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## Evaluation of the Effects of Mobile Applications on the Care Outcomes of Patients Undergoing Surgery for Breast Cancer: A Systematic Review

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## ABSTRACT

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**Background:** Breast cancer surgery requires comprehensive postoperative care to optimize recovery and patient outcomes. Mobile health applications have gained attention as tools to enhance patient engagement, provide education, and support recovery through features like symptom tracking and communication with healthcare providers. This systematic review aimed to evaluate the impact of these applications on care outcomes in patients undergoing breast cancer surgery.

**Methods:** This systematic literature study was conducted from January 2012 to December 2022 across PubMed, ProQuest and Google Scholar databases to identify randomized controlled trials assessing the effect of mobile applications on care outcomes in patients who underwent breast cancer surgery. Studies were included based on specific criteria: they had to evaluate mobile health interventions post-surgery and report on at least one outcome related to symptom management, quality of life, anxiety, depression, or distress. The content, methods and quantitative findings of all publications were analyzed.

**Results:** The review included four randomized controlled trial, covering a total of 318 participants. Across the studies, mobile health applications demonstrated a significant improvement in care outcomes. Symptom management effectiveness improved by 15-25%, anxiety and distress levels decreased by 10-20%, and patient-reported quality of life increased by an average of 15-25%. Additionally, mobile applications were associated with enhanced communication with healthcare providers, facilitating early intervention and support.

**Conclusion:** Mobile health applications were found to significantly improve care outcomes for breast cancer patients undergoing surgery. These applications are also effective and safe in improving the quality of life, managing symptoms, and reducing psychological distress. The integration of mobile health tools can enhance patient care pathways and postoperative recovery. Future research should explore long-term impacts, optimal app features, and scalability in diverse patient populations.

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### INTRODUCTION

Breast cancer is the most common type of cancer globally and in our country.<sup>1</sup> According to the

GLOBOCAN 2020 data published by the International Agency for Research on Cancer (IARC), breast cancer has surpassed lung cancer as the most frequently diagnosed cancer with 2.3 million new cases globally, representing 11.7% of all new cancer diagnosis.<sup>2</sup> Over the past decade, breast cancer incidence has steadily risen worldwide, particularly in high and middle-income countries, where lifestyle

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changes and increased screening have contributed to earlier detection. However, global mortality rates show significant regional disparities, with higher death rates in low-income regions due to delayed diagnoses and limited access to treatment. In 2020, breast cancer incidence in our country increased to 47.7 per 100 000, up from 43.0 per 100 000 in 2014, following global trends of rising incidence.<sup>3,4</sup>

Breast cancer treatment is highly individualized, with numerous options available depending on the cancer stage, biological characteristics, patient preferences, and overall health. Treatment decisions are made collaboratively by the patient and the medical team, considering factors such as the cancer type and stage, biological characteristics, the patient's age, menopausal status, genetic factors and preferences. Treatment typically involves a combination of surgical, radiotherapeutic, chemotherapeutic, hormonal and targeted therapies among the available options.<sup>5-6</sup> Each option is carefully considered in terms of its risks and benefits, with the goal of reaching a shared decision between the patient and the healthcare team. Frequently, surgical procedures include breast-conserving and mastectomy surgeries. Despite equivalent survival rates when combined with radiation, patients eligible for breast-conserving surgery are increasingly opting for mastectomy due to various reasons, such as reluctance towards radiation therapy, fear of recurrence, and a desire for symmetry.<sup>6</sup> A multicenter study conducted by the Turkish Federation of Breast Diseases Associations (2019) on twenty thousand women in our country indicated that 48.3% of cases were diagnosed with stage II, and 76.9% with invasive ductal carcinoma. The study reported that 60.7% underwent mastectomy, while 39.3% received breast-conserving surgery.<sup>7</sup>

These treatment options significantly influence postoperative recovery, including complications and long-term outcomes. Post-surgical complications, both early and late, are common and can adversely affect patients' quality of life. Early complications include seroma formation (3-85% incidence)<sup>8,9</sup>, wound site infection (3-19% incidence)<sup>8,10,11</sup>, pain (20-30% incidence)<sup>12</sup>, and lymphedema (<10% incidence)<sup>8,11,13</sup>. Late complications, such as shoulder dysfunction (15-65% incidence)<sup>8,10,14</sup> and scar hypertrophy<sup>8,10,14</sup>, can develop long after surgery. These complications may adversely affect individuals' quality of life.<sup>15</sup> To maintain independence in daily activities and improve the quality of life, patients require supportive care, treatment, and preventive health interventions.<sup>16</sup> There is a need for education on issues related to late/long-term physical and psychosocial problems to

address the challenges individuals face in their daily lives after breast surgery.<sup>17</sup>

Supportive care interventions, including patient education and preventive strategies, are crucial to mitigating these post-surgical complications. Patients who undergo mastectomy are now being educated not only through written, visual, and auditory materials but also with the use of mobile applications, thanks to technological advances.<sup>18,19</sup> Mobile health has grown rapidly, with apps now playing a key role in facilitating patient engagement, disease prevention, and management across various health conditions.<sup>20,21</sup> Mobile health applications not only impact healthcare service providers but also influence the delivery of nursing care, enhancing the effectiveness of care. The use of technology in healthcare services not only improves the quality of life and healthcare service but also contributes economically.<sup>22</sup>

In recent years, mobile applications aimed at improving the quality of life in the postoperative period have gained significance for patients and market penetration of mobile health applications is increasing globally, with a growing number of breast cancer specific apps designed to support postoperative care.<sup>23-26</sup> For patients discharged home after surgery, in addition to daily monitoring of drainage, spirometry results, blood pressure, heart rate, oxygen saturation, blood glucose levels, and medication adherence, factors such as pain levels, sleep quality, daily life activities, exercise levels, and social issues can also be evaluated, and the continuity of nursing care practices and education through mobile applications enhances the quality of care.<sup>27</sup>

Despite the increasing use of mobile applications in the care of breast cancer patients, there remains a significant gap in understanding how these technologies specifically influence postoperative outcomes, such as pain management, anxiety levels, and overall quality of life. While the existing literature has documented the benefits of mobile health interventions for various cancer types, there is limited research focused on their effectiveness in the context of breast cancer surgery.<sup>28</sup> Furthermore, the varying degrees of patient engagement and the qualitative aspects of their experiences with these applications are underexplored. This research is necessary to address these gaps by providing empirical evidence on the impact of mobile health technologies on the care outcomes of breast cancer patients after surgery focusing on both the physical and emotional needs throughout their recovery process. By identifying the specific features of mobile applications that enhance patient education, engagement, and self-management, this study aims to evaluate the impact of mobile applications on the care



outcomes of patients undergoing surgery for breast cancer.

## METHODS

### *Search strategy*

This systematic literature search was conducted to identify relevant randomized controlled trials published between January 2012 and December 2022. The decision to focus on this 10-year timeframe was based on the increasing integration of mobile health (mHealth) Technologies into healthcare settings over the past decade, with particular advancements in mobile applications for postoperative care.

The databases used for this search included PubMed, ProQuest, and Google Scholar. These databases were selected for their extensive coverage of peer-reviewed medical literature. The search was conducted in English using seven specific keywords and Boolean operators: ('breast surgery' OR 'mastectomy') AND ('mobile application' OR 'mobile app' OR 'mhealth' OR 'mobile health') AND ('quality of life'). Filters were applied to limit the results to studies published between 2012-2022 and to randomized controlled trials. Titles and abstracts of all relevant articles identified through these electronic searches were reviewed. Since all research articles were obtained from publicly accessible electronic databases, no ethical approval was necessary for this review.

This systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure that the review was conducted transparently and methodically. The PRISMA checklist was used throughout the process to ensure comprehensive reporting on all aspects of the review, including study selection, data extraction, and analysis.

### *Study inclusion and exclusion criteria*

The inclusion criteria for this review encompassed all randomized clinical trials that evaluated the impact of mobile application programs on care outcomes in patients undergoing breast surgery. Specifically, the review focused on female patients who had undergone breast surgeries, including mastectomy and lumpectomy. Only randomized controlled trials assessing the effectiveness of mobile application programs were considered for inclusion in this study. The studies needed to compare mobile app interventions with standard care or other interventions, with outcomes measured in terms of quality of life, recovery, or other relevant clinical metrics. Only English-language studies were included.

Exclusion criteria included studies published in languages other than English, studies that did not

include a comparison group, and non-randomized trials. Additionally, qualitative studies and review articles were excluded.

### *Study selection*

The initial database search yielded a total of 553 studies: 3 from PubMed, 296 from ProQuest, and 254 from Google Scholar. Upon reviewing the titles, 113 studies were identified as duplicates across the databases and were removed. The remaining 440 studies underwent further screening, during which 362 studies were excluded for being irrelevant to the research topic. Disagreements between reviewers during screening were resolved through discussion. The abstracts and full texts of the remaining 78 studies were then reviewed according to the predefined inclusion and exclusion criteria. As a result, 67 studies were excluded, comprising non-randomized trials, qualitative studies, and reviews. Finally, 11 studies were identified for detailed examinations.

### *Data extraction*

Following a detailed examination of the 11 studies, 7 were excluded due to incomplete protocols, leaving 4 studies that met all the inclusion criteria and were included in the systematic review. The selection process is illustrated in Figure 1. A thorough quality assessment of the included studies was conducted, evaluating key methodological aspects such as randomization, blinding, handling of missing data, and overall study design to ensure the rigor and reliability of the findings.

## RESULTS

### *Study characteristics and heterogeneity*

This systematic review included four randomized controlled trials conducted between 2012 and 2022 in diverse geographical locations: Taiwan, Turkey, Iran, and China. The review examined a total sample of 318 female patients, aged 18-65, all of whom were diagnosed with stage 1-3 breast cancer and had undergone breast surgery. All participants were capable of using a mobile phone or computer, which was essential as the interventions in these studies involved the use of mobile health applications. Despite the common focus on mobile health applications, the interventions varied significantly in terms of duration, intensity, and specific content.

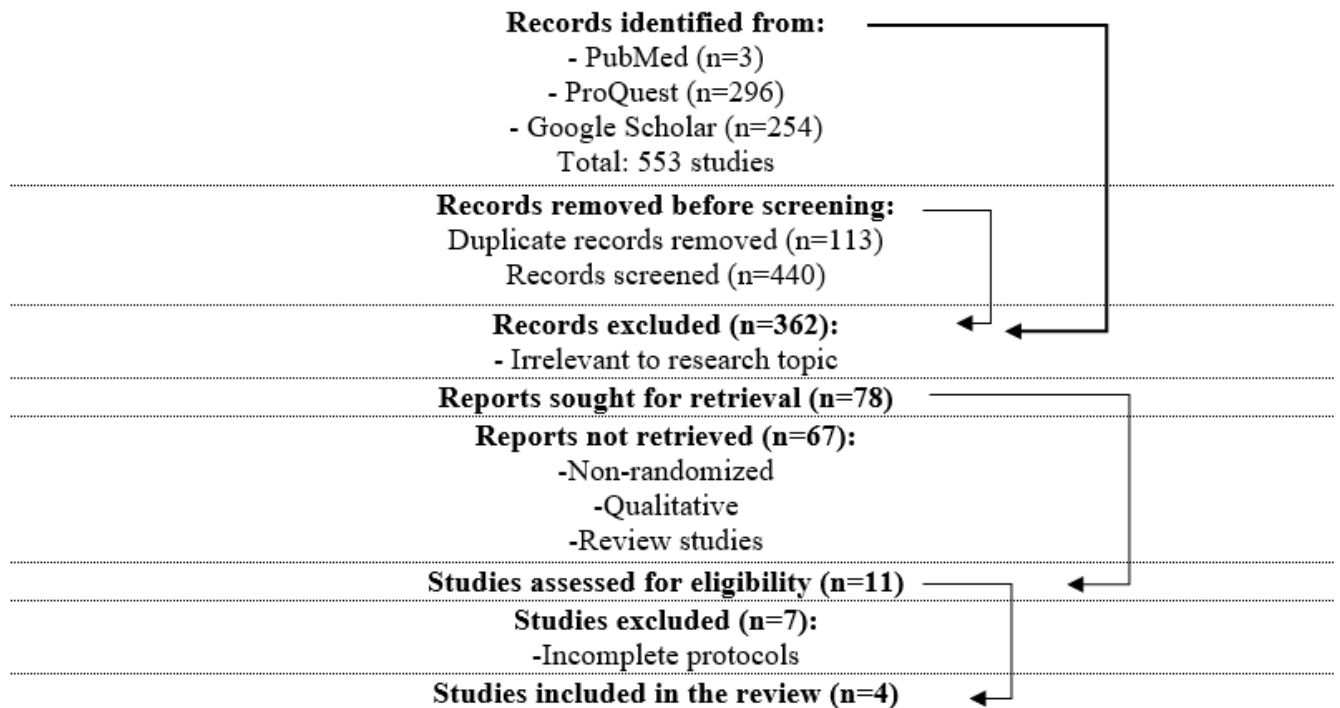
### *Intervention characteristics*

The interventions ranged from mobile-based educational programs and psychoeducational interventions to exercise programs delivered via mobile apps. The duration of interventions varied from one month<sup>37</sup> to three months<sup>26,29</sup>, with Dong *et*



*al.*<sup>30</sup> implementing a 12-week exercise program. The intensity of app usage also differed, with some apps featuring interactive components like group discussions and exercise tracking<sup>30,37</sup>, while others

focused primarily on educational content and patient monitoring.<sup>26,29</sup> These differences contributed to the heterogeneity among the studies, which might have influenced the variability of their outcomes.



**Figure 1.** The flow diagram of this systematic review

The general themes emerging from the content of the studies focused on the following aspects:

**Changes in Quality of Life:** The studies evaluated how mobile health applications influenced the quality of life among breast cancer patient’s post-surgery.

**Symptom Management:** They also examined the effectiveness of these applications in managing both physical, such as pain, fatigue or nausea, and psychological symptoms, such as anxiety, depression and emotional distress related to breast cancer and its treatment.

**Self-Esteem Levels:** The impact of the interventions on patients' self-esteem was another key focus area.

**Psychological Factors:** The studies assessed changes in levels of anxiety, depression, and distress among the patients following the use of mobile applications.

Across all four studies, mobile health applications demonstrated statistically significant positive effects on various outcomes, including quality of life, psychological well-being, and symptom management. While each study used different measurement tools, the combined results consistently supported the effectiveness of mobile apps in enhancing patient outcomes. For quality of life measures, all studies reported significant improvements in the intervention groups compared to

control groups. Using the standardized measurement scales, the studies indicated medium to large effect sizes (Cohen’s *d* ranging from 0.5 to 1.2) for improvements in overall quality of life, emotional well-being, and physical health. In three studies, 95% confidence intervals for key outcomes (quality of life and anxiety reduction) excluded the null value, suggesting a high degree of confidence in the results. For example, Hou *et al.*<sup>29</sup> reported a 95% CI for quality of life improvements between 0.62 and 1.10, indicating a robust effect of the intervention.

Regarding the sample sizes, the study by Hou *et al.*<sup>29</sup> had the largest sample with 112 participants, while the study by Dong *et al.*<sup>30</sup> had the smallest, comprising 60 participants. Despite variations in the sample sizes, all the studies consistently utilized mobile applications developed by the researchers to deliver education on breast cancer diagnosis, treatment processes, post-surgical symptom management, and patient monitoring. While there were differences in their designs, the mobile applications used in these studies shared key technical and content features aimed at improving the quality of life for breast cancer patients. Each app offered a user-friendly interface with features like push notifications, symptom tracking, and real-time data analysis to monitor patient well-being. They provided continuous access to educational content on breast



cancer diagnosis, treatment, post-surgical care, and mental health management. Some applications, like those developed by Dong *et al.*<sup>30</sup> and Ghanbari *et al.*<sup>37</sup>, incorporated interactive elements such as exercise tracking, online group discussions, and social media integration to enhance user engagement and support. These apps also facilitated self-management by guiding patients through treatment processes, helping them track their symptoms, and providing personalized feedback. Overall, these mobile platforms offered an accessible way for the patients to receive care, reduce anxiety, and improve both physical and emotional outcomes. The control groups in these studies received standard care.

The outcomes were measured using various validated scales. Quality of life was assessed using instruments such as the SF-36 (Short Form-36)<sup>31</sup>, the Functional Assessment of Cancer Therapy-Endocrine Symptoms (FACT-ES)<sup>32</sup>, the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30 (EORTC QLQ-C30)<sup>33</sup>, and the EORTC QLQ-BR23 Breast Cancer Module.<sup>34</sup> Psychological outcomes were measured using the State-Trait Anxiety Inventory (STAI)<sup>35</sup> and the Rosenberg Self-Esteem Scale (RSES).<sup>36</sup> The descriptive statistics and further characteristics of these studies are detailed in Tables 1 and 2.

**Table 1.** Characteristics of the studies included in review

Study	Country	Sample Size (N)	Experimental Group	Control Group	Duration	Intervention Focus	Measurement Tool *	Key outcomes
Dong <i>et al.</i> <sup>30</sup>	China	Experimental Group: 30  Control Group: 30	CEIBISMS app (n=30)	Standard care	12 weeks	Exercise program via social media	SF-36 SPSDCT ALT	Improved quality of life, increased muscle strength
Hou <i>et al.</i> <sup>29</sup>	Taiwan	Experimental Group: 53  Control Group: 59	BCSMS app (n=53)	Standard care	3 months	Breast cancer treatment process education	QLQ-C30 QLQ-BR23	Improved quality of life, enhanced body image
Çınar <i>et al.</i> <sup>26</sup>	Turkey	Experimental Group: 31  Control Group: 33	E-Mobile Training app (n=31)	Standard care	3 months	Breast cancer awareness, stress management	FACT-ES Distress Thermometer	Increased emotional well-being reduced distress
Ghanbari <i>et al.</i> <sup>37</sup>	Iran	Experimental Group: 41  Control Group: 41	BCSzone app (n=41)	Standard care	1 month	Psychoeducational support, online discussions	STAI RSES	Reduced anxiety, increased self-esteem

\*Short Form (SF-36)<sup>31</sup>, Stand-up and sit-down chair test (SPSDCT), Arm lifting test (ALT), The European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-C30<sup>33</sup>, The European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-BR23<sup>34</sup>, Functional Assessment of Cancer Therapy-Endocrine Subscale (FACT-ES)<sup>32</sup> State-Trait Anxiety Inventory (STAI)<sup>35</sup>, Rosenberg Self-Esteem Scale (RSES)<sup>36</sup>

In the study conducted by Çınar *et al.*<sup>26</sup>, the impact of e-mobile education on patients aged 18-65, diagnosed with stage 1-3 breast cancer, and undergoing surgical treatment with chemotherapy and radiotherapy, was evaluated. The experimental group received e-mobile education through a mobile application for three months, covering topics such as breast cancer awareness, treatment processes, symptom management, diet, exercise, and stress management. The results demonstrated that the experimental group, which received the e-mobile

education, had statistically significantly higher quality of life scores and lower distress score averages compared to the control group receiving standard care. These findings underscore the effectiveness of mobile applications in enhancing emotional well-being and reducing distress among breast cancer patients.<sup>27</sup>

Hou *et al.*<sup>29</sup> evaluated the effectiveness of a mobile application designed to support breast cancer patients. The experimental group underwent evaluations using quality of life scales before, 1.5



months, and 3 months after using the application. The results showed that the quality of life scale scores in the experimental group were significantly higher than those in the control group, which received standard

care. This suggests that the BCSMS application was effective in improving overall quality of life, particularly in areas related to breast cancer-specific concerns such as body image and sexual functioning.

**Table 2.** Findings of the studies

Studies	Outcome variables	Key findings
Dong <i>et al.</i> <sup>30</sup>	Quality of Life, Muscle Strength, Cardiorespiratory Capacity	Significant improvement in quality of life in the experimental group using the CEIBISMS application compared to the control group. Notable increases in muscle strength and cardiorespiratory capacity in the experimental group.
Hou <i>et al.</i> <sup>29</sup>	Quality of Life (QLQ-C30, QLQ-BR23)	The BCSMS application significantly improved the overall quality of life scores in the experimental group compared to the control group. Improvements in breast cancer-specific concerns, including body image and sexual functioning, were also observed in the experimental group.
Çınar <i>et al.</i> <sup>26</sup>	Quality of Life (FACT-ES), Distress Levels	The E-Mobile Training and Consultancy application led to significant enhancements in quality of life, particularly in emotional well-being, in the experimental group. A marked reduction in distress levels was observed in the experimental group compared to the control group.
Ghanbari <i>et al.</i> <sup>37</sup>	Anxiety, Self-Esteem	The BCSzone application significantly reduced anxiety levels in the experimental group. A significant increase in self-esteem was also noted in the experimental group compared to the control group.

In the study conducted by Dong *et al.*<sup>30</sup> the experimental group participated in exercise programs based on internet and social media applications for 12 weeks. The findings revealed that, by the end of the 12th week, the experimental group had achieved significantly more positive results in fitness, mental health, and health transition measures compared to the control group. This highlights the potential of mobile-based exercise interventions to enhance both physical and mental health outcomes in breast cancer patients.

Finally, in the study by Ghanbari *et al.*<sup>37</sup> the experimental group received psychoeducational interventions through a mobile application and participated in mobile-based online group discussions for one month. Pre-test and post-test evaluations indicated that the experimental group experienced significantly lower anxiety levels and higher self-esteem scores compared to the control group receiving standard care. These results demonstrate the effectiveness of mobile psychoeducational interventions in reducing psychological distress and enhancing self-esteem among breast cancer patients.

While the included studies demonstrated positive outcomes, there are several limitations that should be noted. The primary limitation is the potential for selection bias, as participants were often self-

selected, and there was limited information on how randomization was carried out in some studies. Additionally, blinding was not consistently reported, which could introduce performance bias, particularly in self-reported outcomes such as quality of life and anxiety.

The sample sizes across the studies varied, with Dong *et al.*<sup>30</sup> having the smallest sample (60 participants) and Hou *et al.*<sup>29</sup> having the largest (112 participants). Although the studies were sufficiently powered to detect significant effects, the relatively small sample sizes in some trials may limit the generalizability of the findings.

Another concern is the short follow-up periods in some studies, which may not capture long-term effects of the mobile interventions. For instance, Ghanbari *et al.*<sup>37</sup> only tracked outcomes for one month, while longer studies such as Hou *et al.*<sup>29</sup> and Çınar *et al.*<sup>26</sup> provided more robust data over three months.

Despite these limitations, the overall quality of evidence is moderate to high, with clear improvements in patient outcomes related to both physical and psychological health. Further studies with larger sample sizes, longer follow-up periods, and more rigorous blinding procedures are needed to strengthen the evidence base.



## DISCUSSION

The findings from this systematic review demonstrate the significant role of mobile applications and e-mobile education in improving the quality of life, psychological well-being and physical health of breast cancer patients aged 18-65. These interventions not only alleviate disease symptoms, reduce anxiety, and boost self-esteem but also enhance symptom management, aligned with the existing literature. Studies like Cheng *et al.*<sup>38</sup> highlight the effectiveness of mobile-based symptom management programs, such as mindfulness training, while Zhu *et al.*<sup>39</sup> show improvements in self-efficacy and reduced symptom burden. Collectively, these randomized controlled trials emphasize the adaptability of digital interventions across various cultural contexts, supplementing traditional healthcare approaches.

A key strength of mobile applications is their adaptability and versatility. The applications in these studies primarily focused on educating patients about breast cancer diagnosis, treatment processes, and post surgical symptom management. These studies have shown that these apps improve quality of life by offering accessible information and ongoing support, allowing patients to take a more active role in their health. This is consistent with broader research findings. For example, a review by Nou, Arkes, Frances and Liyan<sup>40</sup> showed that mobile applications significantly improve quality of life and psychological well-being, especially for patients undergoing active treatment. Drawing on theoretical frameworks such as the self-determination theory, mobile applications empower patients by supporting autonomy, competence, and relatedness, which are essential for effective self-care and recovery. By offering easily accessible information and ongoing support, they extend care beyond the clinical setting, empowering patient to take an active role in their own health.

The applications, developed by the researchers themselves, reflect an increasing interest in leveraging technology to enhance patient support. For instance, the study by Çınar *et al.*<sup>26</sup> demonstrates how e-mobile education can significantly improve patients' quality of life by providing comprehensive content on breast cancer, stress management, and lifestyle factors such as diet and exercise. This holistic educational approach, addressing both physical and emotional recovery, plays a crucial role in improving overall patient well-being. Similar findings have been reported in other research. A systematic review by Saevarsdottir and Gudmundsdottir emphasizes that mobile health apps significantly enhance patients' mental and physical health by supporting behavioral interventions, such as

physical activity and mindfulness.<sup>41</sup> This growing body of evidence underscores the importance of digital tools in offering personalized and well-rounded support for breast cancer patients, ultimately improving their overall quality of life.

Similarly, Hou *et al.*'s findings regarding the long-term benefits of mobile applications in improving patient outcomes align with a growing body of literature on the effectiveness of mobile health interventions. For example, systematic reviews and studies on chronic disease management, including diabetes and cardiovascular conditions, have shown that mobile health tools not only offer immediate support but also promote sustained improvements in patient well-being.<sup>42,43</sup> These tools facilitate self-management by providing tailored information, real-time monitoring, and continuous motivation, which collectively improve both physical and mental health outcomes over time.

The study by Dong *et al.*<sup>30</sup> brings a unique focus on physical rehabilitation, combining exercise programs delivered via mobile apps and social media platforms. Research shows that exercise programs delivered via mobile apps can significantly improve physical activity, reduce cancer-related fatigue, and enhance overall quality of life. Similarly, another exercise rehabilitation app aiming to improve the mental and physical health of breast cancer patients in postoperative period has been shown to improve mental health and fitness levels during recovery from chemotherapy or radiotherapy.<sup>44</sup> These findings underscore the effectiveness of integrating physical health interventions into digital platforms to support long-term recovery.

Furthermore, the study by Ghanbari *et al.*<sup>37</sup> on psychoeducational interventions through mobile apps and online group discussions demonstrates the significant psychosocial benefits for breast cancer patients, particularly in reducing anxiety and boosting self-esteem. This aligns with broader findings, such as those by Børøsdund *et al.*, who reported that mobile health interventions, especially those focused on stress management and peer support, can foster psychological well-being and emotional resilience in cancer patients.<sup>45</sup> These digital tools offer critical social support that reduces distress, as noted in several studies emphasizing the importance of psychoeducation and peer networks in improving mental health.

Health professionals should consider integrating these digital tools into the care plans of breast cancer patients, particularly in the post-operative phase, where symptom management and psychological support are critical. For health policy, these results highlight the importance of investing in digital health solutions as part of comprehensive cancer care



strategies. Policymakers should focus on expanding access to mobile health platforms, ensuring that these technologies are affordable and accessible to a broader patient population.

However, despite these promising outcomes, several limitations must be considered. The relatively small number of included studies (four trials), variations in sample sizes, app content, study duration and the cultural contexts of the studies may influence the generalizability of the findings. For example, cultural factors may affect how patients engage with digital tools or perceive the support they provide. Furthermore, there may be publication and language biases, as only studies published in English were included. Additionally, while these studies suggest short- to medium-term benefits, further research is needed to assess the long-term effects of mobile applications on symptom management and psychological well-being. Long-term trials could help refine best practices for integrating these digital interventions into routine cancer care and ensure that they continue to meet the evolving needs of breast cancer patients. By comparing these findings with broader research on mobile health interventions in chronic illness management, it becomes clear that mobile applications hold significant potential, though more work is needed to optimize their use across diverse patient populations.

Future research should aim to address these limitations by conducting larger, multi-center randomized controlled trials that include diverse patient populations. Studies should also evaluate the long-term effectiveness of mobile health interventions and explore potential subgroup differences based on age, stage of cancer, or cultural factors. Additionally, future app development should prioritize user-centered designs that incorporate patient feedback to enhance usability and engagement. Researchers should also consider exploring other outcome measures, such as healthcare utilization, cost-effectiveness, and patient adherence, to provide a more comprehensive understanding of how mobile health tools can be integrated into routine cancer care.

## CONCLUSION

This review highlights the significant potential of mobile applications in enhancing care outcomes for patients undergoing breast cancer surgery. The findings suggest that these digital interventions not only improve the quality of life but also aid in the effective management of symptoms during the postoperative period. Specifically, mobile applications can provide patients with personalized resources and support, thereby alleviating disease symptoms, facilitating better symptom management,

and ultimately reducing the prevalence of psychological disorders. While the positive outcomes are promising, this review also highlights key limitations, including the heterogeneity in study designs, variations in app content, and differing cultural contexts. These uncertainties call for caution in generalizing the results across diverse patient populations.

However, the studies examined in this review reveal notable methodological variations, highlighting the urgent need for standardized approaches in future research. To bolster the evidence base, it is crucial for further studies to identify and control for variables that could influence outcomes across diverse patient populations. Moreover, the selection of study samples should be informed by the existing literature, with a keen emphasis on the timing and duration of app usage to align with established follow-up protocols.

Healthcare providers should consider integrating mobile health applications into routine breast cancer care. Specifically, these tools can serve as adjuncts to traditional care by offering patients continuous access to educational resources, symptom-tracking features, and real-time support outside the clinical setting.

Further research should also focus on monitoring and addressing common postoperative complications, ensuring that mobile health applications offer comprehensive care tailored to the unique needs of breast cancer patients. The broader implications for the field of mobile health and cancer care are significant. In the short term, mobile applications can extend care beyond the hospital, promoting self-management and improving patient outcomes. In the long term, these digital tools have the potential to become integral components of cancer care, providing scalable, cost-effective solutions that address both physical and mental health.

In conclusion, while mobile applications represent a promising avenue for improving outcomes in breast cancer care, there is still much work to be done. The field must continue evolving, driven by evidence-based research and collaboration between healthcare providers, patients, and developers. By doing so, we can fully realize the potential of digital health interventions to improve the quality of life for breast cancer patients worldwide.

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### CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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