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A Systematic Review of Post-Operative Breast Undergarments for Patients with Breast Cancer

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ABSTRACT

Background: Breast cancer is the most common malignancy among Canadian women, affecting approximately 1 in 8 women over their lifetime. Despite advancements in surgical management, many patients experience significant post-operative discomfort. This systematic review evaluates existing post-operative breast undergarments and highlights design shortcomings that impact patient recovery.

Methods: A systematic search was conducted using Ovid MEDLINE and EBSCO CINAHL Complete for literature published between January 1, 1946, and April 30, 2025. The search strategy included a combination of Medical Subject Headings (MeSH) and keywords related to breast neoplasms, mastectomy, post-operative care, and support garments. A total of 126 studies were identified, with 11 duplicates removed. After screening, 29 relevant studies were included.

Results: We identified various shortcomings in conventional post-operative garments, including inadequate storage for surgical drains, poor thermoregulation, and materials causing dermatological irritation. Issues such as non-adjustable straps, discomfort from under-wires, and a lack of accommodations for breast asymmetry and prosthesis fitting were prevalent. Although newer designs have addressed some of these issues by incorporating features like customizable compression and improved front fasteners, significant gaps remain.

Conclusion: Current post-operative undergarments inadequately address key aspects of recovery for breast cancer patients, particularly in the early post-operative period. There is a clear demand for garments with enhanced comfort, adjustable support, better drain management, and skin-friendly materials. Further design innovations and clinical evaluations are required to optimize post-operative care.

INTRODUCTION

Breast cancer is the most common cancer amongst Canadian women and affects approximately 1 in 8 Canadian women in their lifetime.[1] Breast cancer treatment is multimodal, involving surgery, radiation, hormone therapy, and chemotherapy; however, the mainstay of local and regional control remains surgical. Over the last century, surgical management has evolved from an extensive operation, i.e., radical mastectomy, to a more conservative surgical approach, i.e., simple mastectomy versus breast-conserving surgery. Qualitative studies have demonstrated that breast-conserving operations have led to improved quality of

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life, but breast cancer survivors still experience significant physical and psychological discomfort.[2,3] Despite great advancements in oncological and cosmetic outcomes, an important factor that affects women's post-operative experience still remains neglected, overlooked, and outdated: the post-surgical undergarment.[4]

The primary purpose of this study is to review the designs of existing post-operative garments and the issues that breast cancer survivors experience with conventional garments available. We hope to identify the problematic design factors in the existing garments and highlight the demand for an improved product.

METHODS

Eligibility criteria

This review included studies that focused on patients who underwent mastectomy or breast-conserving surgery for breast cancer and examined the use of post-operative breast undergarments, such as mastectomy bras, compression garments, and adaptive undergarments designed for surgical recovery. Eligible studies evaluated patient comfort, post-operative complications (e.g., seroma formation, lymphedema), garment design features, and quality of life. The review considered randomized controlled trials, observational studies, systematic reviews, and qualitative research that provided relevant insights into the post-operative use of these garments.

Studies were excluded if they focused on general undergarments not specifically designed for post-operative use, were case reports, editorials, expert opinions, or conference abstracts without primary data, or were not published in English due to feasibility constraints.

For synthesis, studies were grouped into three main categories: garment design and features, which included studies evaluating material composition, compression levels, fasteners, and prosthesis compatibility; post-operative outcomes, which examined pain, mobility, wound healing, and complications related to undergarment use; and patient-reported experiences, which analyzed comfort, adherence, and patient preferences. Due to the heterogeneity of study designs and outcome measures, a narrative synthesis approach was used, summarizing findings thematically to identify key trends and gaps in post-operative garment design.

Search strategy

A comprehensive search was conducted in Ovid Medline and EBSCO CINAHL Complete, covering literature from January 1, 1946, to January 31, 2021. A subsequent updated search was performed to include studies published between January 31, 2021 and April 30, 2025. These databases were selected due to their extensive coverage of medical and nursing literature, particularly in the areas of breast cancer, post-operative care, and patient-reported outcomes. No grey literature sources (e.g., unpublished studies, clinical trial registries, or government reports) were included due to feasibility constraints and the focus on peer-reviewed literature.

The search strategy incorporated a combination of Medical Subject Headings (MeSH) and free-text keywords related to breast cancer, post-operative care, mastectomy, surgical undergarments, and patient comfort. Boolean operators (AND, OR) were applied to refine search results. Filters were used to limit studies to human subjects and English-language publications. The final search strategy applied to each database is detailed below.

Final Search Strategy for Ovid Medline and EBSCO CINAHL Complete:

("Breast Neoplasms"[MeSH] OR "Breast Cancer" OR "Mastectomy"[MeSH] OR "Breast Surgery" OR "Breast Reconstruction"[MeSH] OR "Mammaplasty"[MeSH] OR "Breast Conserving Surgery" OR "Breast Oncoplasty")

AND ("Post-operative Care"[MeSH] OR "Surgical Wound"[MeSH] OR "Post-operative Complications" OR "Recovery" OR "Rehabilitation" OR "Quality of Life"[MeSH] OR "Pain Management"[MeSH])

AND ("Bra" OR "Bras" OR "Brassiere" OR "Post-Surgical Undergarment" OR "Post-operative Garment" OR "Compression Garment" OR "Mastectomy Bra" OR "Surgical Bra" OR "Supportive Undergarment")

Filters applied: Human subjects, English language

Studies identified through this search were screened based on relevance, and duplicates were removed. Two independent reviewers (NE, CS) assessed the retrieved studies using title/abstract screening, followed by full-text review to ensure eligibility. Any disagreements were resolved through discussion with a third reviewer (JS).

Study selection

All retrieved studies were screened for relevance based on the predefined inclusion and exclusion criteria. The selection process followed a two-stage screening approach. First, 2 independent reviewers (NE, CS) screened all records based on titles and abstracts, excluding studies that clearly did not meet the eligibility criteria. Next, full-text articles of potentially eligible studies were retrieved and independently assessed by 2 reviewers to determine final inclusion. Any discrepancies in study selection

were resolved through discussion between the two reviewers, and if consensus could not be reached, a third reviewer (JS) was consulted. The PRISMA flow diagram presented in Figure 1 provides an overview of the study selection process, including the number of records identified, screened, assessed for eligibility, and included in the final analysis.

Quality assessment

The quality of the included studies was assessed using the Newcastle-Ottawa Scale (NOS) for observational studies and the Cochrane Risk of Bias (RoB) tool for randomized controlled trials (RCTs). The NOS evaluates observational studies across three domains: selection of the study groups (4 criteria), comparability of the groups (2 criteria), and ascertainment of exposure/outcome (3 criteria), with total scores categorized as poor (0-3), fair (4-6), or good (7-9). The Cochrane RoB tool assesses seven domains for RCTs: random sequence generation, allocation concealment, blinding of participants/personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other bias, with each domain rated as low, high, or unclear risk.

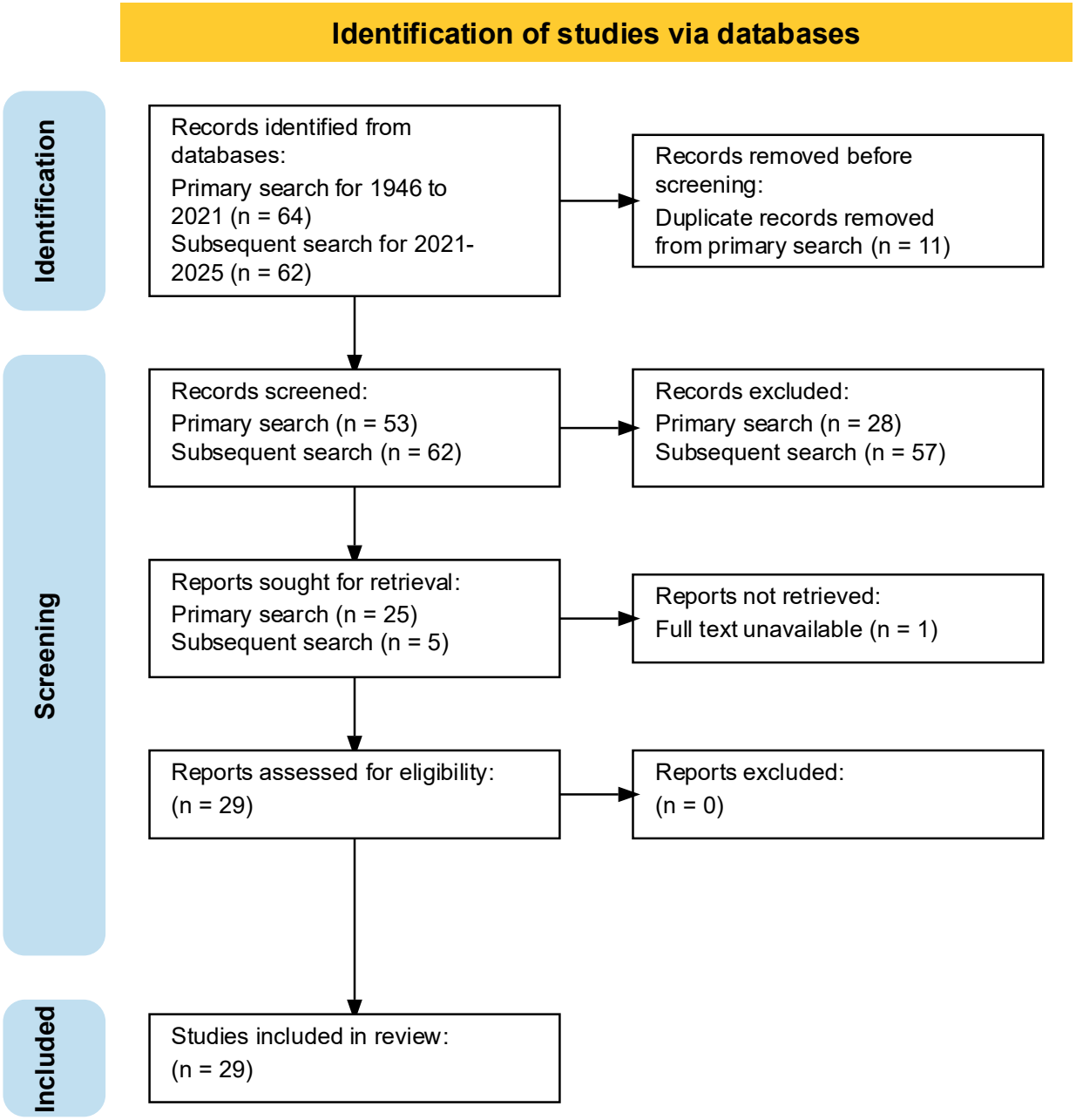

Figure 1. PRISMA Flow Diagram

Data extraction

For each included study, data were extracted on study design, sample size, population characteristics, intervention type, and key outcomes related to post-operative breast undergarments. The primary outcomes of interest included patient comfort, pain levels, post-operative complications (such as seroma formation, lymphedema, and skin irritation), quality of life, adherence to garment use, and functional aspects of the garments (e.g., support, compression, breathability, and adjustability). Secondary outcomes included thermal regulation, garment durability, ease of use, and impact on post-operative mobility. Two independent reviewers (NE, CS) performed data extraction to ensure accuracy, and discrepancies were resolved through discussion. Extracted data were synthesized narratively due to heterogeneity in study designs and outcome measures.

RESULTS

A total of 64 studies were initially identified through the database search (46 from Ovid MEDLINE and 18 from EBSCO CINAHL Complete). After the removal of 11 duplicate records, 53 studies remained for title and abstract screening. Following this screening process, 25 studies met the inclusion criteria and were included in the final systematic review. During the subsequent search for studies published between 2021 and 2025, a total of 62 studies were identified. After screening, 5 remained; 1 was then removed due to a lack of access to the full text. Overall, a total of 29 studies were included. The selection process is outlined in the PRISMA flow diagram in Figure 1, which details the number of records identified, screened, assessed for eligibility, and included in the final analysis.

Summary of included studies

The key characteristics of the included studies, including publication year, authors, and primary aim, are summarized in Table 1.

The final review included 29 studies published between 1998 and 2025. The majority of studies focused on women who had undergone breast cancer surgery, particularly mastectomy with or without reconstruction. A small number also included healthcare providers or women from the general population for comparison or knowledge assessment.

Table 1. Summary of the Final Studies Investigating Post-Operative Bras and Related Outcomes in Patients with Breast Cancer

Study year	Study author(s)	Study design	Key conclusions
2024	Liu *et al.*[5]	Qualitative study (focus group-based thematic analysis)	Post-mastectomy breast cancer survivors experience persistent challenges in finding bras that provide adequate comfort, fit, and aesthetic satisfaction, particularly during the early post-operative and reconstructive phases; these difficulties impact their psychological well-being and underscore the need for evidence-based undergarment design that addresses surgical site sensitivity, fluctuating breast contour, and patient-specific garment preferences.
2023	Backman *et al.*[6]	Randomized controlled trial (RCT)	Demonstrated that while early post-operative pain scores did not differ significantly between groups, breast cancer surgery patients who wore a stable compression bra for 3 weeks reported significantly lower residual breast pain at 3 weeks, along with greater comfort, improved mobility, enhanced perceived support, and a stronger sense of post-operative security compared to those using a soft bra, supporting stable compression bras as the evidence-based standard for post-surgical recovery.
2023	Ng *et al.*[7]	Prospective mixed methods	A customized hand-knitted breast prosthesis used with patients' own bras was preferred by 67% of post-mastectomy women over the conventional bra-prosthesis set. It offered greater comfort, less sweating, and fewer instances of dislodgement, making it a viable alternative for breast cancer patients without reconstruction.
2023	Watanabe *et al.*[8]	Prospective qualitative study with longitudinal patient-reported outcomes	Consistent use of a semi-customized brassiere after breast reconstruction significantly reduced post-operative pain, improved perceived breast aesthetics, and lowered anxiety across a 12-month period, supporting the role of personalized undergarment fitting as a safe, effective adjunct to enhance quality of life in post-mastectomy breast reconstruction patients.
2021	Leung *et al.*[9]	Experimental crossover trial	This controlled laboratory study demonstrated that a heat-reduction mastectomy bra, incorporating a perforated polyurethane cup design, significantly lowered core body temperature and improved thermal comfort and humidity regulation compared to a conventional bra, highlighting the importance of breathable design features for managing thermoregulatory challenges, such as hot flashes and heat retention, in post-mastectomy breast cancer patients.

2021	Jones *et al.*[10]	Multicenter randomized controlled trial	A second-generation biomechanically optimized posture bra significantly improved scapular retraction and depression, reduced breast motion during walking by 17%, and did so without negatively affecting spinal curvature, suggesting its potential as a conservative intervention to alleviate musculoskeletal breast-related strain in women.
2021	Qiu *et al.*[11]	Cross-sectional survey study	There are significant knowledge gaps among Chinese medical professionals regarding external breast prosthesis use, with factors such as age, education level, professional title, years of experience, and geographic region influencing knowledge levels, highlighting the need for targeted education, particularly among younger and less experienced providers, to improve post-mastectomy care and patient support.
2021	Li *et al.*[12]	Meta-analysis	This meta-analysis of 13 RCTs found that compression therapy significantly reduced the morbidity of breast cancer-related lymphedema and improved upper limb range of motion, though its effect on reducing limb volume remained inconclusive due to high heterogeneity.
2021	Shima *et al.*[13]	Meta-analysis	This meta-analysis of 11 studies found that early drain removal after breast cancer surgery is associated with a significantly higher risk of seroma formation but does not increase surgical site infection rates, while offering the benefit of a shorter hospital stay, suggesting that routine early removal may be clinically acceptable when prioritizing discharge timing over fluid accumulation risk.
2020	McGhee *et al.*[14]	Experimental biomechanical study	Demonstrated that increasing the mass of external breast prostheses in women with unilateral mastectomy significantly elevates bra strap loading and perceived discomfort, highlighting the biomechanical impact of prosthesis weight and the need for lighter, better-distributed designs to enhance post-mastectomy comfort and musculoskeletal health.
2020	Sieradzki *et al.*[4]	Critical review	This review argued that the design and distribution of post-surgical bras remained medically and socially outdated, reflecting broader systemic gender inequities in healthcare.
2020	Nicklaus *et al.*[15]	Literature review	Conventional bras fail to meet the diverse anatomical and sensory needs of post-mastectomy patients, underscoring a critical gap in survivorship care. There should be collaborative innovation in undergarment design using technologies like 3D body scanning and biomechanical modeling to improve quality of life for breast cancer survivors.
2020	Wroblewski *et al.*[16]	Cross-sectional survey	Surveyed breast cancer survivors who had undergone mastectomy with prosthetic reconstruction and found that bra preferences are highly individualized; most participants prioritized comfort, soft underarm and underband support, and prosthesis stability, highlighting the inadequacy of one-size-fits-all post-mastectomy bras and the need for customizable design features to better address post-surgical needs and body changes.
2019	Shin *et al.*[17]	Experimental laboratory study	Demonstrated that both bra design and prosthesis material significantly influenced thermal and moisture regulation; bras with breathable structures and lightweight prostheses provided superior heat and sweat dissipation, supporting the need for thermophysiologically optimized designs to improve comfort and skin health in post-mastectomy women.
2016	Piroth *et al.*[18]	Prospective	This analysis found that using a thermoplastic breast bra during whole-breast radiotherapy significantly reduced radiation exposure to the heart and ipsilateral lung without increasing skin dose, supporting its clinical utility in improving treatment safety for breast cancer patients, especially in left-sided cases.
2016	Pimentel Santos Lopes *et al.*[19]	Qualitative interview study	Elderly mastectomized women in Brazil had limited knowledge about the use and benefits of bras and external breast prostheses, underscoring the need for targeted education and nursing support to improve body image, psychosocial well-being, and rehabilitation outcomes in this underserved population.
2015	Ergun *et al.*[20]	Case series Level IV	Dramatic improvements can be achieved with strategic fat placement into brassiere strap grooves. Combining breast reduction with fat injections to correct strap grooves can provide a more aesthetic and harmonious upper body appearance in appropriate patients.
2015	Coltman *et al.*[21]	Experimental crossover study	Bra strap orientation and design significantly affect pressure distribution and perceived discomfort in women with large breasts during exercise; wide, cross-back straps were most effective in reducing shoulder pressure and improving comfort, informing evidence-based design strategies for sports bras that support breast health and physical activity participation.
2014	Gho *et al.*[22]	Experimental laboratory study	Provided evidence-based design guidelines for post-treatment bras by identifying key ergonomic deficits in commercially available options for breast cancer survivors, emphasizing the need for improved strap and band support, reduced

			pressure points, and enhanced fit to accommodate changes in breast volume, asymmetry, and sensitivity following mastectomy and reconstruction.
2014	Sun *et al.*[2]	Comparative cross-sectional	Breast cancer patients who underwent breast-conserving surgery reported significantly higher quality-of-life scores, particularly in body image and emotional well-being domains, compared to those who had mastectomy, highlighting the psychosocial benefits of breast preservation when clinically feasible.
2014	Gho *et al.*[24]	Cross-sectional survey	Identified a high prevalence of self-reported side effects following breast cancer treatment, including fatigue, pain, and upper-body symptoms, and found that regular exercise was associated with fewer and less severe side effects. They noted that bra discomfort, particularly during physical activity, was a common barrier to exercise due to treatment-related changes like lymphedema and skin sensitivity, underscoring the need for better garment design to support physical rehabilitation in breast cancer survivors.
2014	Bradbury *et al.*[25]	Case report	Introduced a novel post-operative bra designed specifically for breast surgery patients with surgical drains, featuring integrated drain support and adjustable compression. The innovation aimed to enhance patient comfort, reduce drain displacement, and support early mobilization, addressing a previously unmet need in post-mastectomy and reconstructive care.
2013	Keller *et al.*[26]	Retrospective cohort	This study found that wearing a bra during radiation therapy for large-breasted women significantly reduced heart and lung radiation exposure without increasing acute skin toxicity, supporting the use of supportive undergarments as a simple and effective method to optimize treatment planning and reduce cardiopulmonary risk in breast radiotherapy.
2012	Risius *et al.*[27]	Qualitative interviews	Older women prioritize comfort, fit, and ease of use when purchasing bras, with physical changes due to aging, such as reduced dexterity, altered breast shape, and increased skin sensitivity, significantly influencing buying decisions. The study underscored the need for bra designs that accommodate age-related anatomical and functional changes in older women.
2010	Gho *et al.*[23]	Cross-sectional survey	Bra discomfort, particularly due to poor fit, pressure on surgical sites, and skin sensitivity, is a significant barrier to exercise participation among breast cancer survivors, with 59% of participants reporting exercise-related bra issues. These findings highlight the need for post-treatment bra designs that accommodate altered anatomy and improve comfort to support physical activity and recovery.
2004	Chadha *et al.*[28]	Retrospective cohort	Discharging patients home with surgical drains after breast surgery is safe and well tolerated, with low rates of complications such as seroma or infection and high levels of patient satisfaction, supporting early discharge protocols as a cost-effective and acceptable practice in post-operative breast cancer care.
2004	Laura *et al.*[29]	RCT	Wearing a well-fitting bra post-breast surgery significantly reduces post-operative discomfort compared to a breast binder.
2003	Greenbaum *et al.*[30]	Cross-sectional observational	Most women referred for reduction mammaplasty wore incorrectly sized bras, with poor fit potentially contributing to their symptoms.
1998	Ganz *et al.*[3]	Cross-sectional survey	Breast cancer survivors reported more frequent physical and menopausal symptoms than healthy women, yet they reported health-related quality of life and sexual functioning comparable to that of healthy, age-matched women.

Most studies evaluated interventions or exposures across 4 main areas:

- Post-surgical bras and prosthetics (e.g., compression bras, mastectomy bras, custom prostheses),
- Clinical or surgical management (e.g., drain use, radiation support),
- Product design and garment ergonomics (e.g., strap orientation, breathable materials),
- Psychosocial or quality-of-life outcomes related to comfort, body image, and garment use.

Outcomes measured included pain, mobility, comfort, thermal regulation, garment satisfaction, psychological well-being, and the safety or effectiveness of post-surgical supports.

Recent studies (2020–2024) have increasingly emphasized user-centered garment design, customization, and post-operative recovery support, reflecting a shift from basic comfort assessment toward more sophisticated, interdisciplinary solutions that integrate technology, patient preferences, and clinical needs.

Quality assessment

Quality assessment revealed variation across the included studies (Table 2). Of the 22 observational studies assessed using the Newcastle-Ottawa Scale, 8 (36%) achieved good quality scores (7–9 points), 12 (55%) achieved fair quality (4–6 points), and 2 (9%) achieved poor quality (0–3 points). The three randomized controlled trials were evaluated using the

Cochrane Risk of Bias tool: 2 studies demonstrated low overall risk of bias, while 1 study had unclear risk due to insufficient methodological detail. The 2 meta-analyses were assessed as high-quality systematic reviews with comprehensive methodology, while the 2 narrative reviews varied in analytical rigor.

Table 2. Quality Assessment of Included Studies Using Newcastle-Ottawa Scale and Cochrane Risk of Bias Tool

Study	Study Design	Assessment Tool	Quality Rating	Key Limitations
Randomized Controlled Trials				
Backman *et al.* (2023)	RCT	Cochrane RoB	Low risk	Participant blinding impossible
Jones *et al.* (2021)	Multicenter RCT	Cochrane RoB	Low risk	Participant blinding impossible
Laura et al. (2004)	RCT	Cochrane RoB	Unclear risk	Insufficient methodological detail
Good Quality Observational Studies (NOS 7-9)				
Ng *et al.* (2023)	Prospective mixed methods	NOS	7/9	Some attrition noted
Leung *et al.* (2021)	Experimental crossover	NOS	8/9	Small sample size
McGhee *et al.* (2020)	Experimental biomechanical	NOS	7/9	Limited sample size
Shin *et al.* (2019)	Experimental laboratory	NOS	7/9	Small sample size
Coltman *et al.* (2015)	Experimental crossover	NOS	8/9	Small sample size
Gho *et al.* (2014)	Experimental laboratory	NOS	7/9	Limited sample size
Keller *et al.* (2013)	Retrospective cohort	NOS	7/9	Some missing toxicity data
Ganz *et al.* (1998)	Cross-sectional survey	NOS	7/9	Cross-sectional design
Fair Quality Observational Studies (NOS 4-6)				
Liu *et al.* (2024)	Qualitative study	NOS	6/9	Single group design
Watanabe *et al.* (2023)	Prospective qualitative	NOS	6/9	No control group
Qiu *et al.* (2021)	Cross-sectional survey	NOS	5/9	Cross-sectional design
Wroblewski *et al.* (2020)	Cross-sectional survey	NOS	6/9	Cross-sectional design
Piroth *et al.* (2016)	Prospective analysis	NOS	6/9	Single arm study
Pimentel Santos Lopes *et al.* (2016)	Qualitative interviews	NOS	5/9	No comparison group
Gho *et al.* (2014)	Cross-sectional survey	NOS	6/9	Cross-sectional design
Sun *et al.* (2014)	Comparative cross-sectional	NOS	6/9	Limited demographic matching
Risius *et al.* (2012)	Qualitative interviews	NOS	5/9	No comparison groups
Gho *et al.* (2010)	Cross-sectional survey	NOS	6/9	Cross-sectional design
Chadha *et al.* (2004)	Retrospective cohort	NOS	6/9	No comparison group
Greenbaum *et al.* (2003)	Cross-sectional observational	NOS	5/9	Cross-sectional design
Poor Quality Observational Studies (NOS 0-3)				
Ergun *et al.* (2015)	Case series	NOS	3/9	Case series limitations
Bradbury *et al.* (2014)	Case report	NOS	2/9	Single case design
Meta-analyses and Reviews				
Li *et al.* (2021)	Meta-analysis	AMSTAR-2	High quality	High heterogeneity noted
Shima *et al.* (2021)	Meta-analysis	AMSTAR-2	High quality	Comprehensive methodology
Sieradzki *et al.* (2020)	Critical review	Narrative	Moderate quality	Limited systematic approach
Nicklaus *et al.* (2020)	Literature review	Narrative	Good quality	Comprehensive coverage

Common methodological limitations included small sample sizes (particularly in experimental studies), inability to blind participants to bra interventions, heavy reliance on subjective patient-reported outcomes without standardized instruments, and limited long-term follow-up data. Strengths included the use of crossover designs in experimental studies to control for inter-individual variability, objective biomechanical measurements in several

studies, and good retention rates in most prospective studies.

DISCUSSION

Failure of conventional garments in treating surgical complications

Drainage and surgical tubing

Post-surgical drains are used to reduce the risk of seroma formation following breast surgery.[13] Though the routine placement of surgical drains has decreased, they are still used regularly following mastectomies, axillary dissections, and oncoplastic and reconstructive procedures. As these operations have become day procedures, patients are increasingly discharged home with drains in situ. Patients have difficulties with drainage care, sometimes inadvertently leading to early accidental removal, and some patients find it embarrassing to carry around drainage bottles in front of others.[28] Innovative post-surgical garments that include pockets to hold tubing and drains allow women to continue their daily activities without tubes getting in the way, tubes being pulled out, and allow patients independence without these surgical accessories being noted by others.[25] Shima *et al.* examined clinical outcomes such as seroma formation and surgical site infection when comparing early versus late drain removal. Their findings suggest that appropriate post-operative garment design could complement drain management strategies by providing consistent compression after drain removal, potentially reducing late seroma formation.[13] Similarly, Chadha *et al.* found that patients discharged with drains in situ experienced challenges with drain management that appropriate garment design could address, potentially improving wound healing outcomes.[28]

Conventional post-surgical garments lack features to secure tubes or carry drains, often complicating recovery. There is a clear need for improvement in the design to include a feature for both the tubing as well as the drain.

Heat and moisture buildup

Thermal dysregulation is an unfortunately accepted side-effect that many women experience with the necessary adjuvant treatment for breast cancer. Additionally, the use of prostheses has also been associated with increased heat trapping. Many patients are frustrated by this issue of heat and moisture build up. Unfortunately, the conventional mastectomy bras do not allow proper airflow which, compounded with the use of prosthesis and heavy padding, leads to overall patient dissatisfaction.[17] A smaller scale study has demonstrated that a heat-reducing mastectomy bra leads to optimal thermal comfort and improves patient satisfaction.[17] A mixed-methods study by Ng *et al.* evaluated patient experiences with a conventional standard-sized bra and prosthesis set versus a customized hand-knitted external breast prosthesis used with the patient's own bra, among 148 Asian women post-mastectomy.[7] The majority (67%) preferred the customized option, citing significantly less sweating ($P < 0.0001$), greater comfort ($P = 0.0195$), and lower dislodgement rates ($P = 0.0269$). Qualitative data highlighted improved confidence, sense of normalcy, and greater emotional ease with the customized prosthesis. Although both options reduced perceived disfigurement, the ability to use one's own bra and the breathability of the hand-knit prosthesis were key drivers of preference, suggesting value in tailoring undergarment solutions to individual comfort and lifestyle needs.[7] Thermoregulation remains an unaddressed issue by the majority of conventional post-operative garments.

Dermatological irritation

Breast surgery compounded with radiation therapy can often lead to increased dermal sensitivity. It is important, especially in the early post-operative period, that care be taken to ensure comfortable garments that do not magnify post-operative discomfort. Unfortunately, most post-operative undergarments available use materials that aggravate the skin. For example, post-mastectomy bras often use Velcro to allow for front closure. While this may improve accessibility to put on and remove the garment, this does introduce potential harm to the underlying dressing and skin. Moreover, breast surgery is often accompanied by axillary surgery and radiation treatment. These therapies increase the risk of lymphedema in the ipsilateral breast, chest, and upper extremity. Most conventional post-operative brassieres do not account for these possible complications. The standard straps, bands, and cup length can cause discomfort and pain beyond that already experienced by patients.[16] Overall, the current undergarments available fail to provide the necessary comfort and can exacerbate post-operative adverse symptoms.

Breast asymmetry and bra fitting

A common problem faced by women, even those that are not breast cancer survivors, is wearing incorrectly sized bras. It has been reported that up to 85% of women wear incorrectly fitted bras and that poor fit is correlated with breast size.[15] This difficulty arises from the natural asymmetry of the breasts. In the general population, studies have demonstrated that wearing a poorly fitted bra can lead to increased pain, poor posture, fatigue, and musculoskeletal problems.[10] This problem is even more pronounced

after breast surgery, as a significant portion, if not the entire breast, has been removed. Current evidence supports a biomechanically informed posture bra to support heavier breasts and improve posture, and reduce musculoskeletal pain.[10] Non-medical bras do not account for this emphasized imbalance and do not provide sufficient support.[15] In a prospective study from Japan, Watanabe *et al.* assessed the impact of a semi-customized, professionally fitted brassiere on post-operative recovery among 46 women following breast reconstruction.[8] The bras were selected and fitted by trained specialists to match each patient's unique anatomy and provided ongoing support through scheduled follow-ups. The bras featured soft, adjustable designs tailored to reconstructed breasts, with attention to minimizing pressure on sensitive areas and surgical scars. The intervention led to significant reductions in post-operative pain at all measured time points ($P < 0.001$ at 1, 3, and 6 months; $P = 0.007$ at 12 months) and significantly improved patient satisfaction and confidence when wearing bras. Aesthetic ratings of breast shape and symmetry were also significantly better with the bra in place, especially at 3 and 6 months post-op. Additionally, consistent use of the custom-fitted bra reduced anxiety, contributed to a greater sense of safety, and promoted adherence to wearing supportive garments in daily life. These findings emphasize the critical role of a personalized fit in optimizing outcomes after breast reconstruction.

Current advancements of features in post-operative garment design

Although current features of non-medicalized garments, such as leisure, sports bras, and mastectomy bras, fail to meet the needs of pain relief, they may actually cause harm to the patient. Regarding symptoms and complications felt after surgery, in recent years, there have been developments in the designs of mastectomy bras that allow for patient comfort by addressing the shortcomings of their former counterparts.

Ventilation and airflow

Many post-operative breast surgery patients will require long-term adjuvant therapy that increases the risk of hot flashes. For this reason, a common source of frustration in conventional mastectomy undergarments is the use of materials that promote heat trapping. To generate more airflow, multiple design features have been developed to counteract the presence of sweat. A study by Kristina Shin *et al.*[17] explored the design of a post-operative garment that addressed this important problem. One solution that has been proposed is the use of a mastectomy bra, which contains holes at the bottom of the cup to promote ventilation. Another consideration has been to create a prosthesis that contains ventilation holes to reduce heat generated by prosthetics.[17] Overall, this addresses the problem by allowing heat to pass through both the garment as well as the prosthesis. When comparing this garment to the standard model during exercise, women experience less humidity and overall lower skin temperature.[17]

Anti-wicking and breathable fabric

An alternative method that has been investigated as a potential solution to contribute to the reduction of perspiration and heat around the breasts is the use of more breathable and cooling textiles in the design of post-operative garments. Although there has been no empirical research on the use of lighter fabrics, surveys of breast cancer survivors have made suggestions advocating for the use of lighter, more breathable fabrics to increase airflow in order to dissipate heat and promote the cooling of the breasts.[23] Materials that contain anti-wicking properties were found to be favorable. Additionally, developing a bra with lighter fabrics also improves heat trapping, assists in creating airflow, and in turn creates less sweat, and improves patient comfort.[9]

Fasteners and surgical site

The use of front opening mastectomy bras has been regarded as practical given their ability to facilitate accessibility in the post-operative recovery period. Most breast cancer patients will undergo some form of axillary surgery which in turn leads to limitations in the range of motion of the arm. The front opening mastectomy bra helps alleviate some of these difficulties.

Many different fasteners are currently on the market, including Velcro and zipper fasteners. The drawbacks of the current models are that they can irritate sensitive skin, get caught by the underlying bandages protecting the wound, and overall cause harm to the patient. These shortcomings call for other mechanisms to be explored. Examples that have been put forward are the standard eye hooks and clips. These options are interesting as they avoid the aforementioned issues that are encountered in the early post-operative period and still maintain the front-opening solution.

Underwire

A common issue that arose amongst breast cancer survivors regarding the post-operative bra is the grievance associated with the underwire of the bra. A study by Wroblewski *et al.*[16] found that most patients reported that their preferred design would not include an underwire. These women described a sense of discomfort and tactile irritation associated with the

wire. Though there is not a large body of evidence on the effects of the underwire on the post-operative breast surgery patient, it is understood that they are disliked by a significant number of patients.

Straps and bands

While some specialty manufacturers now produce post-breast surgery bras with adjustable straps, Wroblewski *et al.*[16] found that many patients still report accessing models without this important feature, suggesting inconsistent availability or awareness of better-designed options. Adjustable straps would allow for lengthening of the bra and creating a more customizable design.

Another observation made by breast cancer survivors is the discomfort associated with the bra straps and bands of the conventional mastectomy bra. Furthermore, breast cancer survivors have advocated for softer materials that make up the bra straps and bands as well as wider straps to provide increased comfort in the early post-operative and post-radiation period.[21] In a study by Coltman *et al.*, the use of wide straps reduces discomfort and minimizes the pressure felt on the shoulder.[21] In a qualitative study by Liu *et al.*, breast cancer survivors described how their experiences and preferences regarding bras evolved from pre-mastectomy through post-reconstruction.[5] Five key themes emerged, highlighting challenges such as poor fit, discomfort from closures (particularly front hook-and-loop styles), and frustration with inadequate post-surgical garment guidance. Survivors expressed strong emotional associations with bra color and style, linking them to well-being, normalcy, and control. Despite clinical recommendations for specific bra types, many participants reported prolonged difficulties finding bras that accommodated their post-surgical anatomy, fluctuating body shape, and sensitivity. The study underscores the need for more customizable, adjustable options and better access to trained fitters to support survivors' long-term comfort and quality of life.[5]

Cup height

A design feature that is being explored by modern bra designers is cup height, which can be defined as the maximal measurement from the base of the brassiere to the top. The use of a lower cup has been examined as it is associated with decreased arm pain and less contact with the surgical scar. Conversely, it has been reported that larger-chested women who wear brassieres with lower cup heights experience spillage.[15] Again, this feature should be a consideration, but it is important to note the specific limitations.

Asymmetry, prosthesis, and garment fitting

Asymmetry is an important factor when considering the post-surgical bra. The bra is associated with a woman's self-image, and struggling to acquire a proper bra can lead to both physical and psychological distress.[15, 27] To address breast asymmetries, weighted prostheses are often an ideal choice. Breast prostheses work by recreating the shape and the size of the missing breast to restore even weight distribution. The use of breast prostheses helps with the correction of posture while also improving women's self-esteem and self-confidence, improving the quality of life of many patients.[11]

There are generally two types of breast prostheses that are utilized. The first type is a contact prosthesis, which possesses an adhesive side that can be applied directly to the chest wall. These prostheses do not require specialized undergarments. The second is a non-adhesive prosthetic where the prosthetic is placed into a pocket of the post-operative garment. This option is available for purchase directly or can be customized to provide a more accurate fitting.

These are important factors that have been considered when creating the post-surgical bra. Often, women are not well-informed with regard to the different options, and this leads to higher expenses as well as increased potential for pain and musculoskeletal problems. The lack of guidance and poor experience with ill-fitting garments may drive women who would benefit from prostheses to avoid the entire process.[15] Conventional post-operative garments do not provide a proper fit to account for a prosthesis or the post-surgical breast.

Compression

Compression is an important consideration when creating a post-mastectomy garment, given its use in treating swelling and lymphedema, increasing mobility, and assisting with drainage to alleviate pressure.[12, 15] On the other hand, high levels of compression can lead to patient discomfort and pressure on sensitive skin.[15] The degree of compression is not well-defined in the literature, as many women have unique levels of comfort and tenderness.[16] This, however, does create a demand for a post-operative garment that utilizes a customizable compressive feature to accommodate these qualitative differences. The OptiBra randomized controlled trial by Backman *et al.* evaluated 201 breast cancer patients undergoing various types of primary surgery and compared outcomes between a soft bra (SB) and a stable bra with compression (SBwC) over a 3-week post-operative period.[6] While no significant difference in overall pain scores was seen across the entire cohort, a subgroup analysis revealed that among patients still experiencing pain at

3 weeks, those wearing the SBwC had significantly lower pain scores (P = 0.018). The SBwC group also reported improved arm mobility (P = 0.031), greater comfort (P = 0.027), and a stronger sense of support and security during daily activities (P = 0.032). These findings suggest that stable compression bras may facilitate early mobilization, reduce the risk of persistent postsurgical pain, and contribute meaningfully to recovery and quality of life following breast cancer surgery.

Minimizing radiation dosing

The standard of care for a woman receiving breast-conserving surgery is to undergo adjuvant radiation. Cardiac and pulmonary complications associated with radiation are limited due to the use of 3D radiation treatment planning.[18] Some patients with physiologic and anatomical differences develop adverse reactions despite these advancements.[18] A study by Piroth *et al.*[18] showed that by using a thermoplastic breast bra, radiation doses to the heart and lungs were lowered without additional skin toxicity. Another study by Keller *et al.* reconfirmed that the use of a bra reduced chest wall separation and heart volume within the treatment field.[26] A post-surgical garment that implements this science may also limit adverse complications associated with radiation and lead to improved patient outcomes.

Examples of developing bras and their contribution

Disposable Hybrid Dressing-Bra Design

An innovative post-operative garment design has emerged that functions as a hybrid between a bra and a dressing. This design was created in response to the insufficient features of existing garments. The single-use disposable design consists of a large bandage without adhesives that wraps around the torso and fastens in front. It provides customizable compression and can accommodate surgical drains. This design addresses previous limitations, including patient mobility restrictions and compression level adjustments. From a hygienic perspective, its disposability prevents the reuse of standard post-operative garments that are often soiled by seepage from surgical sites. These features make it effective for short-term recovery following breast surgery.

However, this design has limitations, including a lack of housing for tubes and the inability to simultaneously store drains and prosthesis. While valuable for short-term recovery, the hybrid approach may not be necessary beyond the early post-operative period, fails to meet all aesthetic preferences, and does not provide maximum breast support.

Clip-Closure Post-Surgical Bra Design

This post-operative garment addresses several common issues. It replaces problematic Velcro closures with clips similar to those used in nursing bras. The design incorporates housing for tubing and drains, and considers optimal cup height with an emphasis on lower cup placement to reduce contact with surgical sites.

Lack of research in current studies

There are still many gaps in the literature that need to be addressed. Firstly, the primary methodology used to obtain pertinent data across the reviewed studies was questionnaires. While the use of questionnaires and surveys is an effective way to obtain qualitative information, it does not allow the collection of empirical evidence and clear quantitative data. Secondly, while the improvement in the manufacturing and design of post-operative garments resonates throughout all these studies, the actual advancements that need to be implemented are unclear, and most suggestions are opinion-based. For example, qualitative surveys have demonstrated a need for post-operative garments with softer materials.[16] However, there are limited data to delineate exactly what material is preferred. Thirdly, current evidence has advocated for improvements, but the proposed changes have not yet been studied. It is unclear if any of the prospective designs will lead to improved patient satisfaction. Further studies are required to better answer these questions.

Limitations

This review has several limitations. First, the included studies exhibited substantial heterogeneity in terms of design, populations, interventions, and outcomes, which limited direct comparisons and precluded formal meta-analysis. Second, many of the studies had small sample sizes, reducing generalizability and statistical power. Third, a significant proportion of the literature relied on subjective, patient-reported outcomes without standardized measurement tools, introducing potential reporting bias. Additionally, few studies reported long-term follow-up data, limiting insights into sustained outcomes beyond the immediate post-operative period.

Another limitation is the geographic and cultural skew of the data. Most studies originated from high-income countries, with underrepresentation of perspectives from low- and middle-income settings, where access to customized post-surgical undergarments and prostheses may be more limited. Furthermore, the review focused primarily on cisgender women, and findings may not fully capture

the needs of gender-diverse populations undergoing chest surgery.

Finally, although an updated literature search was conducted through April 30, 2025, publication lag may have excluded emerging studies currently in press, and non-English articles were not included, which may introduce language bias.

CONCLUSION

An important aspect of breast cancer survivorship is well-designed post-operative garments. The post-operative period involves physical and psychological recovery. Studies have demonstrated that improper bra designs cause discomfort, leading to exercise intolerance and limiting participation in physical activity for women with breast cancer.[23] The post-operative period also involves adjuvant treatments, including radiation or chemotherapy. It is imperative that during this time, the undergarments allow these women to continue their daily lives and treatments with as much comfort as possible.

This review demonstrates that the current design of the early post-surgical bra is not practical and does not provide the necessary support or comfort to breast cancer survivors who have undergone a mastectomy or breast-conserving surgery. Many features are not considered during the development of these post-surgical garments including: lack of storage for prostheses, nonadjustable shoulder straps, back fasteners, harm associated with the use of Velcro, benefits of elastic banding around the thorax versus currently implemented underwires, allowing for ventilation, benefits of lower cup height, added compression and potential advantages associated with minimizing radiation doses. Moreover, they fail to account for post-surgical drains and tubing within the breast and axilla. Our review provides insight into the need for a new post-operative garment design that incorporates solutions to all these addressed problems.

Based on our findings, we propose the following essential design criteria for optimal post-operative breast undergarments:

1. Drain and Surgical Tubing Management
   - Secure housing for tubing to prevent accidental removal
   - Pockets to discreetly hold drainage containers without visible bulging
   - Easily accessible openings for drain inspection and emptying
   - Adjustable positioning to accommodate varying surgical sites
2. Thermoregulation Features
   - Strategic ventilation zones in areas prone to heat buildup
   - Moisture-wicking, breathable fabrics with anti-microbial properties
   - Optional cooling capacity for radiation-induced skin sensitivity
   - Layered design allowing for thermal customization
3. Skin-Friendly Materials and Construction
   - Hypoallergenic, soft fabrics for sensitive post-surgical skin
   - Seamless construction in areas contacting surgical sites
   - Encapsulated edges to prevent rubbing or irritation
   - Non-adhesive closures that do not compromise underlying dressings
4. Adjustability and Fit Considerations
   - Fully adjustable straps with cushioned support
   - Multiple closure points allowing for size fluctuations
   - Front-closure systems with easy-grip, non-irritating fasteners
   - Accommodations for asymmetry with customizable compression
5. Prosthesis Integration
   - Adaptable pockets for various prosthesis types and sizes
   - Designs accommodating both temporary and permanent prostheses
   - Balanced support to prevent posture issues and associated pain
   - Features that evolve with the patient through the recovery continuum
6. Radiation Compatibility
   - Minimal metal components to reduce interference with treatment
   - Design elements to stabilize breast tissue during radiation therapy
   - Features to reduce heart and lung exposure during treatment
   - Material selection that does not exacerbate radiation-induced skin reactions

Further studies are required to better understand these advancements and improve these designs. Newer technologies and materials, including 3D scanning, printing, and biomechanical computing technology, as well as gel pads under the bra strap, can be utilized to improve current modern designs.[15, 21] Overall, new post-operative designs and further research are needed to address these problems.

Future research should focus on evidence-based evaluation of these design criteria, with controlled

studies measuring outcomes such as patient comfort, complication rates, mobility, psychological well-being, and return to normal activities. Additionally, designs should consider the unique needs across different phases of recovery, from immediate post-operative use to long-term survivorship. A multidisciplinary approach involving surgeons, nurses, textile engineers, and patients themselves is essential to create truly patient-centered solutions that address the full spectrum of physical, psychological, and practical needs.

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CONFLICTS OF INTERES

The authors declare no conflicts of interest related to this study.

ETHICAL CONSIDERATIONS

As this study is a systematic review, it does not involve primary data collection with human participants. Therefore, ethical approval was not required. However, we ensured that all included studies adhered to ethical standards as per their respective institutional review boards.

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DATA AVAILABILITY

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request. Additionally, the data supporting the findings of this review are publicly accessible in the studies referenced within this manuscript.

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