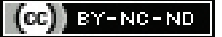


# Using Mobile Health (mHealth) Interventions to Optimise Breast Cancer Care: A Scoping Review

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## ABSTRACT

**Introduction:** Mobile phones have become ubiquitous in recent years. This portable device can be efficiently utilised to promote health and deliver high-quality healthcare services via Mobile Health (mHealth) technology interventions. In view of the increasing global burden of breast cancer cases, mHealth interventions can be constructive in breast cancer prevention and management. Nevertheless, there is a paucity of evidence to support the utility of mHealth interventions in breast cancer care.

**Aim:** To analyse and synthesise evidence from published literature on the feasibility and effectiveness of mHealth interventions employed for breast cancer prevention, detection, management, and rehabilitation. Additionally, this study intends to draft a conceptual framework for mHealth intervention strategies in breast cancer management.

**Materials and Methods:** A comprehensive literature search was conducted at Panimalar Medical College Hospital and Research Institute, Chennai, Tamil Nadu, India, from June 2022 to December 2022. Google Scholar and PubMed databases were used to find published articles relevant to the study's objectives.

The reviewers selected articles based on the relevance of the article and eligibility criteria. Articles on mHealth interventions for the female population above 18 years of age with breast cancer were included.

**Results:** A total of 13 articles were selected based on the eligibility criteria. Regardless of the type of mHealth technology employed, target population, and purpose of intervention, all the studies strongly support the use of mHealth technology-based interventions over usual care to enhance breast cancer management.

**Conclusion:** The use of mHealth applications has increased exponentially in recent years. Since then, many studies have been conducted to validate their use. However, the usability of these applications is not well established. The involvement of not only patients but also healthcare professionals is crucial to develop well-equipped digital health applications. Personalised applications that provide security and safeguard user privacy are highly preferred by patients. A collaborative approach involving patients, healthcare professionals, and application developers will aid in the development of highly efficient mHealth applications.

**Keywords:** Early detection, mHealth application, Prevention, Smartphones, Treatment

## INTRODUCTION

The Global Observatory for electronic health describes mobile health as the adoption of mobile technology and the use of other wireless gadgets to enhance medical and public health practices [1]. The new generation smartphones, which are on par with computers, pave the way for the development and utilisation of health-based applications [2]. These newer mHealth tools can be constructively exploited to promote health, facilitate health behaviour changes, aid in the diagnosis and management of diseases [3]. A combination of mHealth interventions and conventional treatment has the potential to produce promising results in the long-term management of diseases [4]. They assist in achieving the sustainable development goals [5] of good health and well-being, boost health self-governance, and help to keep track of treatment progression [6].

Cancer continues to pose multifarious challenges to patients, as well as healthcare professionals. The struggle is more evident in developing countries due to a deficit of resources, lack of patient awareness, disparities in access to healthcare, and non adherence to treatment plans [7]. A greater number of cancer survivors describe an awful journey of recovery owing to a lack of supportive care for the detrimental long-term consequences of cancer. mHealth interventions are an excellent means to optimise cancer care and confront the unmet demands of cancer survivors through technology [8]. The majority of cancer patients are in agreement with communicating information via an application to reinforce their screening and treatment modalities. Healthcare professionals also recognise the vital role that mHealth interventions can play in determining treatment outcomes [9]. The contemporary mHealth tools undoubtedly help cancer patients

in their battle against the deadly disease. This particularly holds true in regard to breast cancer management.

According to the World Health Organisation (WHO), breast cancer has retained the first position in the list of the most prevalent cancers across the globe since 2020, surpassing lung cancer [10,11]. Novel technologies like mHealth interventions provide a scope to facilitate effective patient-physician interaction, enhancing the knowledge and awareness of patients. This may help reduce the burden of active breast cancer cases globally. The post-diagnostic psychological effects of breast cancer, such as stress, anxiety, and depression, make it imperative for physicians to extend mental support to patients post-diagnosis and treatment. These technological advancements will pave the way to promote the psychological well-being and preparedness of patients towards diagnosis, treatment, and follow-up [12]. The increased risk of recurrence and decreased survival rate among breast cancer patients is associated with obesity [13]. mHealth may serve as a beneficial platform to encourage physical activity among this population, countering the adverse effects and fostering a healthy lifestyle [14-16].

Initial studies assessing the outcome of breast cancer applications have highlighted the lack of a primary evidence base to validate their use. Over the past 10 years, there has been a steady increase in the use of smartphone applications in breast cancer care. Given the ubiquity of smartphones and the increasing global burden of breast cancer, mobile phone applications have a positive impact on breast cancer care worldwide [17]. The paucity of knowledge regarding the clinical effectiveness of these mHealth applications for breast cancer calls for more studies investigating the efficacy and

reliability of mHealth tools. Even though mHealth interventions have played a positive role in improving physical activity among cancer patients, there is a dire need for mHealth interventions individually tailored for breast cancer patients. Hence, the present scoping review was conducted to explore the existing mHealth applications, their efficiency, accessibility, and acceptability among the target population. Additionally, identification of gaps in the successful implementation of these emerging technological interventions was performed.

## MATERIALS AND METHODS

A comprehensive literature search was conducted at Panimalar Medical College Hospital and Research Institute, Chennai, Tamil Nadu, India, from June 2022 to December 2022. The synthesis of evidence was performed based on an extensive search of scholarly articles from the databases Google Scholar and PubMed. Studies from 2009 were considered for the present review. Arksey H and O Malley L reported five-stage methodological framework was followed [18]: 1) Identifying the research topic; 2) Identifying relevant research papers; 3) Selecting the studies; 4) Charting the data; 5) Collating, reporting, and summarising the findings. The PRISMA extension for scoping reviews was followed to structure the present review [19].

### Source of Information

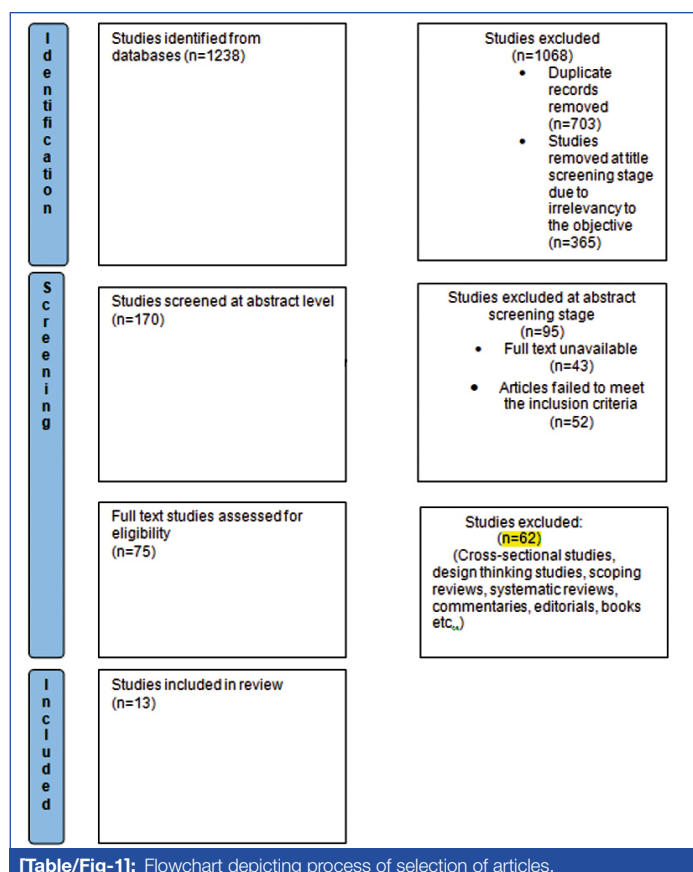
A comprehensive literature search was conducted in the databases Google Scholar and PubMed. Scholarly research articles that were consistent with the inclusion criteria were selected for the review.

### Search Strategy

The following search terms relating to breast cancer were used: ("Breast cancer", "Breast cancer awareness", "early diagnosis", "prevention", "treatment", "postsurgery") and relating to smartphones ("mobile health", "telemedicine", "mHealth applications", "smartphones"). The retrieved articles were further filtered based on inclusion and exclusion criteria.

### Stage 3: Process of Selection

**Eligibility criteria:** Articles were screened and included for the present scoping review based on the following inclusion and exclusion criteria [Table/Fig-1,2].



[Table/Fig-1]: Flowchart depicting process of selection of articles.

Parameters	Inclusion criteria	Exclusion criteria
Language	Only studies published in English	Studies published in languages other than English
Type of data	Qualitative, quantitative and mixed method	Systematic and scoping reviews
Study population	Female population $\geq 18$ years of age	Male population of all ages
Intervention	Mobile health applications and telemedicine interventions for breast cancer	Other types of interventions for breast cancer and mHealth interventions for other types of cancer

[Table/Fig-2]: Criteria for inclusion and exclusion of articles.

### Data Charting

The selected studies were thoroughly analysed, and the extracted data were sorted into variables: Title, name of the first author, year, country, main objective, study design, target population, control group, type of mHealth intervention, target of intervention, summary of intervention, duration, follow-up, features of mHealth technology, purpose of intervention, strength of mHealth technology, limitation of mHealth technology, measures of outcome, and major findings.

## RESULTS

### Selection of Source of Evidence

A total of 1,238 articles were retrieved from the databases Google Scholar and PubMed. These articles underwent screening at three levels (title, abstract, and full-text stage) based on the inclusion and exclusion criteria. Duplicate records, studies that did not meet the inclusion criteria, scoping and systematic reviews, editorials, commentaries, and articles with unavailable full texts were excluded from the analysis. A total of 13 articles were selected for the present review [9,14,20-30].

**Characteristics and results of sources of evidence:** The table below presents an array of parameters that were assessed for the present review. All the extracted data are represented under the appropriate variables [Table/Fig-3-5] [9,14,20-30].

### Characteristics of the Studies Included

The primary search provided 1,238 records, out of which 13 articles were selected for the review following several rounds of screening based on inclusion and exclusion criteria [9,14,21-30]. The present investigation revealed that over the last decade, mHealth technology and its application in breast cancer have shown promising results for targeted patients. The majority of the papers were published in 2020 [9,24,25] and 2021 [14,25,26] (n=3 each) [Table/Fig-6]. The scrutinised articles mainly focused on breast cancer patients, with very few articles discussing the impact of mHealth applications on breast cancer awareness among the general population [22,23]. The authors have included articles under the following types of study design: a) qualitative study [14] (n=1); b) Randomised Controlled Trial (RCT) (n=6) [9,20,21,23,29,30]; c) clinical trial (n=1) [26]; d) mixed-method study (n=2) [22,28]; e) non randomised group control study (n=1) [24]; f) pilot pre-post study (n=1) [25]; g) quasi-experimental study (n=1) [27]. [Table/Fig-7] depicts the number of articles included under different types of study design that have been analysed. 69.23% of the studies considered for the present review involved mobile applications [9,14,22-27,29], while 15.38% used conventional telephone calls as a medium to transfer information [20,21]. The other 7.69% of articles used short message service/text messages [28], and 7.69% used snapchat as the mHealth technology [Table/Fig-8] [30]. Furthermore, among the included articles, it has been found that a greater number of studies were conducted in the USA (n=5) [Table/Fig-9] [22,24-26,29].

Study ID	Title	Author	Year	Country	Main objective	Study design	Target population	Control group
1	Use of mHealth to increase physical activity among breast cancer survivors with fatigue: Qualitative exploration	Martin E et al., [14]	2021	France	To explore the level and barriers to implementation of mHealth intervention	Qualitative study	Patients diagnosed with stage 1 to 3 breast cancer	Not applicable
2	Comparing hospital and telephone follow-up after treatment for breast cancer: Randomised equivalence trial	Beaver K et al., [20]	2009	Manchester	To explore the difference in conventional hospital, follow-up with telephone follow-up post breast cancer treatment	Randomised controlled trial	Women treated for breast cancer	Women treated for breast cancer
3	Quality of life of women after a first diagnosis of breast cancer using a self-management support mHealth app in Taiwan	Hou C et al., [9]	2020	Taiwan	To inspect the quality of life of women with breast cancer in Taiwan	Randomised controlled trial	Stage 0 to 3 breast cancer patients	Stage 0 to 3 breast cancer patient
4	A randomised trial of a telephone-delivered exercise intervention for non urban dwelling women newly diagnosed with breast cancer : exercise for health	Eakin E et al., [21]	2012	Australia	To assess the effectiveness and feasibility of telephone delivered exercise intervention	Randomised controlled trial	Women of 20 to 69 years diagnosed with invasive breast cancer (n=73)	Women of 20 to 69 years diagnosed with invasive breast cancer (n=70)
5	Can mHealth improve risk assessment in undeserved populations? acceptbilty of a breast health questionnaire app in ethnically diverse, older, low-income women	Bravo C et al., [22]	2014	USA	To analyse the attitude on acceptance and practice of mhealth tools using breast health application	Mixed method	English and Spanish speaking women above 40 years of age	Not applicable
6	Application of personalised education in the mobile medical app for breast self examination	Blajda J et al., [23]	2022	Poland	To explore the personalised mobile health application for breast self-examination	Randomised controlled trial	A total of 250 women from Podkarpackie province	A total of 250 women from Podkarpackie province
7	Evaluation of a mobile health intervention to improve wellness outcomes for breast cancer survivors	Cairo J et al., [24]	2020	USA	To examine whether use of commercially available app provides breast cancer patients access to health and wellness	Non randomised group controlled study	Women above 18 years of age with curative intent breast cancer	Women above 18 years of age with curative intent breast cancer
8	Use of mental health applications by patients with breast cancer in United States (US)	Chow P et al., [25]	2020	USA	To evaluate the impact of mental health applications in patients diagnosed with breast cancer	Pilot pre post study	A total of 40 breast cancer patients	Not applicable
9	Acceptability of an m health breast cancer risk reduction intervention in promoting risk assessment education and discussion of risk in the primary care setting	Kalpan C et al., [26]	2021	USA	To assess the acceptability of an mhealth intervention mong people for its education and risk in a primary care setting	Clinical trial	Women patients, doctors receiving breastcare intervention into four ethnic groups	Not applicable
10	A mobile system to improve quality of life via energy balance in breast cancer survivors (BENECA mHealth)	Lozano-Lozano M et al., [27]	2019	Spain	To evaluate the feasibility of BENECA intervention among breast cancer survivors	Quasi experimental study	Breast cancer survivors from 30 to 75 years having BMI more than 25	Not applicable
11	Co-designing a lifestyle focused text message intervention for women after breast cancer treatment- A mixed-method study	Singleton A et al., [28]	2021	Sydney	To analyse the mental and physical health of women after breast cancer treatment with SMS based mobile health intervention	Mixed method study	Women with history of breast cancer treatment within past five years	Not applicable
12	Mobile phone multilevel and multimedia messaging intervention for pressed cancer screening	Vo V et al., [29]	2017	USA	To analyse the impact of mHealth has technology to enhance the breast cancer management among Korean American women	Randomised controlled trial	A total of 60 Korean American women who were aged between 40 to 77-year-old who received the m health intervention	A total of 60 Korean American women with usual care
13	Evaluation of the Snapchat mobile social networking application for breast cancer awareness among Saudi students in the Dammam region of the Kingdom of Saudi Arabia	Ginossar T et al., [30]	2018	Saudi Arabia	To analyse the usability and effectiveness of the Snapchat mobile application in increasing the breast cancer awareness among female students in Saudi Arabia	Randomised controlled trial	A total of 100 female students who received the intervention	A total of 100 female students who did not receive any intervention

**[Table/Fig-3]:** Characteristics of study selected for analysis.

SMS: Short message service; BMI: Body mass index

The majority of the studies 6 (46.15%) have been conducted with an objective to identify the factors that contribute to the acceptability of mHealth interventions among breast cancer patients [14,21,22,24,26,27]. [Table/Fig-10] portrays the target of intervention of the studies included in the present review. Various physical, sociodemographic, psychological, social, and organisational factors act as levers to improve the acceptance of mHealth interventions in breast cancer patients. The results of the studies suggest that digital health innovations are highly accepted by breast cancer patients, and mHealth serves as a reliable medium for imparting knowledge about breast cancer. A mixed-method study conducted

to assess survivor preferences for mHealth applications suggested that preferences vary around themes of relevance, ease of use, and enhancing personal motivation [28]. More personalised and intimate applications are preferred for health interventions by breast cancer patients [28]. [Table/Fig-11] portrays the purpose of intervention of the included studies.

A qualitative study conducted focus group discussions and individual interviews to understand the perceptions and needs of breast cancer patients [15]. This key finding aids in the development of applications and bridges the gap between consumers and developers. Randomised control trials have shown that the use

Study ID	Type of mHealth intervention	Target of intervention	Summary of intervention	Duration and follow-up	Features of mHealth technology	Purpose of mHealth technology
1	Mobile phone application (KIPLIN mHealth group challenge)	Survivorship and rehabilitation	The intervention comprised of mHealth group challenge, wherein the patients had a target of performing 6000 steps, measured by pedometer	2 weeks	The app consisted of Virtual competitive exercise activity conducted in groups Interaction with other patients via chat network Access to physical education information	Physical well-being
2	Telephone voice calls	Treatment follow-up	Participants in the study group received telephone appointments consistent with hospital follow-ups	24 months	30 minutes (20 minutes of consultation and 10 minutes to discuss on the outcomes) of telephone appointments	Educational and follow-up
3	Mobile phone application (BCSMS app)	Breast cancer management and rehabilitation	The BCSMS app was installed on the mobile phones of experimental group and they were trained to use it effectively	Baseline (T0), 1.5 month (T1) and 3 months (T2) follow-up	The main features of the app includes Information about breast cancer postsurgery Physical activity and rehabilitation Nutritional requirements of breast cancer patient Psychological and emotional support Maintenance of personal health records to track prognosis of treatment and side-effects Consultation	Educational, Physical and mental well-being
4	Telephone voice calls	Survivorship and rehabilitation	The participants of the study group telephone voice calls from exercise physiologists. A study workbook and exercise tracker was provided to all participants on request	A total of 8 months (once/week for 2 months, once/fortnight for 2 months, once/month for 4 months)	A total of 16 voice calls lasting for 15-30 minutes of duration over a period of 8 months. Exercise sessions of previous period were assessed and the barriers were discussed and resolved	Physical well-being
5	Mobile phone application (Athena app)	Breast cancer risk assessment	The participants used the Athena Breast Health Questionnaire app	July 2012 to August 2012	The app procures data on personal health, demographics, lifestyle and serves to predict the risk of developing breast cancer	Risk prediction
6	Mobile phone application (Exam oneself)	Prevention and early detection	The participants of the study group received personalised education via the mobile phone application	March 2018 to February 2019	Proprietary interactive tactile test: The technique of breast self-examination was evaluated Proprietary questionnaire: To explore the knowledge and awareness about breast cancer among the users Standardised questionnaire	Educational
7	Mobile phone application (Vida app)	Survivorship and rehabilitation	The participants of study group were provided with six months subscription for Vida app. The control group were given self-guided tool kit.	6 months and 12 months	Via the Vida app the participants were paired with a coach. The pairing occurs on the grounds of the participants' biometrics, health goals and suitable coaching style	Physical well-being
8	Mobile phone application	Rehabilitation	The mobile phone application collected and analysed the information on the health of the patients and distress and mood symptoms reported by the patients	7 weeks	The mobile phone application will analyse and report the data collected on the mental wellbeing of the breast cancer patients and suggested counselling via text messages and phone calls to the patients to improve their mental health	Mental well-being
9	Mobile phone application	Risk assessment and treatment	The breastcare intervention is a tablet based tool that can be used in iPads tablets and mobiles that analysis their reports of substations and generates information on treatment and management for the patients as well as the physicians	1 year 2 months	The complaints of the patients were entered in the application and analysed by the software to predict the risk and treatment of breast cancer. It provided results in English Chinese and Spanish languages. the report was available to the patients as well as the physicians who treated them	Risk predication
10	BENECA mHealth Mobile phone application	Survivorship and management	The mHealth application was installed in the participants phone by a member of the research team and trained them to use the app	8 weeks	Physical activity and diet information was recorded via the application. Based on the data collected, the app sent diet and physical activity recommendations through notification	Physical fitness and nutrition
11	SMS text messages	Survivorship and treatment	The participants received semi-personalised text messages	Not mentioned	Not elaborated	Physical fitness, education, mental well-being, treatment and nutrition
12	Multilevel and Multimedia messages via app (mammogram) (mobile phone application)	Awareness and prevention	The participants of the study group received culturally and personally tailored messages	6 months	The participants received 8 to 21 messages everyday over a period of 1 week. Core areas such as breast cancer screening guidelines, types of screening, risk factors etc	Education and awareness
13	Social media network (Snapchat)	Awareness and prevention	The participants of the intervention group received breast cancer awareness videos, texts and pictures via Snapchat	Not mentioned	Breast cancer awareness information which encompasses knowledge about breast cancer, signs and symptoms, diagnosis, treatment options available were provided to the patients via snapchat	Education and awareness

[Table/Fig-4]: Attributes of mHealth intervention.

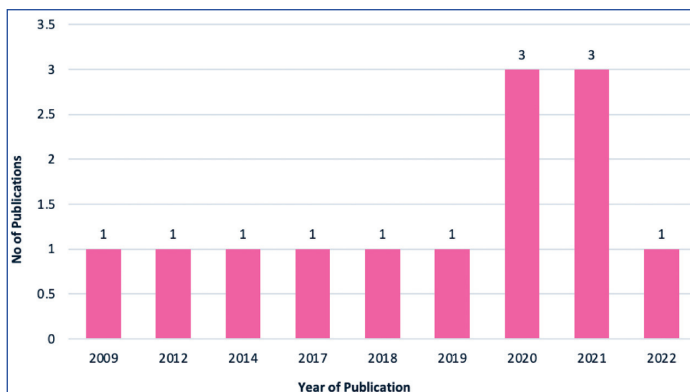


Study ID	Strengths of the mHealth technology	Limitations of the mHealth technology	Measures of outcome	Major findings
1	The mHealth group challenge is a fun competitive activity which motivates the user to perform physical exercise. It makes them feel fresh and healthy and the activity performed is quantifiable	The fact that this intervention is time consuming and applicable only for walking stands as obstacles. Technical glitches also make it inconvenient for the users	Two focus group discussions were conducted to explore the levers and barriers to perform physical activity with the aid of this mHealth technology	mHealth based virtual group challenges are perceived as levers to perform physical exercise among breast cancer patients
2	Convenient (especially for patients who have to travel long distances for in person hospital appointments) and reduces the patient burden in OPD	Patients feel uncomfortable to disclose their problems and discuss their concerns over telephone	Instruments such as Spielberger State Trait Anxiety Inventory (STAI) and General Health Questionnaire (GHQ-12) were employed to assess the outcomes	Telephone follow-ups is a feasible mode of treatment follow-up with no perceived disadvantages
3	Multifaceted, integrated and user centered app with easy accessibility	Prior knowledge about breast cancer via mHealth app increased anxiety and depression during surgery. This was not demonstrated in the study due to recruitment of postoperative participants	The European Organisation for Research and Treatment of Cancer (EORTC) Quality Of Life Questionnaire Core 30 and the EORTC breast cancer specific Quality Of Life Questionnaire were employed for evaluating the outcomes	Smartphone applications like BCSMS app can serve to support breast cancer self-management
4	User centered, individually tailored and personalised	Not specified	Outcomes were measured via postal questionnaires and telephone interview post-intervention	Telephone delivered exercise intervention are effective and feasible means of improving physical well-being among breast cancer patients
5	Innovative, up to date, easy to use	Unfamiliarity of the participants to modern technologies, lack of health literacy to understand terms and concerns about data privacy	The outcomes were measured through semi structured interviews	Ethnically diverse, older women with low income prefer mHealth tools for health data collection
6	Comprehensive and personalised	Not specified	The proprietary questionnaire and standardised questionnaire (Generalised Self-Efficacy Scale) were employed to gauge the outcomes of the intervention	Educational mobile health application dedicated for breast cancer prevention and breast self-examination can improve the breast self-examination skills among the users
7	User centered approach, credibility and personalised app	High cost of app subscription (\$65 per month)	The outcomes were measured by four survey instruments: the Godin-Shephard Leisure-Time Physical activity Questionnaire; Rate Your Plate nutritional assessment questionnaire; the visual analog scale; the Patient Health Questionnaire	Live health coaching app gives effective support to breast cancer patients
8	Easy to learn and use, personalised	The content was to a certain extent irrelevant to breast cancer	The outcomes of the study were measured using the Patient Health Questionnaire-4, Patient Reported Outcomes Measurement Information System. USE-Short form was utilised to analyse the usability of the application	There was an observable decrease in depression and anxiety from baseline to post intervention
9	Easy to use and understand, personalised risk report	The risk reports might increase anxiety among the patients	Survey and structured interviews	The mHealth applications like BreastCARE which are tools of risk assessment are efficient means to transmit information
10	Relevant information is provided, easy to use	The BENECA misses few vital physical exercises and food items, feedback is limited	Structured interviews were conducted by members of research team. A Spanish self-efficacy scale for physical activity was employed to gauge the level of motivation of the participants to perform physical activity. Data on physical activity were collected via accelerometry	The breast cancer survivors were in support of the use and adoption of BENECA application. It produced conspicuous improvement in the quality of life of breast cancer survivors
11	Alleviates loneliness and isolation, motivates to exercise.	Not mentioned	Feedback surveys and semi structured interviews	Co-designing a mHealth application actively involving breast cancer survivors, healthcare professionals and researchers is feasible and effective in developing mHealth application
12	Easy to use, learn and understand	Not mentioned	Primary outcome measure – Mammogram receipt Secondary outcome measure – Surveys to assess knowledge, attitude, health beliefs, cultural beliefs and participant satisfaction	mHealth interventions are feasible and practical means to promote breast cancer screening
13	Personalised and ease of use	Fear of breach in personal data and privacy	Survey questionnaire was adopted from the United Kingdom (UK) cancer research to assess the effectiveness of the mHealth awareness intervention	The SnapChat mobile social networking application was efficacious in promoting breast cancer awareness

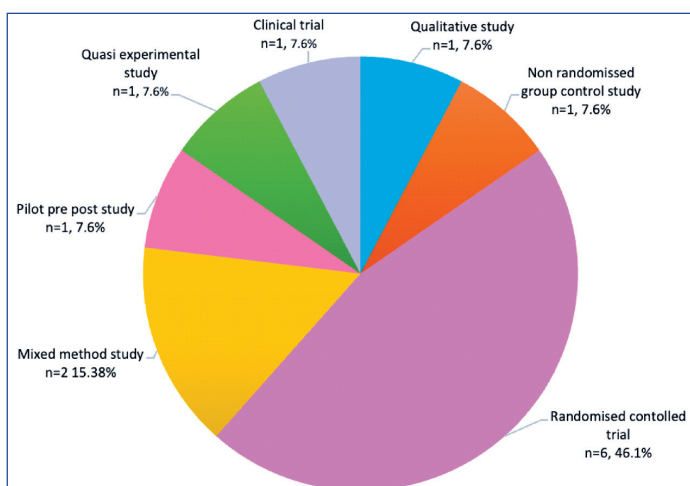
**Table/Fig-5:** Characteristic outcomes of the intervention.  
OPD: Outpatient department

of mHealth applications had a positive impact on promoting the quality of life of women diagnosed with breast cancer. Additionally, the characteristics of breast cancer-associated applications have been studied. A total of 599 applications were reviewed. Many applications were free, and the most common application type was disease and treatment information applications. Only one-fourth of

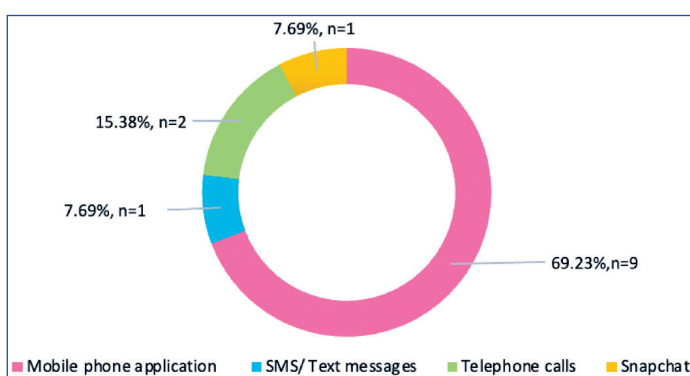
all applications had a disclaimer about usage, and less than one-fifth mentioned references or source material. Lozano-Lozano M et al., concluded that although these applications are highly beneficial, areas like data privacy and data handling need more expertise to widen accessibility and usage among breast cancer patients [27].



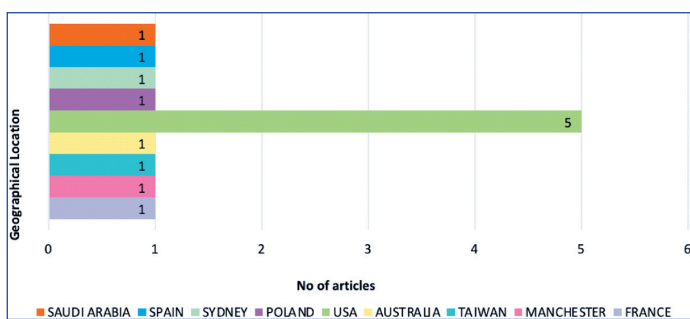
[Table/Fig-6]: Number of publications.



[Table/Fig-7]: Type of study design.



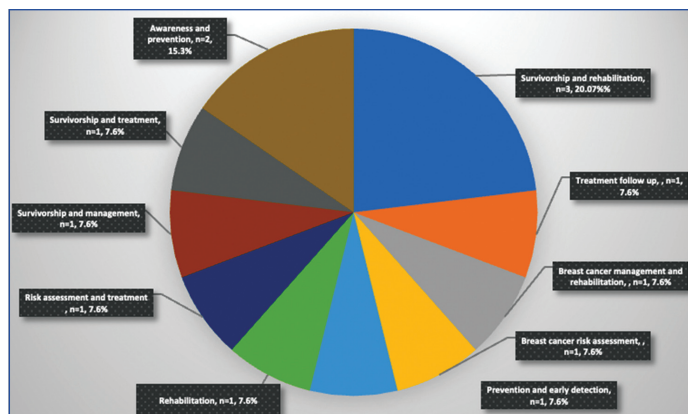
[Table/Fig-8]: Type of mHealth technology.



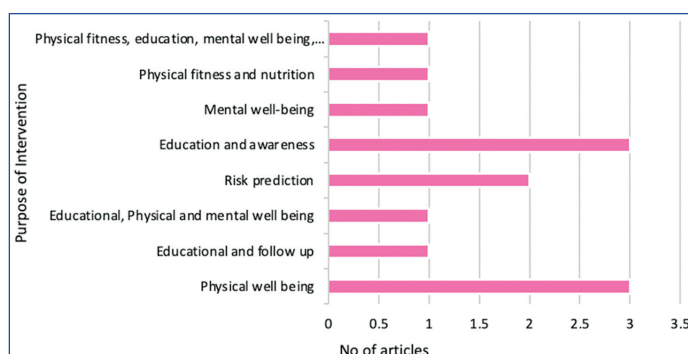
[Table/Fig-9]: Geographical region of study.

## DISCUSSION

The mHealth applications play a crucial role in providing health education and promoting healthy lifestyles. A scoping review focused on mHealth applications for breast cancer revealed that they contribute to awareness, prevention, early diagnosis, and psychological support during medical procedures [28]. However, most of these interventions are prevalent in developed countries [31]. Given the global burden of breast cancer, understanding the utility of related mobile applications is essential [32]. Many of



[Table/Fig-10]: Target of intervention.



[Table/Fig-11]: Purpose of intervention.

these applications focus on raising awareness and educating users about breast cancer [33]. The popularity of mHealth applications is growing due to their cost-effectiveness and widespread mobile technology use, especially among women [34].

Breast cancer patients undergo various stages of care, and mHealth applications are addressing issues like upper limb dysfunction, fatigue, and sleep disturbances [35]. Interventions like the “physical activity and your nutrition for cancer” app provide constructive plans for risk reduction [35]. A study on applications like the Breast Cancer Survivorship Management System (BCSMS) app in Taiwan shows that they improve patients’ quality of life [9]. Image-based behavioural interventions using telemedicine have also demonstrated enhanced quality of life for survivors [36,37].

mHealth technologies effectively spread awareness and knowledge about breast cancer, impacting disease incidence. Applications like the Mammogram app have been shown to improve knowledge and attitudes about breast cancer screening [29]. Even social networking applications like “Snapchat” have been used to educate Saudi Arabian women about breast cancer [30]. Early detection is crucial, and applications are aiding in promoting screenings. A dedicated app for healthcare workers includes data collection, motivational videos, and mammogram appointments for patients [38]. Decision-making aids like the Mammopad on iPad mini positively influence women’s decisions for mammogram screenings [39].

Psychological distress is common among breast cancer patients, and mHealth interventions are addressing this issue. They have shown promise in reducing emotional distress, although further research is needed [40,41]. Applications also improve medication adherence, as seen with the ILOVEBREAST app [42]. For survivors, mHealth tools and virtual wellness programmes are extending supportive care, leading to positive outcomes [43].

While mHealth interventions are beneficial, barriers exist. Sociocultural issues, including gender inequalities and privacy concerns, hinder their adoption [40]. Ethical and legal considerations, as well as a lack of transparency, complicate data collection via these applications [32]. Guidelines are needed to create user-friendly and patient-centered

applications [32]. The mHealth technologies, including text messages and applications, offer support throughout breast cancer treatment and recovery [44,45].

### The “PIONEER” Framework

From the review of existing literature, it is evident that a meticulously framed conceptual framework for the development, implementation, and governance of mHealth interventions is the need of the hour. In this regard, the authors have conceptualised the ‘PIONEER’ framework to aid the development of mHealth technologies and their virtuous implementation in breast cancer care.

**Problem identification:** It is of paramount importance to perform diligent investigation and ascertain the problem in conventional care, along with its root cause. This can be done by analysing and reviewing existing research findings. Additionally, obtaining a reliable source of information can be achieved by interaction with multiple stakeholders and patients.

To effectively address the problem, it is necessary to delineate the severity of the issue, its outcomes, and its impact on the population. This should be done with evidence, highlighting the manifestations of the problem, the population affected, the intensity of the issue, contributors to the problem, and the characteristics of the problem. Furthermore, it is important to identify under what circumstances the problem is likely to flare up.

**Innovate mHealth tool:** Developing innovative, feasible, and effective mHealth tools that can address the gaps in conventional cancer care is crucial. Studies have established the superiority of mHealth tools over usual care in producing better treatment outcomes. However, there are numerous obstacles to the virtuous delivery of healthcare through mHealth tools, with the digital divide being a predominant hurdle. It is imperative to construct innovative mHealth tools with the objective of overcoming these existing barriers.

**Optimise the mHealth tool for breast cancer:** An mHealth tool dedicated to breast cancer should have unique features that comply with the disease course and meet the unique requirements of patients. A multidisciplinary approach is essential to optimise the mHealth tool for breast cancer. Individual, social, cultural, and economic factors need to be considered when optimising the mHealth tool for breast cancer.

### Needs Assessment among the Target Population

Needs assessment is one of the critical investigative tools that help in determining the expected outcomes of mHealth technology-based interventions. Although there are a number of mHealth applications available, there is a paucity of personalised and individually tailored mHealth tools. Studies have evidently presented the existence of irrelevant information in mHealth applications [46]. This calls for extensive needs assessment among the population to develop a user-centered mHealth tool.

### Engage Multiple Stakeholders and Patients in Development Process

A multifaceted approach that actively engages individuals from diverse fields and backgrounds - including healthcare professionals, researchers, app developers, Information Technology (IT) professionals, and, most importantly, end users such as patients representing heterogeneous cultures and societies - is the prime requisite for the establishment of an mHealth tool.

### Educate the Population on the Working and Use of mHealth Application

The mere development of a highly efficacious application cannot guarantee its successful utilisation. It is indispensable for healthcare professionals and developers to educate and train the users to

effectively utilise the mHealth service provided. Training sessions should be conducted, and adequate information on the usage of personal data collected, data privacy, and security should be provided to the users.

### Review the mHealth Tool

Reviews create space for improvement and refinement. It is important to periodically review the mHealth tool and update it in line with technological advancements. Analysing the feedback and reviews provided by users is crucial, and the mHealth tool should be upgraded accordingly.

### Knowledge Gaps

Although numerous studies have been conducted to investigate the influence of mHealth applications on breast cancer care, there are potential gaps in existing knowledge. While ample scientific data exists to support the use of mHealth technology to enhance physical activity and improve mental health, individual patient factors that prevent its acceptability have yet to be investigated. There is a lack of studies to prove that mHealth interventions can play a significant role in spreading awareness about breast cancer. Most of the studies have been performed to analyse the results of mHealth interventions in breast cancer patients [14,20,21,24-30].

### Directions for Future Research

Studying mHealth interventions in the vulnerable population is the need of the hour. This will help generate awareness among the targeted population, leading to the prevention and early diagnosis of the disease. To gain further knowledge about patients' preferences for mHealth applications, a qualitative study should be conducted. The efficacy of mHealth applications can be enhanced by analysing individual factors that influence the acceptability of such applications. Factors such as accessibility to mobile phones, network coverage, and economic status contribute to the acceptance or rejection of eHealth technology. These attributes should be thoroughly examined for the successful implementation of mHealth interventions in breast cancer care.

### Limitation(s)

There are certain potential limitations in this review. Only two databases were involved in the electronic search. Moreover, published articles in languages other than English were excluded. Furthermore, studies with a male study population were not assessed due to the rarity of this disease in them.

### CONCLUSION(S)

The breast cancer-specific mHealth application improved the overall health of the patients, particularly in terms of enhancing physical activity and managing psychological stress. In general, mHealth interventions effectively improved the quality of breast cancer care. Despite the fact that numerous studies have been conducted investigating the impact of mHealth on breast cancer care, the clinical effectiveness of mHealth applications is yet to be clearly defined. A collaborative approach involving patients and healthcare professionals in the process of development and testing can significantly enhance the quality of the application.

### Acknowledgement

The authors acknowledge Panimalar Medical College Hospital and Research Institute, Chennai, and Foundation of Healthcare Technologies Society, New Delhi, for introducing the “Foundations in Research Methodologies” course in the I Bachelor of Medicine and Bachelor of Surgery (MBBS) curriculum. This course provided the knowledge and skills necessary for conducting and publishing the present study.



**Authors contribution:** Conceptualisation: K.M.S.; Methodology: S.P., J.N.B., A.J., and K.M.S.; Software: K.M.S.; Validation: S.P., J.N.B., A.J., and K.M.S.; Formal analysis: S.P., J.N.B., A.J., and K.M.S.; Investigation: S.P., J.N.B., and K.M.S.; Resources: K.M.S.; Data curation: A.J. and K.M.S.; Writing-original draft preparation: S.P., J.N.B., and K.M.S.; Writing-review and editing: S.P., J.N.B., A.J., and K.M.S.; Visualisation: S.P., J.N.B., and K.M.S.; Supervision: K.M.S.; Project administration: K.M.S.; Funding acquisition: K.M.S.

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**PLAGIARISM CHECKING METHODS:** [\[Jain H et al.\]](#)

- Plagiarism X-checker: Jun 02, 2023
- Manual Googling: Aug 18, 2023
- iThenticate Software: Oct 03, 2023 (11%)

**ETYMOLOGY:** Author Origin**EMENDATIONS:** 7**AUTHOR DECLARATION:**

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **May 30, 2023**Date of Peer Review: **Aug 07, 2023**Date of Acceptance: **Oct 05, 2023**Date of Publishing: **Jan 01, 2024**