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Review Article

A review of digital maternal health promotion to optimise access and utilization of care services in sub-Saharan Africa

Oluwamayowa O. Ogundaini [1*], Faith Siva [2], Danny R. Nyatuka [2], Naita Awene [3], Lisa Dionne Morris [4]

[1] Graduate School of Business Leadership, University of South Africa, South Africa
[2] School of Computing and Engineering Sciences, Strathmore University, Nairobi, Kenya
[3] Telecom Namibia Limited, Republic of Namibia
[4] School of Mechanical Engineering, University of Leeds, United Kingdom

*Correspondence to: Oluwamayowa O. Ogundaini, Email: ogundoo@unisa.ac.za

Abstract: In sub-Saharan Africa, maternal mortality rates remains high among women as the vulnerable demographics of reproductive age and breastfeeding mothers compared to other parts of the world. The situation is exacerbated by the region's underperforming healthcare systems. Although digital health interventions have increased since the emergence of COVID-19 pandemic to enhance health promotion in terms of maternal health vulnerability, the access to and utilization of care services, the record of positive impacts remains limited. The objective of this paper was to analyse the status of digital maternal health promotion in supporting female of reproductive age, first-time and nursing mothers to access and utilise maternal healthcare services during their perinatal and postpartum periods in underserved settings of sub-Saharan Africa. A literature review of peer-reviewed publications between 2020 and 2023 was conducted by searching online databases using keywords and filtering the results using a set of inclusion and exclusion criteria. Findings indicate that digital maternal health promotion is increasingly enabling access to hard-to-reach populations, but the utilization of associated care services remains relatively low. Particularly, mHealth and asynchronous audio-visual digital media are critical for delivering maternal health educational content to the targeted populations, including their partners, and are most likely to increase utilization of maternal care services. Digital promotion of maternal health requires multi-stakeholder collaboration to address the limiting socio-economic, cultural and technical factors that determine access to and utilization of care services during the perinatal and postpartum period, if mortality rates are to be reduced towards the sustainable development goal for good health and well-being.

Keywords: Maternal health, Digital health, Health promotion, Health security, sub-Saharan Africa

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Introduction

Health, wellness, and well-being are crucial for social and economic development and self-development. They are the hallmarks of prosperity, social progress and are at the centre of the realization of communal development, such as the United Nations sustainable development goals (SDGs) 2030 and the Africa Agenda 2063. Humans seek to achieve their highest level of well-being to ensure individual and community survival, fulfill their aspirations and meet their daily needs while coping with the environment. This requires principles and areas of action that enable people to synergistically increase control over their health improvement, hence health promotion [1]. Thus, health promotion is associated with coordinated actions that encompass advocacy, enabling communication and mediation of health-related needs through a community participatory approach [2]. Health promotion goes beyond the provision of information aimed at actively changing individual behaviour towards a wider perspective of social and environmental interventions through which primary health care contributes to building resilient health systems. However, the low and middle income countries (LMICs), particularly in sub-Saharan Africa (SSA), fall short of addressing the unsettling realities associated with maternal health, including postpartum complications, which are the scourge of an overburdened and less inclusive health system [3].

Maternal health refers to the state of a woman's (or girl's) well-being in the perinatal (antenatal, postnatal or postpartum) period. Due to peculiar challenges, SSA records high maternal mortality rate (MMR), accounting for two-thirds of global maternal deaths [3-5]. Maternal mortality is the death of a woman that occurs during pregnancy or within 42 days after delivery due to some pregnancy-related complications such as infectious diseases comorbidities, haemorrhage and eclampsia [4]. Other factors that influence high MMR and limit many health systems include poor state of public health infrastructure, staff shortage and socioeconomic status, which inhibits lack of access to quality maternal care [4, 5]. In addition, supply chain disruptions and impact of COVID-19 have contributed to the high MMR among pregnant women and girls [6, 7]. According to Onambele et al [4], the emergence of COVID-19 pandemic has exacerbated resource constraints in LMICs with significant threats to the progress in reducing MMR. As a result, the pandemic magnified constraints on health information resources, which requires a need for coordinated interventions to increase access, efficiency, quality, equity, and flexibility of maternal health services through digitalization so as to strengthen the health systems [8]. As the pandemic strained health systems around the globe, several countries speedily adopted digital health technologies (DHTs) to enable the detection of and response to the pandemic [9, 10].

The situation necessitated a rapid digitalization of health interventions as a way to increase the resilience of health systems in SSA to epidemic challenges. Particularly, digital interventions have the potential to improve pregnancy monitoring in rural areas, although the user of mobile phone is reported relatively low especially among mothers. The dawn of digital health innovations has prompted interventions directed at strengthening health systems to improve the outcomes of maternal health and promote wellness towards achieving health security [11, 12]. In this paper, we adopt the definition by Kutzin and Sparkes [13] health security refers to the ability of a health system to reduce vulnerability to health threats through its resilience to absorb and withstand destabilizing forces; it is able to adapt and respond to service needs accordingly.

Contextual relevance of digital health in post COVID-19 SSA

Digital health involves the use of computing tools and techniques for healthcare and related purposes, creating a coordinated continuum of care to ensure resilience [14]. In the efforts by national governments to contain the consequences of ongoing COVID-19 pandemic, the use of DHTs to combat the menace has been ubiquitous [15]. For instance, mobile health technologies, electronic health records, decision support systems and telemedicine have provided platforms for specialists such as Gynaecologists to track health-related matters and make data-driven decisions [16, 17]. SSA countries continue to make incremental efforts towards using digital health to address the challenges experienced in engaging hard-to-reach populations in underserved and remote areas for health promotion. For instance, at the peak of COVID-19 pandemic, South Africa adopted a variety of digital technologies and preventative measures to provide healthcare services. Examples of such digital technologies include SMS-based solutions such as MomCnnect and NurseConnect to link pregnant women and first-time mothers to healthcare workers [18, 19]. These digital technologies are being leveraged in various ways for health service delivery, such as creating awareness and communication for management of maternal health, surveillance and monitoring of infectious and non-infectious diseases, medication and treatment compliance [20].

The World Health Organisation's (WHO) vision for the global digital health strategy is to improve the health of all people everywhere by accelerating the adoption of digital health, hence the need for digital health promotion [21]. Digital health promotion plays a crucial role in protecting the global population from acute public health events; and, in particular, to redress issues relating to maternal mortality. Digital health is instrumental in information management, to track and predict health problems based on digital health data for evidenced-driven contextual decision-making [22, 23]. By using digital tools in SSA, maternal health care can

be digitized, thereby improving service delivery and enabling people to take more control through proactive and reactive approaches. For example, the use of digital health has been reported to improve treatment support and facilitate person-centred interventions, which is relevant to address pregnancy-related complications on a case-by-case basis [14-16]. Although there is a positive trend in digital health interventions, it remains critical to evaluate the consistency and effectiveness of solutions in providing positive outcomes to maternal health services in SSA.

Digital maternal health promotion in SSA

The benefits of digital health for promoting maternal health nudge SSA towards attaining health security and SDG 3 – good health and well-being for all. Successful digital maternal health promotion includes ensuring increased accessibility to maternal care, enhanced digital health literacy, established trust towards increasing receptivity of utilizing antenatal care (ANC), nutrition adherence, improved facility-based delivery, and child immunization among other services [27, 28]. However, challenges identified include misinformation, socioeconomic inequalities, privacy issues, cybersecurity threats, non-contextual implementations, and cultural issues [3, 29]. These challenges delay the opportunities and benefits associated with digital maternal health promotion in a region that is already struggling with the crisis of a weak healthcare system, non-communicable diseases and re-emerging infectious diseases.

Despite the opportunities and benefits associated with the increased use of DHTs to strengthen health systems globally since COVID-19 pandemic, maternal health awareness and advocacy in underserved areas in SSA continues to yield limited results [15, 24, 25]. These limitations could be attributed to critical factors such as users' unfamiliarity with digital devices in underserved areas, infrastructural disparities in rural areas compared to urban areas and unsafe sociocultural practices [30]. Other factors that impede digital health interventions in SSA can be categorized into organizational, financial, political and regulatory factors [15]. Ultimately, these factors contribute to underserved settings in SSA not benefiting from innovation while recording the highest maternal mortality rates.

Hence, this paper seeks to analyse the role of digital health in offering the necessary support to pregnant women or girls and nursing mothers to access and utilize maternal health information and care services, mediate communication, and advocate for healthier choices of lifestyle during the perinatal and postpartum periods to achieve health security. The guiding question of the paper is: How can digital health interventions be optimized to improve access to maternal health information and services for nursing mothers in SSA during the perinatal and postpartum periods? The objective of this paper was to conduct a literature review that would establish the:

- status of digital health technologies in supporting maternal health care services and health security within SSA.
- enabling factors that influence optimization of access and utilization of digital maternal health promotion in post-COVID-19 SSA.

Materials and methods

To achieve the aims of this paper, an analysis of the existing literature on the use and outcomes of DHTs to promote maternal health was considered. A literature review was conducted by the authors as a strategy to highlight the available and prospective opportunities for improving the utilization of DHTs to optimize maternal health promotion in underserved areas in SSA. A three-step process was followed to conduct the literature review, as informed by the previous studies prescribed by [31] and operationalised by [32, 33]. The steps include a search for relevant literature (using keywords to identify and retrieve), screening (inclusion and exclusion criteria) and summarizing (critique of existing studies). These steps are described in the subsequent paragraphs.

Search strategy

In the search strategy of this paper, keywords were used to search online databases including Google Scholar, Scopus and PubMed. However, Google Scholar was selected as the reference database to conduct the search because it has a wider range of indexed publications to avoid duplicates and, most importantly, because the strings of keywords are retrieved via the title, abstract and full text. The keywords selected include "health promotion", "digital health", and "maternal health". A combination of keywords with the logical operator 'AND' was used to query the online database. For instance, the string of keywords is "digital health" AND "maternal health" AND "health promotion" AND "Africa". A three-year time frame (2020-2023) was selected to represent the periods during and after COVID-19 pandemic, when the adoption of digital health for diverse purposes, including health promotion, increased rapidly.

Inclusion and exclusion criteria

To screen the results, inclusion and exclusion criteria (as shown in Table 1) were used to filter yielded articles. The inclusion criteria considered peer-reviewed journal and conference publications on the different forms of digital health used to facilitate health promotion. Only articles published in English were retrieved, as this is the authors' first language and studies conducted in SSA were prioritized. Also, the focus themes include the use of digital health to raise awareness, teach and promote health

The exclusion criteria were applied to discard studies written in other languages, closed access articles were not retrieved, dissertations and books were not included. Subsequently, the titles and abstracts of included articles were read to further exclude articles that did not align with how digital health is used to promote maternal health in SSA. The initial process of filtering was performed by two authors, while a third author verified that the data extracted satisfied the objectives of the paper and ensured a consensus of eligible publications by extension.

Table 1. Inclusion and exclusion criteria of eligible publications

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2020 - 2023	Before 2020
Topic of interest	Digital health for maternal health; technology-enabled health promotion	Non-technology-aided maternal health promotion
Type of publications	Journal, book chapters and conference publications in open access journals	Dissertations, non-open access publications, books
Context	sub-Saharan Africa (SSA)	Outside of SSA

Thematic analysis

A thematic analysis was conducted to operationalise the objectives of this study. The procedure followed was to operationalise the variables of the objectives in relation to the key findings of the included articles. Firstly, the authors summarised the attributes of the included articles based on the key findings and implications for achieving health security as described in Table 2. Subsequently, words or phrases that indicated the extent to which digital health technologies (DHTs) are being used to promote health for pregnant women and girls of reproductive age in SSA were extracted. For example, the type of DHTs used, cases of access or utilization for specific purposes, experiences from usage of DHTs, and the outcomes described were used to determine the status and enabling factors that optimises access and utilisation of maternal health services.

The summary of selected literature included attributes such as: title, author, context, the type, and purpose of DHTs and implications of the findings regarding their use in achieving health security and SDG 3 in SSA to enable analysis of existing studies. Summarising these attributes enabled the authors to assess the status of digital health for health promotion and identify the factors that enable the use of digital health in maternal healthcare services in underserved settings of SSA. Ultimately, the authors were able to address the extent to which DHTs have been and can be adopted to promote access to relevant health information, mediate communication between key stakeholders, and raise the awareness of healthier lifestyles in terms of preventative practices against critical maternal health problems.

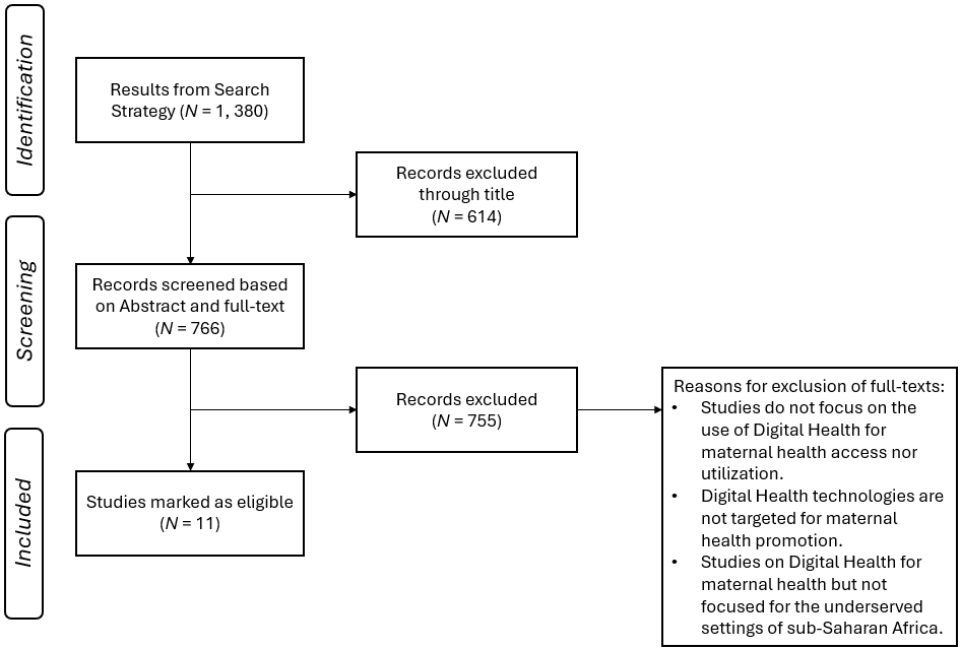

Figure 1. Flow diagram of literature analysis on eligible publications based on paper objectives

Results

The initial query from the search strategy produced a total number of 1, 380 publications. Subsequently, the yielded results were screened by applying the inclusion and exclusion criteria with a total number of 614 publications being eliminated. To identify the eligible articles for inclusion, the titles and abstracts were further filtered as illustrated in Figure 1. After screening, the publications were reduced by 755 and the included articles that satisfied the objectives of the paper was 11. The included articles are mainly aimed at improving the access and utilization of maternal health services in the underserved settings of SSA. The countries in which the included studies were conducted include Burundi, Ghana, Nigeria, South Africa and Uganda. Two of the included studies adopted qualitative research, while three deployed quantitative research techniques. Four of the studies conducted different types of literature reviews, while another two studies conducted randomized control trials.

The included peer-reviewed publications represent those articles published between 2020 and 2023 and are summarized in Table 2. The attributes of the included paper include title and year of publication, aim of study, context/country, type/purpose of digital health, key findings, and implications towards achieving health security and SDG 3.

Discussion

Status of DHTs for maternal health promotion in SSA

The WHO has recognised technology as a crucial building block for strengthening the health system. Therefore, it is important to continuously evaluate digital health interventions, their impact on health-related services and health outcomes [40]. Based on the literature review, there is a growing number of literatures that demonstrates the need to improve access to maternal health for hard-to-reach populations, improve utilization of maternal health services, and empower vulnerable women and girls of reproductive age as well as nursing mothers in the underserved settings of SSA [36, 41]. Several studies have considered and developed digital health interventions to address the identified needs, but the underutilization of maternal health services remains unabated [7, 8]. Therefore, the authors argue for an intensification of existing interventions or opportunities associated with the promotion of digital maternal health through frugal innovation based on contextual peculiarities and limited resources attributed to SSA.

Limited access to services, communication gaps between pregnant women or nursing mothers and healthcare professionals, and advocacy for healthier lifestyles can be addressed with context-appropriate technologies. Existing literature on maternal health promotion indicates that the innovative use of wireless-enabled mobile devices such as smartphones is ubiquitous in SSA countries [42]. The ubiquity can be attributed to the continued expansion of cellular mobile communication systems and fourth generation (4G) services that enable short message services (SMS), near real-time instant messaging, and sharing capabilities of digital media [43, 44]. The 4G services support two-way communication between healthcare professionals and pregnant women to bring them closer to care and enable asynchronous sharing of audio-visual educational content for inclusive participation [20]. Therefore, the promotion of digital maternal health offers interventions that facilitate communication with pregnant women in underserved settings and influences the necessary behavioural changes to improve maternal health care utilization.

The promotion of digital maternal health not only enables access to health care services, but also facilitates communication. For example, there are mobile devices and apps such as instant messengers and social networks that can be used to establish peer support groups including pregnant women, nursing mothers and community health workers [19, 20, 37]. The proximity to internet-enabled digital devices also supports telemedicine in the unforeseen events that pregnant women are unable to access or cannot afford to utilize facility-based maternal health care. Both text and audio-visual communication ensure that pregnant women minimize their risk of falling victim to misinformation associated with pregnancy and the postpartum period [28]. Simultaneously, individuals who understand audio-visual communication in their native language are targeted. As a result, advocacy for maternal health continues to grow in SSA.

Some of the studies that investigated the development of digital health in pregnant women indicate that partners need to participate in pregnancy journeys, while the cautionary and encouraging messages shared are likely to influence positive behavioural change [43]. For example, positively worded messages that encourage seeking of professional care against pregnancy complications, early warning signs and debunking of harmful sociocultural beliefs were preferred to authoritative and rebuking-worded messages [3, 28]. In SSA, the households of pregnant women or girls largely depend on their male partners for economic support. Therefore, it is imperative that men become actively involved and encourage utilization of professional support [35]. In other words, support programs created by stakeholders including government and non-government organizations, nurses and community health workers should consider the inclusion of men and be aware of how influential the tone of messages are perceived by pregnant women and its impact on their willingness to self-express, including the use of technology. The advocacy for antenatal care (ANC) utilisation, facility-based delivery and healthier nutrition would likely yield and extend positive maternal health

outcomes.

Table 2. Summary of literature on digital maternal health promotion

Title, author(s) and year of publication	Aim of study	Context	Study design	Type and purpose of digital health	Key findings from the study	Implications of findings towards attaining health security and SDG 3
Rural women perceptions of digital media influence on awareness creation about maternal health information in Minna, Nigeria [34]	To investigate how rural women perceived digital media in awareness creation on maternal health	Minna, Nigeria	Quantitative research – survey questionnaire	Digital media for maternal health awareness creation amongst rural women	Social networking media like Facebook, Whatsapp groups, blogs and support forums serve as a source of maternal health information for women living in rural areas. This enables a sense of community	The expansion of resources such as affordable internet, ubiquity of smart mobile phones, and instant messaging can effectively support maternal health promotion in underserved settings. These resources, relevant person-centered content and self-efficacy associated with digital media would extend the reach, communication and active participation of pregnant women to meet their health needs and plan accordingly
Effects of mHealth interventions on improving antenatal care visits and skilled delivery care in low- and middle- income countries: systematics review and meta-analysis [30]	To summarize the effect of mHealth interventions on the uptake of ANC visits, skilled birth and facility deliveries among the pregnant women in Low- and Middle- Income Countries (LMICs)	Resource limited settings in selected LMICs	Systematic review and meta-analysis	mHealth to manage ANC visits	mHealth interventions for two-way communication increases ANC utilization and visits in resource limited settings	The acceptance of mHealth interventions offers several opportunities of health workers to facilitate health promotion amongst pregnant women in preparation for childbirth and postpartum. In this way, the risk of fatal complications can be reduced.
Digital health technologies for maternal and child health in Africa and other low- and middle-income countries: cross-disciplinary scoping review with stakeholder consultation [20]	To conduct a scoping on the use of digital health interventions for Maternal and Child Health (MCH) in LMICs	sub-Saharan Africa	Scoping review	Mobile apps, wearables, web-based applications, SMS text messaging and social media were identified as technologies to develop digital health for easier access to services and to facilitate communication with healthcare workers.	The authors advocate for the inclusion of key role players within communities in LMIC settings during the design process of digital health technologies for MCH. Community-based co-design is identified as the most suitable approach in designing digital health interventions for MCH.	For the success of digital maternal health promotion to become a reality that ultimately improves MCH outcomes, the meaningful engagement and active participation of all key stakeholders in the design process of digital health interventions is critical, especially in underserved or low-resource settings. As a result, maternal health education, information and related advocacy can become inclusive and contribute to improving MCH services access and utilization to meet SDG 3

Leaving no woman or girl behind? Inclusion and participation in digital maternal health programs in sub-Saharan Africa [35]	To review literature on digital maternal health programs across sub-Saharan Africa that excludes the most vulnerable women and girls	sub-Saharan Africa	Literature review	Digital health interventions for maternal health promotion	Digital maternal health seems to always exclude women based on digital device ownership, digital literacy and disabilities.	A government-private led partnership that seeks to subsidize or incentivise digital maternal health promotion targeted at girls and women of reproductive age would likely minimize the causes of exclusion, increase access, use as well as participation in maternal health utilization.
Improving maternal health services utilization in Ghana: Should digital health be considered? Correspondence [12]	To highlight the benefits of digital health towards improving Maternal and Child Health service utilization	Ghana	Correspondence	Telemedicine, digital health technologies, mHealth, mobile devices for improving access to information and maternal health Service	Digital health interventions encourage behavioural changes.	Since health promotion is largely concerned with advocacy for preventive measures to avoid health vulnerabilities and the adoption of a healthy lifestyle, Digital health interventions can assist community health workers to provide relevant up-to-date maternal health information to pregnant women and first-time mothers, with a chance of reducing the risks and vulnerabilities associated with ante- and post- natal care. In this way, Digital health interventions contribute to reducing the rates of infant and maternal morbidity thereby ensuring an inclusive universal healthcare.
A mobile phone-based multimedia intervention to support maternal health is acceptable and feasible among illiterate pregnant women in Uganda: qualitative findings from a pilot randomized controlled trial [36]	To assess the acceptability and feasibility of a mobile application to support maternal health amongst illiterate pregnant women in Uganda	Rural southwestern, Uganda	Randomized control trial – qualitative and quantitative mixed methods	Mobile app (MatHealth) to access health education content; for appointment reminders and calling function	Using MatHealth enabled the pregnant women and their spouses' access to relevant health information that positively influenced their adherence to antenatal care utilization and proper diet practices	Access to asynchronous educational health content (video and audio) will have a positive impact on adherence, awareness, communication and advocacy of best maternal health practices in underserved settings of sub-Saharan African countries. However, strategies to address socio-cultural, technical and economic issues threaten the success of digital maternal health promotion.

Reflections on digital maternal and child health support for mothers and community health workers in rural areas of Limpopo Province, South Africa [37]	To explore experiences of mothers, community leaders, and community health workers (CHWs) on mHealth for digital maternal and child health support in rural areas	Limpopo, South Africa	Qualitative research	Digital apps to support maternal and child health awareness and communication	Digital apps enhance communication and support the sharing of relevant information about the pregnancy journey and after delivery. Socioeconomic constraints and network connectivity impacts user satisfaction.	Infrastructural deficiencies, asynchronous use of digital media, digital literacy, sociocultural beliefs and peer support groups are highlighted as key areas that influence digital maternal health promotion if nursing mothers, and pregnant women are to adopt a healthier lifestyle and utilize accessible care services in a sustainable manner.
mHealth-based health promotion intervention to improve use of maternity care services among women in rural Southwestern Uganda: iterative development study [38]	To develop a patient-centered text and audio messaging mHealth intervention to support women's use of maternity care services in Mbarara district, southwestern Uganda.	Southwestern, Uganda	Qualitative research	mHealth to facilitate the use of maternal care services	When target users participate in the design of an intervention, they develop a sense of ownership. Digital health interventions such as mHealth supports personalization of educational content to suit the needs and preferences specific to pregnant people.	Inclusion of end users in the co-development of digital health interventions is likely to yield the intended positive health outcomes. Reducing maternal mortality towards achieving health security becomes a reality when diverse groups are able to participate and benefit from digital health promotion awareness.
Evaluating the feasibility, acceptability, and preliminary efficacy of support moms-Uganda, an mHealth-based patient-centered social support intervention to improve the use of maternity services among pregnant women in rural Southwestern Uganda: randomized controlled trial [27]	To evaluate a mHealth messaging app to promote maternity service use among pregnant women in Uganda.	Southwestern, Uganda	Randomized control trial – qualitative and quantitative methods	Support moms-Uganda mHealth to promote the use of maternal services	Digital maternal health interventions are accepted when the technology is easy to use, useful, interesting and engaging.	Digital maternal health promotion that leverages social support networks, personalized educational content and timely messaging influence the uptake of maternal care services. To achieve SDGs 3 and health security, there is a need to scale such interventions through collaborative partnerships between the government and private sector. This will help to collect relevant data for informed decision-making that includes hard-to-reach populations.

Evaluating the effect of maternal mHealth text messages on uptake of maternal and child health care services in South Africa: a multicentre cohort intervention study [39]	To evaluate the effects of mHealth intervention on maternal health services uptake and use.	Johannesburg inner-city, South Africa	Quantitative research	One-way maternal health information sent twice in a week to pregnant women receiving ANC.	When pregnant women receive maternal health information via SMS, the utilization of ANC visits increases.	The timing and relevance of maternal health messages shared through digital platforms is likely to influence behavioural change in pregnant women to complete the continuum of care. In this way, the risks and complications associated with pregnancy are managed towards reducing the high records of maternal mortality.
A digitalized program to improve antenatal health care in a rural setting in North-Western Burundi: early evidence-based lessons [7]	To design and test a digital intervention as well as to understand the perceptions of mothers and pregnant women	North-Western Region, Burundi	Quantitative research – Cross-sectional survey	Mobile platform for maternal Health to manage ANC appointments and service utilization.	The use of digital intervention influenced the increase in ANC visits. The lack of mobile device ownership had a negative impact on the acceptability of the intervention.	Digital maternal health promotion requires pregnant women living in rural settings to own internet-enabled devices at affordable costs. These devices support interventions to detect early warning signs of pregnancy-related complications and the appropriate response through collaborative networks with CHWs.

Enabling factors that drive DHTs for maternal health promotion

Given the complex situational realities associated with underserved settings in sub-Saharan African (SSA), the authors sought to identify the factors that drive digital maternal health promotion towards the realization of SDG 3. The success and sustainability of digital maternal health promotion depends on the presence, availability and suitability of socio-cultural, socio-economic and technical factors. These factors influence the willingness and commitment of pregnant women to embrace technology, raise awareness and change behaviour to make healthier lifestyle choices to reduce the high rates of maternal and infant mortality in SSA. Socio-economic conditions such as inadequate education, unemployment and poverty affect the affordability of the internet and ownership of smart devices [3]. It has been found that many women in households in underserved settings are not financially stable and have low levels of literacy [4, 38].

However, the literature on digital maternal health promotion has shown that the most feasible initiatives are driven by mobile health (mHealth), which require access to or ownership of phones, internet and digital literacy [35, 37]. mHealth enables access to services, mediates communication and can be a suitable tool to support advocacy for pregnant women in underserved settings to express their rights and concerns [45]. Suffice it to say that there is a correlation between some of the socio-economic determinants faced by pregnant women in underserved settings and socio-cultural beliefs or practices. Socio-cultural beliefs are mostly driven or influenced by historical gender roles [3]. These gender roles are pervasive in the underserved settings of SSA to the extent that they tend to relegate women to the households and prevent them from the participation in lucrative economic activities [4]. Thus, women's lack of economic participation restricts their access to financial empowerment to own smart or internet-enabled digital devices and limits their time to participate in health promotion programs because they spend most of their time in the household front.

However, the success of digital maternal health promotion depends on the autonomy of women to participate in activities that guarantee economic stability, the active inclusion of male partners, and the freedom to engage in peer support groups, either face-to-face or through digital health initiatives [30]. The literature on digital maternal health promotion points to the technical requirements that should be in place as facilitating conditions to ensure the success of digital health initiatives in terms of health security and the inclusion of pregnant women in underserved settings [36, 46]. Table 3 highlights the facilitating conditions that must be met. These include an internet infrastructure that ensures meaningful connectivity and affordable mobile devices that are easy to use for communication and exchange of audio-visual maternal health content.

Table 3. Enabling factors driving digital maternal health promotion.

Categories of enabling factors	Elements of factors that drive digital maternal health promotion
Socio-economic realities [35, 37, 38]	Affordable cost of internet
	Computer literacy programs to empower women
	Affordable nutrition – balanced diet
	Proximity to healthcare facility
Socio-cultural beliefs [4, 30, 41]	Ownership of internet-enabled digital devices
	Participation of men in maternal health advocacy
	Inclusion of women and girls in the entire design phases of digital health
	Community peer-support groups
	Influence of traditional and religious communities
Technical requirements [36]	Internet infrastructure
	Digital sources of maternal health information (SMS, websites, mobile apps)
	Descriptive audio-visual digital educational content on maternal health (reassurance, monitoring and tracking the pregnancy journey, and preparing for or reviewing content from their face-to- face consultations)
	Two-way instant messaging in English and native languages
	Suitability of technology to support maternal health-related activities and empower users

Based on the discussion section, Table 3 summarises the categories of enabling factors that influence the optimisation of access and utilisation of maternal health information and care services. There is a considerable number of growing publications in SSA researching how pregnant women or girls of reproductive age and nursing mothers in hard-to-reach populations of SSA utilize digital health, but less on their participation in the development processes of these interventions. While a behavioural change is observed in the increased rates of ANC visits and continuum of care when interventions such as mHealth-facilitated promotion are introduced, assimilation, scalability and consequences remain sparse [12]. The unintended consequence of low participation is that digital health is not considered fit for purpose in

terms of promoting maternal health to influence long-term behavioural change among the intended demographic [47]. Ultimately, digital health technologies are discarded while users are dissatisfied, and positive maternal health outcomes are rarely achieved, especially with persisting constraints by socioeconomic, sociocultural, and technical factors.

Conclusions

The objective of this study was to identify the status and enabling factors for digital health technologies (DHTs) to optimise access to and utilisation of maternal healthcare services during the perinatal and postpartum period in SSA. The findings show that the proliferation of mobile technologies and digital content sharing in SSA has been utilised by different stakeholder groups to develop digital health solutions that facilitate maternal health advocacy and enable communication and mediation of perinatal care and postpartum needs by community health workers to support pregnant women or girls. The enabling factors that influence the optimal utilisation of digital maternal health promotion and care services are the socioeconomic realities of pregnant women and girls, their sociocultural beliefs and the technical facilitating conditions provided by the relevant institutions.

The provision of essential maternal care in low- and middle- income societies is a complex issue that requires integrated, multidisciplinary and context-based interventions to build a resilient health system in SSA. In particular, the influence of partners of pregnant women and nursing mothers serves as a critical sociocultural factor in the development of programs tailored to the utilisation of maternal healthcare services. Although, studies in SSA have evaluated the impact of digital health interventions, most are limited to single issues and outcomes. DHTs can be deployed strategically to promote health and reduce the urban-rural divide that consistently leaves out the low- and middle- income societies. The main limitations of this work are that relevant scholarly articles might have been omitted due to lexical semantics, publications in journals with limited access due to university's limited subscription, and the use of a single online reference database from Google Scholar.

The challenges associated with digital maternal health promotion necessitate that an assessment of needs and interventions should be conducted across the lifecycle, through multi-stakeholder collaborations to figure out context-specific solutions and to determine key performance indicators to measure the impact of DHTs on maternal health outcomes. In protecting humans and resources for future societies, health promotion models must further explore the autonomy of pregnant women and girls to empower them with health information and behaviours through DHTs, to reduce the risk of maternal mortality. These considerations should be in line with social protection and well-being promotion by collaboratively working towards reorientation of health services, upskilling and nurturing supportive environments.

Authors' contributions

O.O. and F.S. conceptualised the research problem, objectives and wrote the original draft of the paper. F.S. and N.A. conducted extensive data curation by searching for the relevant articles. O.O. and F.S. were responsible for the methodology. D.N. was responsible for conducting quality checks on the included articles. O.O., D.N. and L.D.M. finalised the writing and reviewing the final draft. L.D.M. was responsible for coordination of the paper writing.

Conflict of interest

The authors declare that there is no conflict of interest, as there were no personal circumstances or interests that could inappropriately influence the presentation, analysis or interpretation of the reported research findings and the writing of the manuscript.

References

[1] World Health Organization. *Health promotion*. Available at: https://www.who.int/health-topics/health-promotion#tab=tab_1. [Accessed 3rd November 2023].

[2] World Health Organization. *The Ottawa Charter for Health Promotion*. Available at: https://www.who.int/teams/health-promotion/enhanced-wellbeing/first-global-conference. [Accessed 3rd November 2023].

[3] Bico, MS. Factors Associated with Delayed Utilization of Antenatal Care Services among Pregnant Women: A Case Study at Jinja Regional Referral Hospital, Uganda. *International Digital Organization for Scientific Research (IDOSR) Journal of Biology, Chemistry and Pharmacy (JBCP)*. 2024; 9 (1): 29 - 36. doi: 10.59298/IDOSR/JBCP/24/91.2936.

[4] Onambele L, Guillen-Aguinaga S, Guillen-Aguinaga L, Ortega-Leon W, Montejo R, Alas-Brun R, Aguinaga-Ontoso E, Aguinaga-Ontoso I, Guillen-Grima F. Trends, Projections, and Regional Disparities of Maternal Mortality in Africa (1990-2030): An ARIMA Forecasting Approach. *Epidemiologia*. 2023; 4(3): 322-351. doi: 10.3390/epidemiologia4030032.

[5] Lukwa AT, Chiwire P, Aggrey S, Akinsolu FT, Nyabunze A, Okova D. Evaluating Value-Based Maternal Healthcare in Sub-Saharan Africa: A Systematic Review. *Women*. 2024; 4(3): 226-240. doi:

10.3390/women4030017.
[6] Benski AC, Schmidt NC, Viviano M, Stancanelli G, Soaroby A, Reich MR. Improving the quality of antenatal care using mobile health in Madagascar: five-year cross-sectional study. *JMIR mHealth and uHealth*. 2020; 8(7): e18543. doi: 10.2196/18543.
[7] Misago N, Habonimana D, Ciza R, Ndayizeye JP, Kimaro JKA. A digitalized program to improve antenatal health care in a rural setting in North-Western Burundi: Early evidence-based lessons. *PLOS Digital Health*. 2023; 2(4): e0000133. doi: 10.1371/journal.pdig.0000133.
[8] Rinke de Wit TF, Janssens W, Antwi M, Milimo E, Mutegi N, Marwa H, Ndili N, Owino W, Waiyaiya E, Garcia Rojas DC, Dolfing M. Digital health systems strengthening in Africa for rapid response to COVID-19. *Frontiers in health services*. 2022; 2: 987828. doi: 10.3389/frhs.2022.987828.
[9] Mason C, Lazenby S, Stuhldreher R, Kimball M, Bartlein R. Lessons learned from implementing digital health tools to address COVID-19 in LMICs. *Frontiers in Public Health*. 2022; 10: 859941. doi: 10.3389/fpubh.2022.859941.
[10] Maeder A, Parameshwar NB, Williams P. Contextualising digital health contributions to fighting the COVID-19 Pandemic. *Journal of the International Society for Telemedicine and eHealth*. 2020; 8(e3): 1-5. doi: 10.29086/JISfTeH.8.e3.
[11] Maliwichi P, Chigona W, Sowon K. Appropriation of mHealth Interventions for Maternal Health Care in Sub-Saharan Africa: Hermeneutic Review. *JMIR mHealth and uHealth*. 2021; 9(10): e22653. doi: 10.2196/22653.
[12] Asumah MN, Mohammed MY, Abubakari A, Padhi BK. Improving maternal health services utilization in Ghana: should digital health be considered? Correspondence. *Annals of Medicine and Surgery*. 2023; 85(3): 557. doi: 10.1097/MS9.0000000000000247.
[13] Kutzin J, Sparkes SP. Health systems strengthening, universal health coverage, health security and resilience. *Bulletin of the World Health Organization*. 2016; 94(1): 2. doi: 10.2471/BLT.15.165050.
[14] Cilliers L. A digital health ecosystem for Africa during the COVID-19 pandemic. In *Digital Innovation for Healthcare in Covid-19 Pandemic*. 2022; 39-51. Academic Press. doi: 10.1016/B978-0-12-821318-6.00013-X.
[15] Ahmed MAA, Gagnon MP, Hamelin-Brabant L, Mbemba GIC, Alami H. A mixed methods systematic review of success factors of mhealth and telehealth for maternal health in Sub-Saharan Africa. *Mhealth*. 2017; 3. doi: 10.21037/mhealth.2017.05.04.
[16] Venkataramanan R, Subramanian SV, Alajlani M, Arvanitis TN. Effect of mobile health interventions in increasing utilization of Maternal and Child Health care services in developing countries: A scoping review. *Digital Health*. 2022; 8: 20552076221143236. doi: 10.1177/20552076221143236.
[17] Mbunge E, Batani J, Gaobotse G, Muchemwa B. Virtual healthcare services and digital health technologies deployed during coronavirus disease 2019 (COVID-19) pandemic in South Africa: A systematic review. *Global Health Journal*. 2022; 6(2): 102-113. doi: 10.1016/j.glohj.2022.03.001.
[18] Sibuyi IN, de la Harpe R, Nyasulu P. A stakeholder-centered mHealth implementation inquiry within the digital health innovation ecosystem in South Africa: MomConnect as a demonstration case. *JMIR mHealth and uHealth*. 2022;10(6): e18188. doi: 10.2196/18188.
[19] Nombakuse R, Tsibolane P, Roodt S. *Exploring Healthcare Workers' Perceptions of Digital Healthcare Support Platforms: The Case of NurseConnect*. In: Ndayizigamiye, P., Twinomurinzi, H., Kalema, B., Bwalya, K., Bembe, M. (eds) Digital-for-Development: Enabling Transformation, Inclusion and Sustainability Through ICTs. IDIA 2022. Communications in Computer and Information Science, vol 1774. Springer, Cham. doi: 10.1007/978-3-031-28472-4_11.
[20] Till S, Mkhize M, Farao J, Shandu LD, Muthelo L, Coleman TL, Mbombi M, Bopape M, Klingberg S, van Heerden A, Mothiba T. Digital health technologies for maternal and child health in Africa and other Low-and middle-income countries: cross-disciplinary scoping review with Stakeholder consultation. *Journal of Medical Internet Research*. 2023; 25: e42161. doi: 10.2196/42161.
[21] World Health Organization (WHO). *Global Strategy on Digital Health* [Internet]. Vol. 57, World Health Organisation/The millennium village project. 2021. Available from: https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf [Accessed 26th February 2024]
[22] Manyazewal T, Woldeamanuel Y, Blumberg HM, Fekadu A, Marconi VC. The potential use of digital health technologies in the African context: a systematic review of evidence from Ethiopia. *Npj Digital Medicine*. 2021; 4: 125. doi: 10.1038/s41746-023-00839-2.
[23] Batani J, Maharaj MS. Towards data-driven models for diverging emerging technologies for maternal, neonatal and child health services in sub-Saharan Africa: A systematic review. *Global Health Journal*. 2022; 6(4): 183-91. doi:10.1016/j.glohj.2022.11.003.
[24] Butcher CJ, Hussain W. Digital healthcare: the future. *Future Healthcare Journal*. 2022; 9(2):113-117. doi: 10.7861/fhj.2022-0046.
[25] Nyatuka DR, de la Harpe R. Co-designing person-centred eHealth information services: The case of maternal health care in Kenya. In *Service Design for Emerging Technologies Product Development:*

Bridging the Interdisciplinary Knowledge Gap. 2023; p. 299-326. Cham: Springer International Publishing. doi: 10.1007/978-3-031-29306-1_16.

[26] Haugan G, Eriksson M. An introduction to the health promotion perspective in the health care services. *Health Promotion in Health Care–Vital Theories and Research*. 2021:3-14. doi: 10.1007/978-3-030-63135-2_1.

[27] Atukunda EC, Siedner MJ, Obua C, Musiimenta A, Ware NC, Mugisha S, Najjuma JN, Mugyenyi GR, Matthews LT. Evaluating the Feasibility, Acceptability, and Preliminary Efficacy of SupportMoms-Uganda, an mHealth-Based Patient-Centred Social Support Intervention to Improve the Use of Maternity Services Among Pregnant Women in Rural Southwestern Uganda: Randomized Controlled Trial. *JMIR Formative Research*. 2023;7: e36619. doi: 10.2196/36619.

[28] Koh A, Swanepoel DW, Ling A, Ho BL, Tan SY, Lim J. Digital health promotion: promise and peril. *Health Promotion International*. 2021; 36(Supplement_1): i70-80. doi: 10.1093/heapro/daab134.

[29] Amoakoh HB, Klipstein-Grobusch K, Ansah EK, Grobbee DE, Yveoo L, Agyepong I. How and why front-line health workers (did not) use a multifaceted mHealth intervention to support maternal and neonatal healthcare decision-making in Ghana. *BMJ Global Health*. 2019;4(2): e001153. doi:10.1136/bmjgh-2018-001153.

[30] Rahman MO, Yamaji N, Nagamatsu Y, Ota E. Effects of mHealth interventions on improving antenatal care visits and skilled delivery care in low-and middle-income countries: systematic review and meta-analysis. *Journal of Medical Internet Research*. 2022; 24(4): e34061. doi: 10.2196/34061.

[31] Snyder H. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*. 2019; 104: 333-339. doi:10.1016/j.jbusres.2019.07.039.

[32] Miah SJ, Gammack J, Hasan N. Methodologies for designing healthcare analytics solutions: A literature analysis. *Health Informatics Journal*. 2020; 26(4): 2300-14. doi: 10.1177/1460458219895386.

[33] Cruz-Cárdenas J, Zabelina E, Guadalupe-Lanas J, Palacio-Fierro A, Ramos-Galarza C. COVID-19, consumer behaviour, technology, and society: A literature review and bibliometric analysis. *Technological Forecasting and Social Change*. 2021; 173: 121179. doi: 10.1016/j.techfore.2021.121179.

[34] Agboola AK, WAZIRI T. Rural women perceptions of digital media influence on awareness creation about maternal health information in Minna, Nigeria. *Asian Journal of Social Science and Management Technology*. 2020;(3):61 - 73.

[35] Udenigwe O, Yaya S. Leaving no woman or girl behind? Inclusion and participation in digital maternal health programs in sub-Saharan Africa. *Reproductive Health*. 2022; 19(1): 54. doi: 10.1186/s12978-022-01358-1.

[36] Musiimenta A, Tumuhimbise W, Pinkwart N, Katusiime J, Mugyenyi G, Atukunda EC. A mobile phone-based multimedia intervention to support maternal health is acceptable and feasible among illiterate pregnant women in Uganda: Qualitative findings from a pilot randomized controlled trial. *Digital Health*. 2021; 7: 2055207620986296. doi: 10.1177/2055207620986296.

[37] Muthelo L, Mbombi MO, Bopape MA, Mothiba TM, Densmore M, van Heerden A, Norris SA, Dias NV, Griffiths P, Mackintosh N. Reflections on digital maternal and child health support for mothers and community health workers in rural areas of Limpopo Province, South Africa. *International Journal of Environmental Research and Public Health*. 2023; 20(3):1842. doi: 10.3390/ijerph20031842.

[38] Atukunda EC, Matthews LT, Musiimenta A, Mugyenyi GR, Mugisha S, Ware NC, Obua C, Siedner MJ. mHealth-based health promotion intervention to improve use of maternity care services among women in rural southwestern Uganda: iterative development study. *JMIR Formative Research*. 2021; 5(11): e29214. doi: 10.2196/29214.

[39] Coleman J, Black V, Thorson AE, Eriksen J. Evaluating the effect of maternal mHealth text messages on uptake of maternal and child health care services in South Africa: a multicentre cohort intervention study. *Reproductive Health*. 2020; 17: 1-9. doi: 10.1186/s12978-020-01017-3.

[40] Nyatuka DR, De La Harpe R. Design considerations for patient-centred eHealth interventions in an underserved context: A case of health and wellbeing services within Nairobi's informal settlements in Kenya. *The Electronic Journal of Information Systems in Developing Countries*. 2022; 88(3): e12164. doi: 10.1002/isd2.12164.

[41] Kachimanga C, Divala TH, Ket JC, Kulinkina AV, Zaniku HR, Murkherjee J, Palazuelos D, Abejirinde IO, van den Akker T. Adoption of mHealth Technologies by Community Health Workers to Improve the Use of Maternal Health Services in Sub-Saharan Africa: Protocol for a Mixed Method Systematic Review. *JMIR Research Protocols*. 2023; 12(1): e44066. doi: 10.2196/44066.

[42] Iacoella F, Gassmann F, Tirivayi N. Which communication technology is effective for promoting reproductive health? Television, radio, and mobile phones in sub-Saharan Africa. *PLoS One*. 2022; 17(8): e0272501. doi: 10.1371/journal.pone.0272501.

[43] Arnaert A, Ponzoni N, Debe Z, Meda MM, Nana NG, Arnaert S. Experiences of women receiving mhealth-supported antenatal care in the village from community health workers in rural Burkina Faso, Africa. *Digital Health*. 2019; 5: 2055207619892756. doi: 10.1177/2055207619892756.

[44] Morris LD, Nyatuka DR, Ogundaini OO, de La Harpe R, Siva F, Murugu DK. *Towards a Person-centred Maternal and Child Health Information System Framework for Sustained African Health Security using Kenya as an ICT4D Case*. In: 2023 IST-Africa Conference (IST-Africa) 2023; p. 1-12. IEEE. doi:10.23919/IST-Africa60249.2023.10187841.

[45] Dol J, Richardson B, Murphy GT, Aston M, McMillan D, Campbell-Yeo M. Impact of mobile health (mHealth) interventions during the perinatal period for mothers in low-and middle-income countries: a systematic review. *JBI Evidence Synthesis*. 2019; 17(8):1634-67. doi: 10.11124/JBISRIR-2017-004022.

[46] Akeju D, Okusanya B, Okunade K, Ajepe A, Allsop MJ, Ebenso B. Sustainability of the effects and impacts of using digital technology to extend maternal health services to rural and hard-to-reach populations: experience from Southwest Nigeria. *Frontiers in Global Women's Health*. 2022; 3: 696529. doi: 10.3389/fgwh.2022.696529.

[47] Ogundaini O, de la Harpe R, McLean N. Unintended consequences of technology-enabled work activities experienced by healthcare professionals in tertiary hospitals of sub-Saharan Africa. African *Journal of Science, Technology, Innovation and Development*. 2022; 14(4): 876-85. doi: 10.1080/20421338.2021.1899556.