

THE INFLUENCE OF MOBILE HEALTH TECHNOLOGIES IN ENHANCING CANCER CONTROL IN LOW-AND-MIDDLE INCOME COUNTRIES: A SYSTEMATIC LITERATURE REVIEW

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Abstract

Mobile health (mHealth) technologies are global emergent technologies that can enhance cancer control interventions. This study is aimed at examining the existing published literature on the influence of mHealth in cancer control in Low-and-Middle-income countries (LMICs). A systematic review of studies published between January 1, 2013, and December 31, 2023, was conducted via 4 databases: IEEE, Google scholar, Science Direct and PubMed. A cumulative sample size of 437,971 participants (cancer patients, healthcare providers, family members, and community members) were involved in the studies reviewed. 18 studies revealed that mHealth had enhanced cancer control interventions. A single study showed insignificant results. mHealth applications (mAPPs) were most utilized, highly feasible and proved efficient in enhancing cancer control interventions in LMICs. Extensive research on the impact of mHealth in cancer prevention and awareness raising on cancer risk factors, likewise, the promotion of mHealth adoption in the cancer care continuum in LMICs is needed.

Keywords: Cancer; Cancer control; mHealth; mAPPs; LMICs.

Introduction

Nowadays, health care systems in LMICs are facing challenges relating to the poor implementation of public health strategies aimed at reducing the burden of diseases, overcrowded healthcare facilities, fewer beds and poor access to healthcare services in resource-constrained areas. This has gradually led to the development of novel models of care aimed at resolving these issues. Mobile health technologies (mHealth) are effectively assuming an emerging role in this phenomenon. In Cameroon for example, mHealth has been a feasible approach to supporting the alleviation of the burden of some diseases and equally generating improvements in healthcare outcomes such as eliciting positive health-related behaviors as well as improving treatment adherence in women and patients/individuals (Sevidzem et al., 2019).

The World Health Organization describes the term cancer control as a broad term constituted of 3 major constructs: cancer prevention; early detection (screening, early diagnosis); treatment and palliative care (WHO, 2008). Cancer control in general aims to reduce the incidence, morbidity and mortality from cancer and improve cancer patients' quality of life via prevention, early detection, treatment, and palliative care (WHO, 2008). Cancer prevention on its part seeks to minimize the burden of the disease and its associated risk factors (WHO, 2024), meanwhile, the goal of early detection (which involves early diagnosis and screening) is to spot precancerous changes or subsequent cancer as soon as possible, when a treatment could increase survival or lower morbidity (Crosby et al., 2022). Cancer treatment aims to treat cancer, stop it from spreading or reduce the side effects of other drugs (CDCBreastcancer, 2023). Meanwhile, palliative care seeks to improve the quality of life of cancer patients and their families (Agarwal & Epstein, 2017).

Cancer is, a chronic disease that ranks across the globe as the leading cause of death and a major barrier to increasing life expectancy (Bray et al., 2021). An estimated 19.3 million new cancer cases and almost 10.0 million cancer deaths occurred worldwide in 2020 (Sung et al., 2021). Cameroon's prevalence rate increased from 15,769 to 19,564 new cases and 10,533 to 12,798 registered deaths from 2018 to 2021, respectively (Bray et al., 2021). Survival rates have equally been a major challenge over the past years in LMICs. The overall survival rate at 5 and 10 years for breast cancer in Cameroon, for example, was estimated at 30% and 13.2% respectively and is much lower than those of patients in developed countries, which stands between 90% and 82% at 5 and 10 years respectively (Zingue et al., 2021).

It is worth nothing that, mHealth encompasses a wide range of mobile technologies, including Web-based information resources, phone messaging (short message service/SMS, multimedia messaging service/MMS), videoconferencing, remote patient monitoring, remote interpretation of medical reports and telehealth, including the remote surgical services and telerobotics (Nasi et al., 2015). It is a subset of electronic health (Zakerabasali et al., 2021). The World Health Organization (WHO) defines mobile health as medical and public health practices supported by mobile devices, such as mobile phones, personal digital assistants, patient monitoring devices and other wireless devices (Donkor et al., 2023). In other words, it involves using mobile communications technology applications in health care to promote health-related practices (Salmani et al., 2020).

Mobile health in cancer control is being investigated worldwide to improve cancer surveillance and access to healthcare in geographically inaccessible locations, reduce healthcare costs and facilitate patient-provider communications (Titilayo & Okanlawon, 2014). It has been demonstrated that mHealth is effective in providing equitable access to healthcare in LMICs (Haron et al., 2020). There is, however, a paucity of literature on the role of mHealth in cancer control in LMICs which raises concerns, as to, the impact of the disease's burden in the nearest future, on a population that is predominantly socio-economically deprived. As a matter of fact, traditional cancer control strategies in these countries are yet to yield satisfactory results owing to implementation-related challenges. Cameroon still has a major challenge which is that of fighting cancer, owing to the ineffective implementation of cancer control strategies (Nchang et al., 2021).

Mobile health technologies could enhance cancer prevention, screening, early diagnosis, treatment and palliative care, improve quality of life of cancer patients, render healthcare services more accessible, provide more appropriate care, and less burden on health care processes, if used in cancer control interventions. This review examined the influence of mobile health technologies to enhance cancer control in LMICs. It is expected that results obtained from this study will serve as a model for LMICs in general and Cameroon in particular, which is yet to effectively integrate mHealth in cancer control interventions.

Literature review

Critical review on relevant literature

According to literature, mHealth has a crucial role to play since it can effectively enhance cancer control interventions. From a critical perspective, this phenomenon however has not been properly investigated in LMICs, as a remarkable scarcity of literature was could attest to this. The situation is even more worrisome as none was found to have been conducted in Cameroon. Moreover, most mobile health interventions focused on cancer early diagnosis and screening throughout the

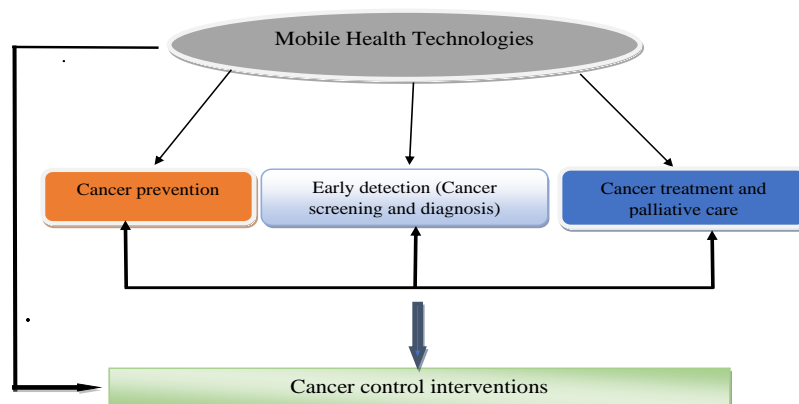
continuum of care, with less focus on palliative care and treatment. In addition, most of the reviewed studies were descriptive in nature, hence the need for more robust studies which will take into consideration the control of cancer risk factors. There is equally need for research on the implementation of primary preventive methods like raising awareness on cancer risk factors with the use of mHealth. Cancer prevention is cost-effective, hence a vital strategy in the fight of the disease in socio-economically deprived settings. Though a significant proportion of the reviewed studies proved to be feasible and effective in enhancing cancer control, none was supported by a theoretical framework, thus, making it challenging for most authors to clearly provide explanations relating to human behaviors in relation to their intentions to utilize m-Health technologies. Cameroon has a dire need for research in mHealth integration in cancer control given the scarcity of literature and the fact that, recent employed strategies have proven to be ineffective in cancer control. Cameroon still has a major challenge in fighting cancer, fostered by the ineffective implementation of cancer control strategies (Nchang et al., 2021).

Conceptual framework

Literature has revealed positive outcomes relating to the use of mHealth in enhancing cancer control interventions. This relationship is illustrated in fig 1 below and highlights that, mHealth (independent variable of the study) could influence cancer control (dependent variables). Cancer control is constituted of the following constructs; cancer prevention, Early detection and Cancer treatment and palliative care.

Figure 1

Conceptual framework showing the influence of mHealth in cancer control interventions



Method

For the purpose of quality assurance, this systematic review was conducted and reported following recommendations from the Preferred Reporting Items for Systematic Review and Meta-analysis guidelines (PRISMA) (Page et al., 2021).

Research Design

A review of literature was undertaken to understand evidence relating to the influence and role of mHealth, with regards to cancer control. For this to be achieved, a comprehensive search was conducted to explore contemporary, relevant studies. The search involved articles published from

January 1, 2013, to December 31, 2023, using 4 electronic databases: IEEE, PubMed, Science Direct and Google Scholar, selected because they are regularly updated with new publications. Additional studies were equally hand-searched via Google and references of articles already included for the study were equally traced. The search strategy included terms relating to the following keywords: Cancer, cancer control, mHealth, mAPPs and LMICs. The keywords stipulated under abstract and medical subject heading (MeSH) terms were used in various combinations. 4 broad themes were derived and combined with the Boolean operator 'AND'. The first theme in Mesh 'mobile health' was created by the Boolean operator 'OR' to combine text words ('Mobile Health', OR 'm-Health', OR 'mAPPs', OR 'Smartphone*', OR 'Mobile app*'). The second theme in Mesh, 'Low-and-Middle income countries,' was created by the Boolean operator 'OR' to combine text words ('low-resource countries', 'resource-constrained countries', 'Low-and-middle income countries), the third theme in Mesh 'Cancer', was created by the Boolean operator 'OR' to combine text words ('Cancer, OR 'Oncology', OR 'Tumor*', OR 'Malignancy*') and finally the fourth theme 'cancer control', the broad theme was created by the Boolean operator 'OR' to combine text words ('Prevention', OR 'Screening', OR 'Early Detection*', OR 'Diagnosis*', OR 'Treatment', OR 'Therapy' OR 'Palliative').

Inclusion and Exclusion criteria

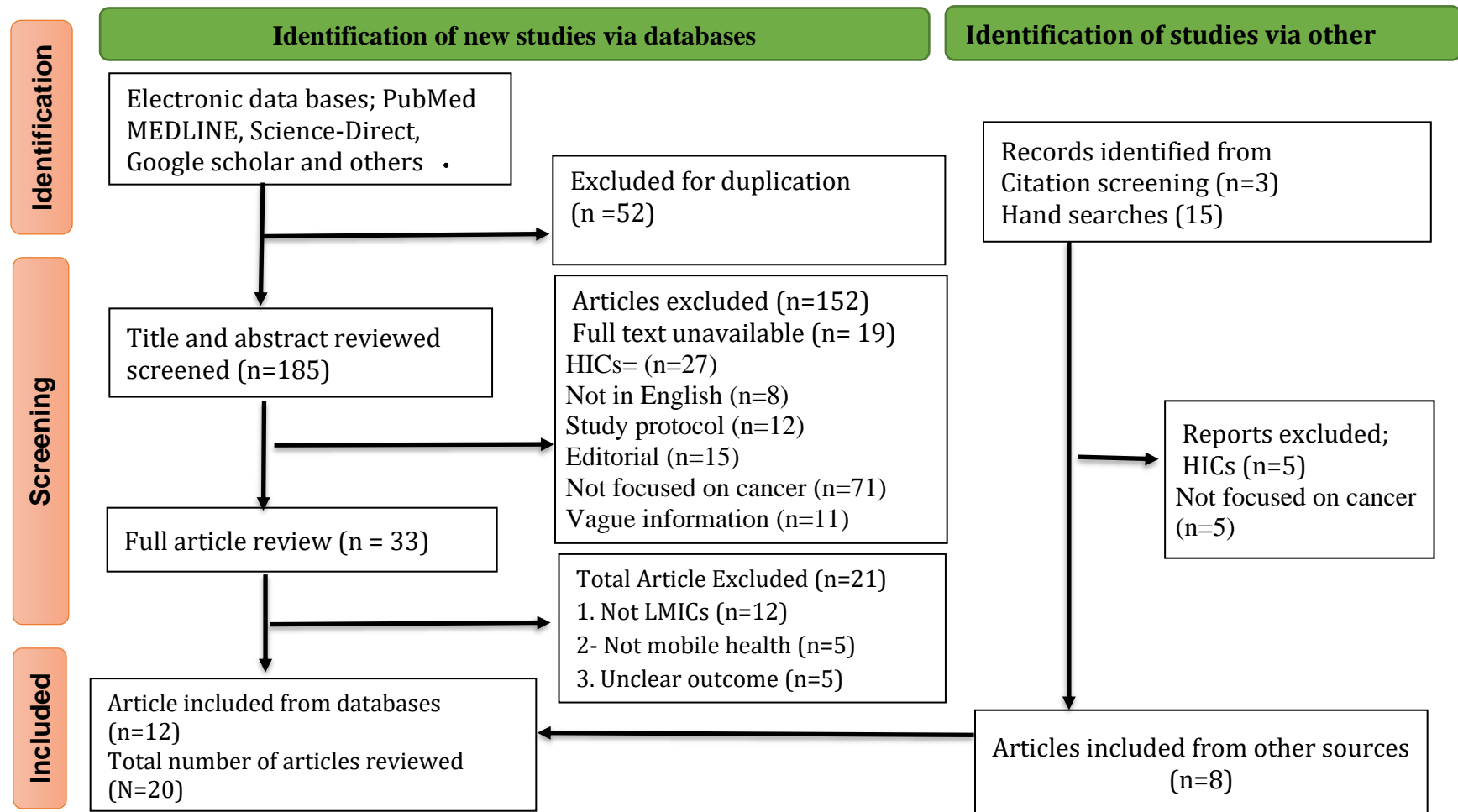
The inclusion criteria limited admission to studies that were: (1) Published in the English language; (2) reported primary research findings about mobile health-based (Mobile apps, automated and non-automated, SMS, telemedicine) interventions in control cancer; (3) conducted in Low-and-Middle income countries; and were published between 2013-2023, (4) related to cancer: prevention, screening, diagnosis, treatment and palliative care interventions. In this study, exclusion criteria were unrelated studies not focusing on cancer control and care, studies with insufficient or vague information on cancer control, editorials, conference proceedings, dissertations, non-original articles, studies conducted in HICs exclusively, and articles published in languages other than English were excluded.

Study selection (Sampling)

Following the searches conducted in the electronic databases, all citations of the identified records were directly saved into the ZOTERO version 6.0 reference manager. Their respective DOIs, PMIDs or PCMIDs were copied, pasted and automatically saved in the said reference App. Duplicated articles were extracted and sent to the trash. Based on the titles and abstracts assigned to the inclusion and exclusion criteria, three investigators independently assessed the papers; the irrelevant studies were eliminated. One reviewer conducted data extraction, and other reviewers rechecked the accuracy of the results. These same investigators read and reviewed the entire text until a consensus was reached. The reasons for inclusion and exclusion had earlier been spelt out.

Figure 2

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)



Data extraction and synthesis

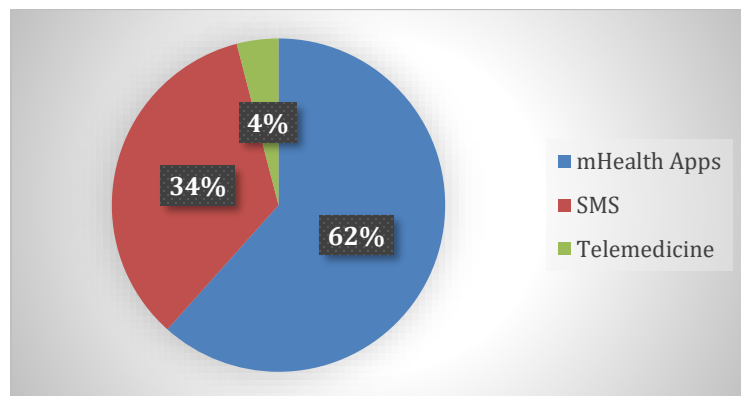
A data summary form was developed at the initial stage of the review. Relevant data elements were extracted from articles that met the inclusion criteria and summarized in Microsoft excel 2011. An initial search through the electronic databases yielded 237 studies, of which 52 duplicates were detected and removed. The 185 remaining articles were screened by title and abstract, and 152 were excluded following the exclusion criteria. Of the remaining 33 articles, 12 articles met the inclusion criteria. An additional 8 articles were included through reference tracing and hand searches (figure 2 above). Finally, 20 articles met the inclusion criteria, 19 of them reported on; role, feasibility, effectiveness and efficacy of m-Health to enhance cancer control interventions. A single study reported on the barriers to cervical cancer screening in Cameroon (Roux et al., 2021).

Results

This section describes the results of our review of existing studies on the influence of mobile health technologies in enhancing cancer control in LMICs. An analysis of the characteristics of the reviewed studies reveals that, a cumulative sample size of 437,971 participants were involved in the reviewed studies. They included cancer patients, healthcare providers (oncologists, physicians, FHW, nurses), family members, and community members. Meanwhile, 3 mHealth interventions were reportedly used in cancer control in the reviewed studies as indicated in fig 3 below: mHealth APPs (62%), Short message service (SMS) (34%) and Telemedicine (4%).

Figure 3

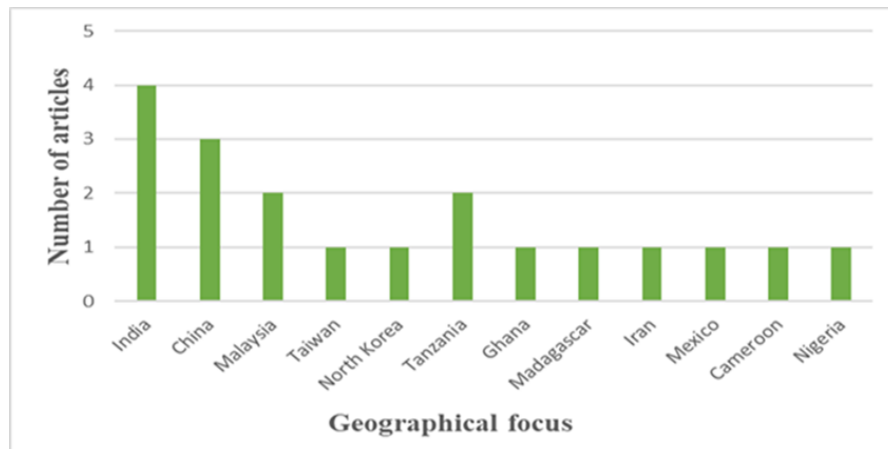
Proportion of mHealth interventions used in reviewed studies



All studies reviewed were conducted across 12 LMICs distributed over 4 continents (Fig 4) as follows: 30 % (n=6) of the studies were conducted in Africa and distributed as follows: Ghana (n=1) (Asgary et al., 2016), Tanzania (n=2), (Linde et al., 2020; Yeates et al., 2016), Madagascar (n=1) (Catarino et al., 2015), Nigeria (n=1) (Akingbade et al., 2022) and Cameroon (n=1) (Roux et al., 2021). Meanwhile, 60% (n=12) were conducted in Asia; India (n=4) Birur et al., 2018; Birur et al., 2015; Subramanian et al., 2021), China (n=3) (Cheng et al., 2020; Wang et al., 2021; Zhu et al., 2018), Malaysia (n=2) (Haron et al., 2017, 2020; Mohamad et al., 2019), Taiwan (n=1) (Hou et al., 2020) and North Korea (n=1) (Jung et al., 2023), and 1 study was conducted in the Middle East (5%); Iran (n=1) (Salmani et al., 2022) and North America (5%); Mexico (n=1) (Buller et al., 2015). The study conducted in Cameroon focused on the barriers associated with cervical cancer screening in Cameroon.

Figure 4

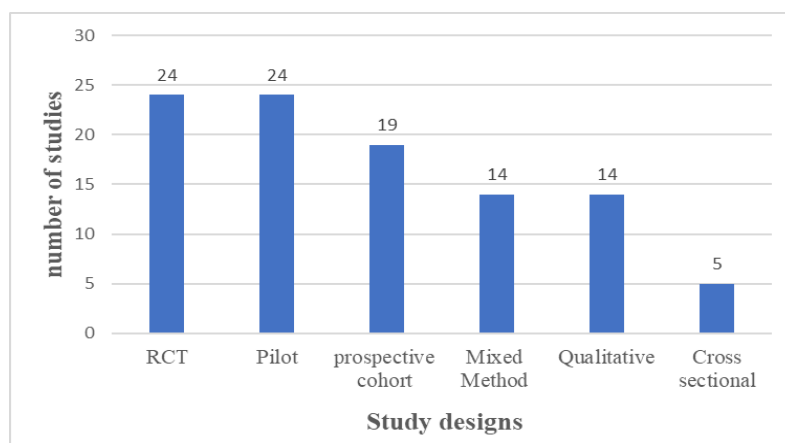
Geographical focus of LMICs included in the study



Looking at fig 5 below, out of the 20 articles reviewed in this study, 24% (n=5) used the pilot study design (Catarino et al., 2015; Haron et al., 2017, 2020; Salmani et al., 2022; Subramanian et al., 2021; Wang et al., 2021), 24% (n=5) randomized control trial design (Buller et al., 2015; Cheng et al., 2020; Hou et al., 2020; Jung et al., 2023; Linde et al., 2020; Subramanian et al., 2021 2017; Zhu et al., 2018), 19% (n=4) used the prospective cohort study designs (Asgary et al., 2016; Birur et al., 2018; Birur et al., 2015; Cheng et al., 2020), 14% (n=3) used mixed method study designs (Bhatt et al., 2018, 2018; Mohamad et al., 2019), 14% (n=3) used qualitative study design (Akingbade et al., 2022; Haron et al., 2020; Roux et al., 2021) and 5% (n=1) used the cross-sectional design (Yeates et al., 2016).

Figure 5

Proportion of study designs used in reviewed studies



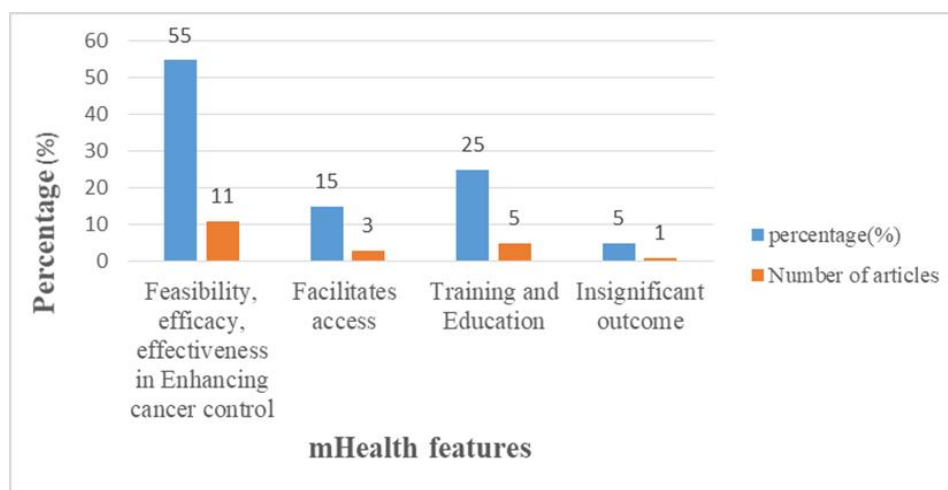
The first finding to be highlighted is that, more than half (55%) of the studies revealed that m-Health Apps were feasible, efficient and effective in enhancing; early cancer detection/diagnosis

(Akingbade et al., 2022; Asgary et al., 2016; Bhatt et al., 2018; Birur et al., 2018; Birur et al., 2015; Haron et al., 2020; Hou et al., 2020; Subramanian et al., 2021; Wang et al., 2021) and cancer screening (Asgary et al., 2016; Bhatt et al., 2018; Birur et al., 2015; Catarino et al., 2015; Haron et al., 2020; Hou et al., 2020; Mohamad et al., 2019; Subramanian et al., 2021), cancer prevention (Buller et al., 2015; Catarino et al., 2015; Mohamad et al., 2019; Subramanian et al., 2021), palliative care (Hou et al., 2020; Jung et al., 2023; Mohamad et al., 2019; Subramanian et al., 2021; Wang et al., 2021; Zhu et al., 2018), cancer treatment (Akingbade et al., 2022; Catarino et al., 2015; Subramanian et al., 2021; Wang et al., 2021) as illustrated in figure 6.

Another pertinent finding highlighted is that, 25% of the reviewed studies reported positive outcomes regarding the influence of m-Health in training and educating HCPs and the community (Asgary et al., 2016; Birur et al., 2018; Birur et al., 2015; Haron et al., 2020; Mohamad et al., 2019; Yeates et al., 2016). Moreover, 15% of studies equally found m-Health to have positively influenced access to health care and facilitated access to specialist services and health-related information (Bhatt et al., 2018; Birur et al., 2018; Haron et al., 2020; Salmani et al., 2022; Zhu et al., 2018). On the contrary, a single study (5%) revealed that m-Health was ineffective in improving the attendance rate for cervical cancer screening uptake in low-resource settings (Fig 6).

Figure 6

Influence of mHealth in enhancing cancer control interventions in reviewed studies



Discussions

This systematic review provides evidence of the significant influence of mHealth in cancer control in LMICs. Our revealed that, there is limited literature in this field in LMICs, despite the fact that cancer continues to pose a serious public health threat affecting more and more people every day. In addition, the use of mHealth technologies is limited to the use of one-way text messages and mobile applications. Meanwhile, telemedicine is still underutilized in these countries. Cancer screening and early diagnosis are the interventions that make the most use of mHealth technologies.

There are two strategies for early detection in cancer (early diagnosis and screening) (WHO, 2024c). The goal of early detection is to spot precancerous changes or subsequent cancer as soon as possible, when a treatment could increase survival or lower morbidity (Crosby et al., 2022). Bhatt et al. (2018) revealed that m-Health approaches supported cancer screening in poor rural communities with low levels of health literacy. Similar findings were obtained as a majority of the studies revealed positive outcomes with mHealth supporting cancer early detection (Akingbade et al., 2022; Asgary et al., 2016; Bhatt et al., 2018; Birur et al., 2018; Birur et al., 2015; Haron et al., 2020; Hou et al., 2020; Subramanian et al., 2021; Wang et al., 2021) and cancer screening (Asgary et al., 2016; Bhatt et al., 2018; Birur et al., 2015; Catarino et al., 2015; Haron et al., 2020; Hou et al., 2020; Mohamad et al., 2019; Subramanian et al., 2021). Mobile health-enabled telemedicine demonstrated the potential role of m-Health in supporting screening and early diagnosis of cancers (Catarino et al., 2015). Meanwhile, Cameroon is yet to integrate m-Health to support cancer screening and diagnosis, there have been reports of numerous challenges faced in implementing these activities in the country. Roux et al. (2021) identified two major barriers to cervical cancer screening in Cameroon: lack of basic knowledge on cervical cancer among most women and men and the lack of awareness of the role and existence of screening programs to prevent it.

Cancer prevention can greatly be enhanced by mhealth (Buller et al., 2015; Catarino et al., 2015; Mohamad et al., 2019; Subramanian et al., 2021). Unfortunately, few studies focused on mHealth in cancer prevention interventions. Cancer prevention can be population or individual-based interventions for primary and secondary detection which aims to minimize the burden of the disease and its associated risk factors (WHO, 2024a). As the saying goes, “prevention is better than cure”. This is particularly true with Cancer because, the cost of treating the disease poses huge financial burdens on the populations especially in the LMICs where large segments of the populations are impoverished and often face huge challenges having access to health care. Treating cancer in Cameroon for example is costly for an average national, as a complete course of chemotherapy followed by radiotherapy costs approximately XAF 1,500,000 (\$2,480) (Mapoko et al., 2023). There is therefore a need for emphasis to be laid on cancer prevention in LMICs.

Mobile health technologies positively influenced the treatment of cancer as revealed by this study (Akingbade et al., 2022; Catarino et al., 2015; Wang et al., 2021). Text messages aimed at reminding patients of their appointments, when they had to take their drugs or follow any form of therapy were found to be significantly enhanced by mHealth. It equally proved to be effective in enhancing recovery after surgery among patients with esophageal cancer (Cheng et al., 2020). Contrarily, Linde et al. (2017) revealed that m-Health was unable to support cancer control, likewise, improving the attendance rate for cervical cancer uptake in low-resource settings. This result could however be attributed to the strikingly low attendance rate of participants involved in the study. In cancer control, palliative care is an essential part of the overall treatment plan for patients. The goal of its clinical practice is to improve the quality of life for patients and their families who are dealing with life-threatening illnesses (Agarwal & Epstein, 2017). Treatment in cancer care is done considering the diseases’ stage. It either aims to treat cancer, stop it from spreading or reduce the side effects of other drugs (CDCBreastcancer, 2023).

In addition to enhancing cancer control interventions, mHealth has the ability to enhance training and educating healthcare workers including specialist, community members; increasing health care workers’ skills and accuracy in cancer screening and diagnosis, and increasing knowledge on

cancer screening among physicians, HCPs and frontline HCW. This is a crucial feature of m-Health in cancer control as capacity building and the exchange of novel knowledge among healthcare practitioners facilitated by mHealth is relatively cost effective as opposed to having to displace staff or other members of the community to different geographical locations for knowledge and skill acquisition. Mohamad et al. (2019) revealed that m-health was quite effective in educating the community on colorectal cancer. Enhancing access to equitable healthcare, medical specialists, and health-related information is another prominent feature of m-Health, as revealed in this study. Access to general healthcare and specialist care is a major barrier to receiving adequate cancer care in most developing countries due to limited human resources (specialists) and limited healthcare facilities. Integrating m-Health in cancer control provides an opportunity to break this gap.

mHealth integration in cancer control interventions in LMICs is faced with several challenges. Theoretical models have been used to provide explanations to these phenomena. In the context of the current study, we used the Technology Acceptance Model (TAM) to in a bid to provide an in-depth understanding of the influence of m-Health in enhancing cancer control. The technology acceptance model (TAM) evolved from Ajzen and Fishbein's theory of reasoned action (TRA) and Planned behavior (TPB) and was developed by Davis in 1989 (Worthington, 2021a). This model posits that, when users perceive that a given technology is useful and easy to use, they will be willing to use it. Consequently, the more health care service providers and users recognize that mHealth will render their tasks easier to perform; the higher the chance that they will use it and accept the new technology as being useful (Ajibade, 2018). The TAM has 2 constructs (Nguyen et al., 2020). Both constructs focus on the factors which determine behavioral intention to use new technologies (Kalayou et al., 2020). They are: Perceived usefulness; which is the extent to which mHealth is believed to enhance cancer control interventions (cancer; prevention, diagnosis and screening, treatment and palliative); Perceived ease of use which is the degree to which the use of mHealth technology is perceived as effortless by healthcare workers.

Theoretical/Practical Implications

Mobile health technology is fast gaining grounds in Asia. In this study, several mobile health applications were found to have been successfully designed and effectively implemented in cancer control intervention in this region. These have yielded positive outcomes and have equally been a contributing factor to the relatively high survival rates in cancer and the reduction in the disease's incidence and, consequently, its burden. This study reviewed many more articles from Asia, with India (n=4) and China (n=3) leading the charts. There is an urgent need for m-Health to be integrated into cancer control interventions in Africa because the traditional methods of door-to-door sensitization campaigns have not yielded the desired outcome over the years. It was revealed that only 30% (n=6) of these studies were conducted in Africa. This means that there is need for more extensive research studies to be conducted on mHealth technologies in Africa. This will aid in developing home-grown interventions to eradicate cancer.

Limitations of the study

Though this review could serve as a landscape for prospective studies, its findings could not be generalized for the following reasons; first, we excluded other types of papers such as studies conducted in high-income-countries, editorials, full text unavailable, study protocols and publications in languages other than English, second, this systematic review was restricted to

published articles from 2013 to 2023, third, given our limited resources, it was challenging to provide a global overview and so our review was limited to LMICs only.

Conclusion

In this study, the influence of mHealth technologies on cancer control interventions have been spelt out. Most of the employed mHealth technologies reported positive outcomes across the continuum of cancer control. The use of mHealth technologies revealed positive outcomes in facilitating access to health and specialist care services, enhanced cancer prevention, screening, diagnosis, treatment and palliative care. mHealth is however still underutilized in LMICs despite its advantages. This underutilization may depend on issues relating to, healthcare systems, infrastructure and deficient or inexistence training. mHealth has demonstrated the potential to address cancer control-related challenges in LMICs thus, making research in this field prospects for improving cancer control. Although several studies have suggested a positive influence of mHealth in enhancing cancer control interventions, there is great need to have more extensive studies in this field on the impact of mHealth in cancer prevention and awareness raising on cancer risk factors. Furthermore, there is a need for the elaboration of policies that promote the integration of mHealth in cancer control activities.

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