the SSA region, or lacked a digital element were excluded.

Information Sources and Search

Systematic searches were performed in databases of Google Scholar, Scopus, and PubMed. It is supplemented by tailored grey literature searches of international health agencies, institutional repositories, plus program websites. In addition, keywords combined terms associated with cancer detection, digital health, telemedicine, mHealth, SSA, and referral systems. Searches were limited to English-language articles from 2010 to 2025.

Study Selection

The search outcomes were imported into a reference management tool for deduplication. Abstracts and titles were screened for eligibility, and full texts were evaluated. From the original pool of more than 2,000 records, 30 articles met every criterion and were involved in the review. The 30 articles included 18 peer-reviewed sources plus 12 grey literature documents that explained implemented digital interventions.

Data Extraction

The review used a standardized charting template to extract key information, including country, type of digital intervention, cancer focus, implementation setting, function (surveillance, referral, or detection), and operational results.

Data Analysis

Lastly, the extracted data were descriptively synthesized. Interventions were organized by function and implementation context to map the range of digital strategies utilized in the region and to determine deployment patterns, rather than

evaluating effectiveness.

Results

Study Selection

As noted, the systematic search conducted in the Google Scholar, Scopus, and PubMed databases was complemented by grey literature searches. It identified 2047 records that were published from January 2010 to March 2025. After excluding 327 duplicates, 1720 titles/abstracts were screened with the PCC framework eligibility requirement. Here, 1582 records were removed because they lacked a digital health element, did not address cancer, were done outside SSA, or focused solely on palliative care or treatment without connection to referral pathways, early detection, or surveillance. Further, 138 full-text articles were retrieved and evaluated for eligibility. After the full-text screening, 108 studies were removed. The major reasons for the removal included inadequate implementation or methodological detail to support data collection ($n = 39$), interventions mainly on treatment without referral, detection, or surveillance ($n = 27$), implementation outside SSA ($n = 22$), and lack of an explicitly explained pathway element or digital tool ($n = 20$). Generally, 30 studies met the inclusion criteria and were included in the final synthesis. They contain 18 peer-reviewed articles plus 12 eligible grey literature studies, including institutional documents, program reports, and implementation outcomes. Figure 1 summarizes the study selection procedure in accordance with PRISMA guidelines.

Study Characteristics

Across the 18 peer reviewed articles, most concentrated on cervical cancer prevention pathways, which reflected the VIA suitability, testing of HPV, and digital cervicography for remote supervision and task sharing in the SSA region. The major nations represented in the peer-reviewed studies include Kenya, Botswana, Tanzania, Madagascar, and Rwanda. Types of intervention clustered into the following: a. Phone or SMS communication for outcome notification plus screening uptake. b. Smartphone-based cervicography plus decision support for quality enhancement of VIA. c. Application of mHealth to support society health workers plus home-centred HPV testing pathways. d. Tele-triage or telepathology to fasten diagnostic confirmation plus referral. e. Smartphone tools for detection of early signs plus triage of suspicious lesions. On the other hand, grey literature articles majorly explained multi-country or national digital cancer data solution strengthening and evaluation of telehealth needs that are relevant to referral coordination, early detection, plus surveillance. These were frequent in Nigeria, Rwanda, and Zambia, and were helpful for mapping readiness of scale up, interoperability objectives, and implementation limitations instead of estimating effectiveness.

i. Peer-reviewed articles ($n = 18$)

Table 1
Summary of Peer-reviewed studies

S No.	(Author and year)	Nation	Cancer emphasis	Digital intervention	Role (surveillance/detection/referral)	Settings
1.	Mpunga (2016)	Rwanda	Mixed cancers	Telepathology triage system	Referral and diagnosis support	Cancer center/ rural referral hospital
2.	Huchko (2019)	Kenya	Cervical (HPV screening)	Cell phone outputs delivery (call or text options)	Referral (outcomes→ follow up)	Screening programs (clinic plus outreach)
3.	Erwin (2019)	Tanzania	Cervical	SMS attitude change messages ± eVoucher transportation	Detection (heighten uptake of screenings)	Society connected screening
4.	Quinley (2011)	Botswana	Cervical	Mobile telemedicine using cervix images upon VIA	Detection and referral support	See/treat screening clinics
5.	Gormley (2010)	Botswana	Cervical (HIV positive females)	Mobile phone cervix photo capture+ remote review	Detection and referral support	Clinic-centred screening
6.	Catarino (2015)	Madagascar	Cervical	Smartphone-centred VIA images using off site diagnosis	Detection (QA/ triage)	Screening campaigns
7.	Gallay (2017)	Madagascar	Cervical	Smartphone image app for VIA/VILI as colposcopy alternative	Detection (image supported evaluation)	Screening campaigns
8.	Quercia (2018)	Madagascar	Cervical	Mobile data gathering system to track screening respondents	Surveillance and follow up monitoring	Screening campaigns
9.	Urner (2017)	Madagascar	Cervical (HPV positive triage)	Smartphone triage strategy under screening workflow	Detection (triage)	Screening program
10.	Yeates (2020)	Tanzania	Cervical	SEVIA platform for image sharing, QA, tracking, and supervision	Detection and referral pathway support	Multi facility/ national screening services
11.	Ferguson (2024)	Tanzania	Cervical	SEVIA program's implementation evaluation	Detection and quality enhancement	Rural and Urban screening sites
12.	Peterson (2016)	Kenya	Cervical	EVA system decision support	Detection and tracking (program QA)	Screening program/camp

S No.	(Author and year)	Nation	Cancer emphasis	Digital intervention	Role (surveillance/detection/referral)	Settings
				job aid + image portal		
13.	Mink (2016)	Kenya	Cervical	Implementation case study: MobileODT EVA system approach.	Detection and QA tracking	Screening programs
14.	Stocks (2022)	Kenya	Cervical (HPV based screening)	Qualitative development study: mSaada CHV support application	Detection and referral facilitation	Community health and CHVs
15.	Nguyen (2025)	Kenya	Cervical (HPV testing)	mSaada pilot for home-based HPV pathway	Detection and referral facilitation	Community and home-focused screening
16.	Rubagumya (2020)	Tanzania	Skin cancer risk (albinism)	Smartphone application to obtain expert review + lesions	Detection (triage)	Cancer institute and outreach
17.	Zeufack (2025)	Kenya	Cervical	Pocket colposcope feasibility in nurse-base screening	Detection (image supported screening)	Nurse headed screening clinics
18.	Linde (2020)	Tanzania	Cervical	Connected2Care: One-Way Text Messaging	Detection and uptake of screenings	Clinic-centred screening

ii. Grey Literature Studies (n = 12)

Table 2
Summary of Grey literature studies

No.	(Source and year)	Nation	Cancer emphasis	Digital intervention/system	Role (surveillance/detection/referral)	Setting and level
1.	CHAI, 2023 White Paper	Zambia	Cervical	SmartCerv digital repository for program patient data	Surveillance and pathway tracking	Facility and program level
2.	CHAI, 2023 Web page	Zambia	Cervical	SmartCerv execution summary (offline capable digital system)	Surveillance and follow up monitoring	Facility and program level
3.	IARC, GICR, 2023 PDF	Multi (Rwanda led)	Registry	E-NNOVATE DHIS2 Oncology module plus CanReg linkage	Surveillance	National and registry systems
4.	IARC, GICR, 2023 page	Multi (Rwanda led)	Registry	E-NNOVATE DHIS2-CanReg app overview	Surveillance	National and registry systems
5.	SPIDER Centre, Telehealth.report	Zambia	Cervical	Telehealth needs evaluation for cervical screening plus care	Detection plus referral pathway support	National and system readiness
6.	SPIDER Centre, Telehealth.report	Kenya	Cervical	Telehealth needs evaluation for cervical screening plus care	Detection plus referral pathway support	National and system readiness
7.	NICRAT, 2023 report	Nigeria	Cancer control	Nigeria impACT review report (capacity plus system gaps)	Surveillance and referral strengthening	National
8.	IAEA, impACT report	Nigeria	Cancer control	Nigeria impACT review report (IAEA hosted copy)	Surveillance and referral strengthening	National
9.	Zambia NCCSP 2022–2026	Zambia	Cancer control	Usage of CanReg5 plus registry info system details	Surveillance	National
10.	ENCR abstracts, 2023	Rwanda	Registry	Adoption of Rwandan cancer registry into DHIS2 (conference abstract)	Surveillance	National plus registry
11.	DHIS2 community program page	Global and SSA relevant	Registry	Integration of CanReg5 with DHIS2 (description of session)	Surveillance	National plus registry
12.	NICRAT page (announcement)	Nigeria	Cancer control	ImpACT report access point	Surveillance and system planning	National

Figure 2. Geographic distribution of included studies in SSA (n = 30)

Study Designs and Methods

Across the included studies, methodological strategies reflected the early implementation stage of digital cancer interventions in SSA. Of the 18 peer-reviewed articles, 6 employed experimental or quasi-experimental designs, including RCTs that assessed mobile-based delivery of results, SMS reminders, and digitally based screening pathways to enhance follow-up and uptake. 8 articles utilised feasibility or observational designs to validate telepathology platforms, smartphone-based cervicography, or mobile decision-support technologies, which evaluates usability, diagnostic concordance, or integration of workflows across the screening services. Furthermore, 4 articles employed qualitative or mixed-methods designs, which combine system deployment with interviews or usability testing to explore acceptability among patients, providers, and community health workers. On the other hand, the 12 grey literature studies were technical program documents or descriptive implementation reports. They concentrated on regional or national system deployment like digital cancer registries, telehealth program rollouts, and DHIS2-linked oncology modules, and offered operational ideas instead of comparative assessment. Overall, the 30 included studies are dominated by descriptive implementation research (12/30) and feasibility (8/30) studies with fewer robust efficiency studies (6/30), which highlights the transition of the field from the pilot testing stage to scalable adoption.

Critical Appraisal

As shown in Fig. 3, the methodological quality of the 30 studies was evaluated with the MMAT (Mixed Methods Appraisal Tool), which is appropriate for scoping reviews that involve heterogeneous study designs like RCTs, qualitative research, implementation reports, and observational studies. From the 18 peer-reviewed articles, 6 experimental or quasi-experimental sources met most of the MMAT requirements. They showed defined study questions, outcome measures, and acceptable data gathering process. Nevertheless, just 2 studies reported comprehensive consideration of confounding components, as none involved cost-effectiveness analysis or long-term follow-up. In addition, 8 observational or feasibility articles indicated moderate methodological quality. They offered sufficient descriptions of intervention implementation plus context, however, they often lacked comparator groups, depended mostly on small sample sizes, and focused mainly on operational results instead of effectiveness. Also, the 4 mixed-methods articles showed appropriate adoption of quantitative and qualitative elements, although reporting on the process of data integration was often limited. Meanwhile, the grey literature were not published as evaluative research and thus were appraised for clarity of intervention description, transparency, and relevance to implementation context rather than internal validity. The documents constantly explained deployment processes, system design, and operational issues, but hardly involved formal assessment metrics. In general, this body of evidence was found to be moderate in methodological quality, with powerful representation of implementation and feasibility research but restricted high-rigour effectiveness studies. This reflects the developmental phase of SSA digital oncology interventions.

Synthesis of Evidence Across Included Studies

a. Types of digital health tools utilised to support early cancer detection

The included studies identified 4 major divisions of digital health interventions. Firstly, mobile health communication tools were utilised to enhance uptake of screening and patient engagement. Quasi-experimental and randomised studies like Wanyoro and Kabiru (2017) in Kenya [13], Erwin et al in Tanzania [14], and Huchko et al in Kenya [15] implemented phone result notification, SMS messaging, or reminders to elevate cervical cancer screening attendance plus follow-up visits. Secondly, smartphone visual evaluation technologies were widely utilised to solidify the quality of frontline screening. Publications from Madagascar's Urner et al [16], Gallay et al [17], and Catarino et al [18] plus the work of Ferguson et al [19] and Yeates et al [20] in Tanzania, reported the usage of digital cervicography platforms like SEVIA to capture cervical images, back up remote expert review, and direct treatment decisions in visual inspection using VIA (acetic acid). Similarly, Mink et al [21] and Peterson et al [22] in Kenya described the EVA system (an

enterprise unified commerce platform) as a mobile platform that integrates image capture, program monitoring, and decision support. Thirdly, telemedicine plus remote diagnostic systems were utilised to mitigate specialist shortages. In Rwanda, Mpunga et al [23] used telepathology to hasten diagnostic triage between referral centres and rural hospitals, while in Tanzania, Rubagumya et al [24] adopted smartphone-focused evaluation for early determination of suspicious skin lesions across high-risk groups.

Fourth, community health tools and digital workflow were designed to support decentralised screening methods. In particular, the mSaada app documented by Nguyen et al [25] and Stocks et al [26] in Kenya assisted health volunteers in the community to direct HPV-focused screening plus referral pathways. Meanwhile, grey literature studies supplemented these results by talking about the system-degree digital platforms. For instance, Zambia SmartCerv program via Clinton Health Access Initiative [27] designed a digital repository to monitor treatment, screening, plus follow-up data, whereas the E-NNOVATE program organised by IARC [28] explained the DHIS2-focused oncology modules that connects facility data with countries' cancer registries.

b. Implementation contexts, settings, and targeted cancer types

Many interventions concentrated on the screening of cervical cancer in outreach or primary care settings, which reflects digital augmentation's programmatic feasibility. These were implemented in mobile clinics, district hospitals, or society-based screening campaigns in Tanzania, Kenya, Botswana, Madagascar, and Zambia. Telepathology plus diagnostic support efforts like the Rwandan's Butaro Cancer Centre program were carried out in referral hospitals to solidify diagnostic capacity. In addition, the grey literature sources such as Zambia's National Cancer Control Strategic Plan [29] and Nigeria's imPACT Review [30] explained the strengthening of national digital registry plus the importance of surveillance infrastructure to enhance coordination and case reporting within facilities.

c. Barriers and facilitators affecting scale-up and implementation

From both grey literature and peer-reviewed studies, interventions repeatedly reported operational enablers like enhanced communication between providers, minimised delays in getting results, plus improved screening activities documentation. For instance, Tanzania's SEVIA research reported enhanced supervision plus screening services quality assurance [19], while the SMS-focused interventions showed elevated follow-up attendance [14]. Moreover, implementation reports from IARC (E-NNOVATE) [31] and CHAI (SmartCerv) documented facilitators like adoption with existing platforms of health information and education of frontline health personnels to utilise digital technologies [32].

d. Evidence gaps and implications for shifting from pilot to scale

The studies generally indicated that many interventions were carried out as pilots, program demonstrations, or feasibility studies instead of fully institutionalised national solutions. Several articles reported short implementation timeframes plus localised deployment in specific facilities or districts. Grey literature focused on ongoing initiatives to shift towards integrated surveillance technology, especially via DHIS2-connected oncology data platforms and national cancer registry improving programs [33].

Discussion

As reported in the results section, this review mapped 30 studies and detailed digital health interventions that support referral coordination, early cancer detection, and surveillance in SSA. Across the body of evidence, the most repeated signal is that *digital oncology* in SSA is driven less by large-scale effectiveness trials and more by concrete service-delivery requirements. That is, ways to reach people, triage risk, document screening, and extending the oversight of specialists into environments with limited oncology plus pathology capacity.

An explicit pattern is the centrality of cervical cancer pathways as the major digital tools' testing ground. This is not accidental. Workflows on cervical screening include repeated processes that are simple to digitise (appointment reminders identification, results testing, follow-up, and visual inspection quality assurance). Many program assessments and peer-reviewed trials demonstrate that basic mobile communication interventions can affect follow-up and attendance, which are significant failure points during screening activities. For instance, Erwin et al tested the SMS attitude-change messaging plus an eVoucher strategy for transport reimbursement within Tanzania [14], which reflects a logic of intervention that recognizes distance and cost challenges as prominent determinants of the uptake of screening. Also, Linde et al evaluated one-way text messaging to enhance follow-up screening attendance among HPV-positive females in Tanzania, while targeting loss to follow-up after a positive test [34]. In Western Kenya, Huchko et al assessed options for providing HPV results via cell phone (calls and text messaging) and evaluated result receipt and outcome of follow-up [15]. This addresses a significant delay in the screening-to-treatment level. Generally, these articles demonstrate constant operational findings, which say that mobile communication could be adopted into cervical screening initiatives to lessen informational delays and ensure continuity, although evidence strength differs by outcome and design.

The second significant set of findings includes smartphone-based cervicography plus digital quality assurance for VIA screening. The studies conducted in Madagascar offer good instances of how smartphone imaging could act as an *intermediate technology* that enhances decision-making where pathology and colposcopy are scarce. In particular, Catarino et al documented a pilot research of smartphone usage for screening of cervical cancer in Madagascar, while supporting offsite diagnosis with digital VIA images [18]. In the same vein, Gally et al assessed a smartphone image app as a colposcopy alternative in poor screening campaigns, while demonstrating that structured review and image capture could be operationalised in outreach contexts [17]. Also, Urner et al discussed a smartphone triage strategy for HPV-positive females in Madagascar [16]. The authors showed how digital imaging could be used as a triage layer if HPV testing increases but specialist evaluation capacity does not keep pace. In remote regions of Madagascar, Quercia et al reported a mHealth data gathering system utilised to track females partaking in a screening activity [35]. The writers showed that digitisation is not just clinical but equally logistical. That is, monitoring who was screened, what outcome was received, and the pending follow-up. Furthermore, in Tanzania, the SEVIA platform represents a more systematised strategy: quality assurance, smartphone-improved training, tracking, and teleconsultation integrated into VIA screening, created to support frontline providers via structured image sharing and remote supportive supervision. The SEVIA implementation assessment literature equally highlights that the technology cannot be separated from the training models, workflows of supervision, and governance (that is, how feedback is delivered, who reviews images, how data are saved, and how performance is tracked). The implication in these cervicography articles is that digital imaging could simultaneously serve multiple roles (QA, training, documentation, and triage), but only when the workflow is designed deliberately on real limitations like staff time, connectivity, privacy practices, and supervisors' availability.

Another key theme is specialist extension via remote diagnostic support and telepathology. At Butaro district hospital in remote Rwanda, Mpunga et al described the validation and implementation of telepathology triage, which responds to a significant barrier in SSA cancer control; absent or delayed pathology confirmation [23]. Also, a related synthesis study on Africa's telepathology experiences reports high concordance in the Butaro static image method compared with subsequent glass slide review, which shows that diagnostic support could be safely elongated with *store and forward* strategies when paired with training plus standardised procedures [23]. Recent telepathology discussions on the continent continually see such models as concrete solutions in contexts with limited pathologists, but equally emphasize infrastructure requirements, sustainable financing, and quality management. Generally, the evidence base for telepathology supports a concrete conclusion; digital tools could lessen diagnostic isolation and enhance

diagnostic accuracy and timeliness, but they need structured/codified governance and should not be treated or seen as exclusively IT projects.

Additionally, society-connected tools plus workflow support apps that link primary care services or community health workers to referral systems was also widely used. In Kenya, the mSaada work is a good example, which was designed to support and assist community health workers or volunteers in cervical cancer screening pathways, reflecting the idea that a large portion of screening activity relies on non-specialist cadres and society-facing engagement. Also, Uganda's telemedicine implementation study which is reported in JMIR discusses smartphone telemedicine strategies for screening of cervical cancer. It reflects a transition from isolated pilots to better intentional service delivery integration. These are vital since they demonstrate that *digital health for early detection* is sometimes less focused on novel algorithms but more on supporting work sharing, standardising procedures, and minimising drop-off points across referral pathways.

Meanwhile, sources from grey literature offer a different view of evidence. The sources show how partners and countries seek to shift from pilots to infrastructure. For example, the Zambia SmartCerv white paper writes about the reason for a centralised data management solution for programs in cervical cancer, particularly reporting barriers with maintaining extensive program data without a rigorous repository/positioning SmartCerv as a patient data system that supports follow-up and decision-making [36]. Moreover, the E-NNOVATE documents from the Global Initiative for Cancer Registry Development of the International Agency for Research on Cancer (IARC) explains the establishment of a DHIS2 oncology module plus DHIS2-CanReg connection to enhance the capture of cancer data for use in cancer control planning. Also, the report of imPACT Review from Nigeria offers a country system view. It documents recommendations and gaps within cancer control capacity, such as data needs and information systems [37]. Zambia's SPIDER Telehealth Needs Evaluation report provides contextual evidence on expectation of stakeholders plus the perceived needs for telehealth during cervical care and screening [38], which emphasizes that confidentiality, acceptability, concerns, plus implementation readiness should be addressed early. Meanwhile, a key finding from the grey literature is that pathway tracking and registry strengthening are increasingly seen as key cancer control strategies, however, the evidence is still mostly descriptive since these are yet to be fully implemented and scaled.

In the evidence base, the balance between implementation evidence and efficiency evidence matters. Some peer-reviewed articles are published to test outcomes (attendance, follow-up, and uptake), but several others are validation, feasibility, or implementation assessments. This is appropriate for scoping reviews, however, it sets restrictions on what could be summarised. A risk in writing the discussion is overclaiming efficiency based on the feasibility studies. The most defensible and safest interpretation is that the strongest evidence exists for mobile communication interventions affecting follow-up attitude in cervical screening pathways as seen in Kenya [39], [40] and Botswana [41], [42] while registry tools and teleconsultation or imaging demonstrate high feasibility and service value but need larger long-term and comparative evaluation.

In addition, the review outlines repeated implementation limitations that affect intervention types. Power reliability and connectivity are clearly indicated in the design choices (smartphone capture with delayed upload, *store and forward* instead of real-time; and program repositories supporting offline workflows). Also, data governance shows consistently, particularly in registry and telehealth documents since cancer information can be sensitive and cross-facility exchange induces ownership and confidentiality challenges. Human resource limitations are equally central; cervicography and telepathology tools lessen specialist scarcity effects, but only when there is a codified supervisory structure and when the frontline staff are able to carry out the extra work of capture, documentation, upload, and follow-up monitoring. These shortcomings are not tertiary; they determine if an intervention can survive beyond the pilot stage.

A practical effect for the scoping review objectives and question is that the evidence backs up a *function-focused* way of reasoning about digital interventions instead of a *technology-based* perspective. Across the evidence base, the digital tools like smartphone imaging, SMS, and DHIS2 modules could provide diverse roles based on design, including QA, patient engagement, triage, referral tracking, and surveillance. Also, the programs that show the most maturity are ones that mix functions instead of addressing a narrow view. SEVIA is a good case of multi-function design with QA, monitoring, and training. SmartCerv is stationed as a system repository for program decision-making and continuity not only for data entry. E-NNOVATE clearly targets interoperability plus connection between registry software and routine health information, which is vital for continued surveillance.

Lastly, the evidence base suggests an explicit shift point for digital oncology in the SSA region; moving from the pilot stages to integrated country platforms. In particular, the DHIS2-associated cancer registry study shows increasing institutional attention to interoperability and standardisation, such as efforts to scale standardised data gathering in national health information solutions. Nevertheless, national documents equally demonstrate that system readiness is not even and that governance, financing, and capacity of workforce remain decisive [43]. For the contribution of this review, the major defensible *so what* is not that digital tools have already addressed early detection barriers, but that the evidence now explicitly determines which roles are feasible, where the biggest result evidence exists, plus what infrastructure needs consistently determine if implementations could scale.

Linking Findings to the Review Objectives

To clearly resonate the findings with the objectives of the scoping review, 4 evidence clusters emanate from the included studies.

1. Sources, such as Kenya's Huchko et al and Tanzania's Erwin et al, assessing SMS communication plus mobile result-delivery approaches addressed the aim of determining digital tools that enhance early detection pathways by solidifying follow-up communication and patient engagement. The major implication from here is that low-cost mobile interventions could minimise delays between subsequent care and screening, though the evidence base is restricted to short-term attitude outcomes instead of long-term diagnostic effect.
2. The smartphone-focused quality-assurance platforms and cervicography documented in studies from Kenya, Madagascar, and Tanzania (such as the EVA and SEVIA implementations) align to the aim of explaining implementation contexts plus technologies utilised to back up diagnostic frontline workflows. These sources show that digital imaging could extend the capacity or supervisory and standardise screening activities in decentralised environments, however, they equally report an evidence gap on scalability beyond the pilot stages/programs and integration with countries' information solutions or systems.
3. Telepathology initiatives like the Rwandan Butaro method resonate with the aim of exploring digital tools that assist in diagnostic confirmation and referral coordination [44]. These interventions demonstrate the feasibility of integrating peripheral facilities with specialist interpretation, but underline constant evidence gaps on infrastructure requirements, sustainability, plus long-term diagnostic turnaround enhancement at scale.
4. DHIS2-connected oncology efforts and registry-strengthening seen in grey literature studies like Zambia's SmartCerv and the E-NNOVATE initiative address the aim of mapping surveillance-based digital interventions. These articles show increasing institutional investment in system monitoring and data integration, while equally highlighting the requirement of frameworks for standardised interoperability and formal assessments of their effect on cancer control planning.

Limitations

- a. The evidence base is heterogeneous and relatively small, which reflects the early phase of digital health implementation for SSA cancer detection and referral. Several included articles were pilot or feasibility assessments with restricted sample sizes and little follow-up times. This limits evaluation of long-term sustainability and effectiveness.
- b. The use of grey literature, while important to obtain programmatic innovations plus system initiatives, might cause variability in the quality of reporting and methodological rigour compared to peer-reviewed studies.
- c. Only articles published in the English language were included. This might have removed relevant studies from lusophone or francophone regions.
- d. Lastly, differences in intervention design plus outcome reporting restricted the ability to compare results across settings.

Conclusion

Drawing on 30 studies that comprise implementation-based grey literature and peer-reviewed articles from 2010 to 2025, this scoping review indicates that digital innovations are increasingly utilised to mitigate significant gaps in the cancer care pathway, especially in screening support, communication, data management, and diagnostic linkage. Mobile communication measures, telepathology platforms, smartphone screening technologies, and initiatives on digital registry have shown promise in solidifying service delivery in poor settings. Nevertheless, the evidence shows that most interventions are still program-level implementations or localised pilots, with little integration into countries' health systems. Though these digital tools have enhanced operations like data capture, follow-up tracking, and quality assurance, there is still inadequate evidence on their long-term efficiency, scaled sustainability, and cost implications. The result, therefore, underlines the importance of intentional alignment of digital innovations with countries' health information systems, cancer control measures, plus workforce capacity-building initiatives. Generally, digital health offers a promising avenue to minimise delays in SSA cancer detection and referral, but sustained effect will rely on shifting from fragmented initiatives to structured, system-level implementation.

Declarations

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Author Contributions

Conceptualization: Chigbo Chisom Godswill (CCG), Elima Jedy-Agba (EJA).

Methodology: Chigbo Chisom Godswill (CCG), Omosivie Maduka (OM), Temitope Olukomogbon (TO), Elima Jedy-Agba (EJA).

Literature Search and Study Selection: Chigbo Chisom Godswill (CCG).

Data Curation: Chigbo Chisom Godswill (CCG), Ayobami Ademola (AA).

Formal Analysis and Evidence Synthesis: Chigbo Chisom Godswill (CCG).

Visualization: Chigbo Chisom Godswill (CCG).

Writing – Original Draft: Chigbo Chisom Godswill (CCG).

Writing – Review & Editing: Omosivie Maduka (OM), Temitope Olukomogbon (TO), Nneoma Harris (NH), Ayobami Ademola (AA), Olushola Oyewande Tinuoye (OOT), Emeka Odiaka (EO), Elima Jedy-Agba (EJA).

Supervision: Omosivie Maduka (OM), Elima Jedy-Agba (EJA).

All authors critically reviewed the manuscript, approved the final version for publication, and agree to be accountable for all aspects of the work.

Data Availability Statement

All data generated or analysed during this study are included in this published article and its supplementary information files.

Ethics

Ethics approval and consent to participate were not required because this study synthesized data from previously published studies.

Competing interests

The authors declare that they have no competing interests.

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Figures

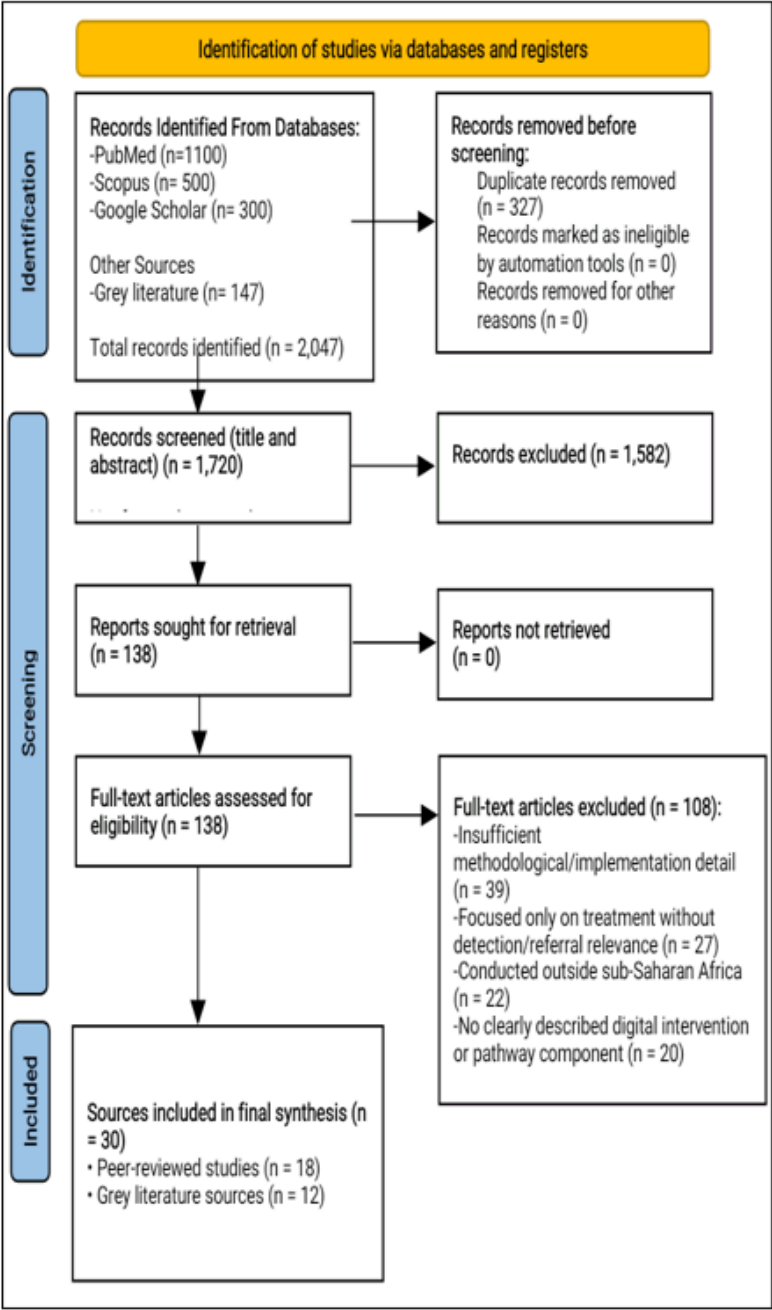


Figure 1

PRISMA Flowchart

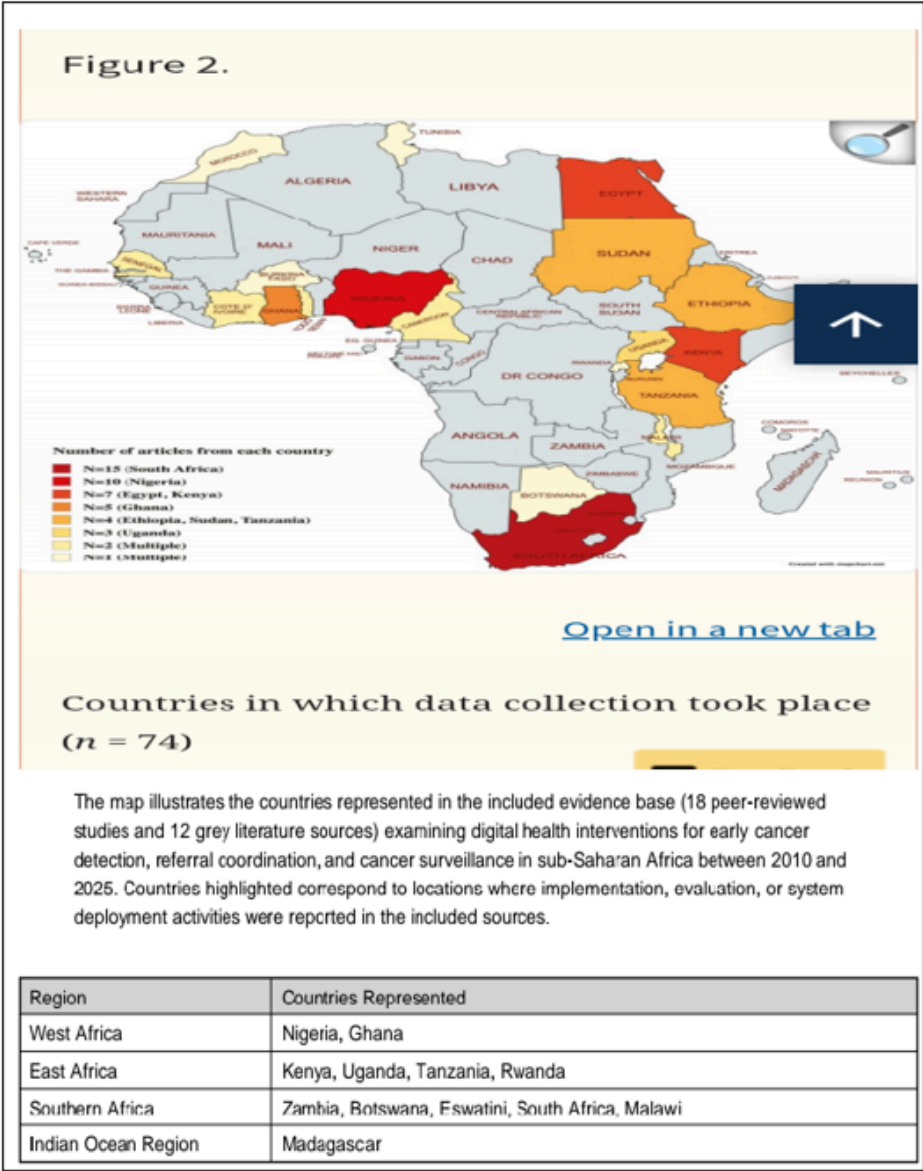


Figure 2

Geographic distribution of included studies in SSA (n= 30)

Mixed Methods Appraisal Tool (MMAT) Assessment Summary of Included Sources (n = 30)						
Study Category	Design Type	Number of Studies	MMAT Screening Criteria	Methodological Strengths	Key Limitations	Overall Quality
Experimental / Quasi-experimental	Randomized / Controlled	6	Research questions clear; data appropriate	Measured screening uptake and follow-up outcomes	Limited confounder adjustment; short follow-up	Moderate-High
Observational / Feasibility	Implementation / Validation	8	Relevant to objectives; context described	Strong real-world implementation insight	Small samples; no comparator groups	Moderate
Mixed Methods	Qualitative + Quantitative	4	Integration aligned with research aims	Captured usability and acceptability	Limited reporting of integration rigor	Moderate
Grey Literature	Programmatic Documentation	12	Transparency of intervention description	System-level implementation evidence	No formal evaluation metrics	Descriptive
MMAT appraisal focused on methodological appropriateness, coherence between study aims and design, data collection quality, and relevance to early detection, referral, or surveillance functions.						

Figure 3

MMAT Assessment Summary of Included Sources (n = 30).