INPLASY

Effectiveness of Nursing Model Interventions in the Prevention and Improvement of Upper Limb Dysfunction after Breast Cancer Surgery: A Systematic Review and Meta-analysis

INPLASY202550059

doi: 10.37766/inplasy2025.5.0059

Received: 21 May 2025

Published: 21 May 2025

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ADMINISTRATIVE INFORMATION

Support - Guangdong Basic and Applied Basic Research Foundation (2025A1515011824).

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202550059

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 20 May 2025 and was last updated on 25 June 2025.

INTRODUCTION

Review question / Objective Research questions The systematic review is guided by the following research questions, aligned with our research objectives:
1.What are the different nursing models used for the rehabilitation of upper limb function in breast cancer patients?
2.How effective are these nursing models in improving upper limb functional recovery among breast cancer patients?
3.What is the impact of these nursing models on exercise adherence/compliance in breast cancer patients during rehabilitation?
4.What are the effect sizes of nursing model interventions in improving functional outcomes and exercise adherence compared to usual care or control groups?

Objective
Currently, various nursing models—including peer support (Pinto et al., 2015), group interventions (Naumann et al., 2012), home-based activity interventions (Pinto et al., 2005), web-based rehabilitation guidance systems (Ariza-Garcia et al., 2019), and psychological interventions (Hou et al., 2024)—have been shown to improve rehabilitation outcomes and exercise adherence among breast cancer patients, achieving positive results. However, there remains a lack of systematic summaries, effectiveness evaluations, and comprehensive analyses of intervention effect sizes concerning nursing models targeting the functional rehabilitation of breast cancer-affected limbs. Therefore, this study aims to conduct a systematic review of nursing models that focus on the functional rehabilitation of the affected limbs and exercise adherence among breast cancer patients. Additionally, we will estimate the effect sizes of various nursing models in improving patient outcomes and exercise adherence, thereby providing evidence-based recommendations for clinical nursing practice.

Condition being studied Breast cancer ranks first among malignant tumors in terms of both incidence and mortality among women worldwide (Bray et al., 2024). Owing to the large population base, China accounts for the highest number of new cases and deaths from breast cancer globally

(Wang Yuxin et al., 2024). With continuous advances in treatment modalities, the survival rate of breast cancer patients has improved significantly. Data from the National Cancer Center indicate that the 5-year survival rate for breast cancer patients in China reached 92.9% in 2019, with rates in some regions approaching those of developed countries (Zeng et al., 2024). Consequently, as the mortality rate continues to decline, the quality of life and long-term prognosis of breast cancer survivors have become increasingly important research focuses.

Breast cancer-related upper limb dysfunction (BCULD) is a common complication during breast cancer treatment. It manifests as restricted upper limb movement, pain, lymphedema, muscle weakness, and axillary web syndrome (AWS), among other symptoms. The incidence of BCULD varies depending on surgical modality and individual patient factors. Studies have shown that the incidence of shoulder dysfunction can be as high as 84% (McNeely et al., 2023), lymphedema of the affected limb occurs in 14–24% of cases (Lin et al., 2021; Shen et al., 2022), axillary web syndrome in 47.1–50% (Koehler et al., 2018; McNeely et al., 2023), pain in 21.7–40% (McNeely et al., 2023), and muscle weakness in 15.2–30.9% (McNeely et al., 2023).

Upper limb dysfunction not only significantly reduces the range of shoulder movement and daily living activities, but also severely impairs the quality of life. Its impact on rehabilitation, social reintegration, and long-term prognosis is profound, mainly in the following three aspects: (1) Prolonged Rehabilitation and Increased Economic Burden: The recovery of limb function after surgery is often suboptimal, with rehabilitation periods extended by a year or more; without timely intervention, symptoms may worsen over time (Zhang Huiting et al., 2020a; Zhang Huiting et al., 2020b). The severity of dysfunction is positively correlated with economic burden: some patients are forced to reduce or discontinue rehabilitation therapy due to financial constraints, creating a vicious cycle of functional decline and economic hardship (Bian et al., 2023). (2) Delayed Radiotherapy and Compromised Outcomes: Postoperative radiotherapy is critical for comprehensive breast cancer management, and is most effective when administered within 4–8 weeks after surgery (Gradishar et al., 2024). Patients receiving radiotherapy more than 8 weeks postoperatively have a 1.62-fold higher five-year local recurrence rate compared to those treated within 8 weeks (Huang et al., 2003). Notably, at 3 months post-surgery, 37.5% and 46.43% of patients exhibit shoulder flexion and abduction limitations (<120°), respectively, meaning nearly half may miss optimal therapy windows due to upper limb limitations, thereby adversely affecting prognosis (Zhang Huiting et al., 2020b). (3) Reduced Quality of Life and Impaired Social Function: Upper limb dysfunction after breast cancer surgery markedly affects abilities required for daily living (such as dressing, grooming, and household chores) and is often accompanied by psychological problems (e.g., anxiety, depression) (Zhang et al., 2021). Furthermore, restrictions in shoulder movement, pain, and fear of lymphedema hinder the ability to perform occupational tasks requiring lifting, prolonged writing, or repetitive arm movements, directly undermining job performance and economic independence—posing significant barriers, especially for patients engaged in physical labor (Zhu et al., 2025).

The primary causes of upper limb dysfunction following breast cancer surgery include lymphatic reflux obstruction, nerve and soft tissue injury due to mastectomy, axillary lymph node dissection, and radiotherapy, as well as scars and tissue fibrosis. These factors reduce the elasticity of skin, connective tissue, and muscles around the shoulder, causing adhesions or atrophy, and ultimately lead to restricted movement and functional impairment (Sclafani and Baron, 2008). Timely and scientifically guided postoperative rehabilitation exercises accelerate wound healing, promote lymphatic return, reduce limb swelling, prevent joint stiffness and muscle atrophy, enhance muscle strength, and holistically improve physical and mental recovery by modulating immune and inflammatory responses. The first 3 months post-surgery are crucial for functional recovery; sustained rehabilitation for at least 3–6 months, and even lifelong maintenance, is recommended (Bruce et al., 2022; Carretti et al., 2022). Systematic reviews show that research on postoperative rehabilitation exercise in breast cancer patients is mainly focused on aerobic exercise, shoulder and elbow exercises, resistance training, massage, and manual lymphatic drainage (Lin et al., 2023). However, clinical experience reveals that the implementation and adherence to rehabilitation exercises are far from ideal at 3 months after surgery, and compliance tends to decrease further over time (Petito et al., 2012; Zheng Xiao-jun et al., 2013). Therefore, despite robust evidence for the efficacy of rehabilitation, its benefits are substantially diminished without sustained patient participation.

METHODS

Search Strategy To identify relevant studies, we will systematically search the following databases: PubMed, Cochrane Central Register of Controlled

Trials (CCTR), Web of Science, Embase, China National Knowledge Infrastructure (CNKI), Wanfang Data, VIP Database for Chinese Technical Periodicals, and Sinomed Database. The search strategy will employ a combination of Medical Subject Headings (MeSH) and free-text terms. Detailed search strategies are provided in Appendix 1. The literature search will cover publications from January 2005 to May 2025.

Participant or population Adults (aged 18 years or above) who have undergone or will undergo breast cancer surgery.

Intervention Nursing Model Interventions,including but not limited to: nursing models, nursing management, based on theoretical frameworks, nursing pathways, nursing projects, health education, patient education and many other pathways.

Comparator Conventional nursing,Standard nursing,Those without specific nursing model intervention.

Study designs to be included Only randomized controlled trials(RCTs) will be included in this study.

Eligibility criteria We will include only the literature of randomized controlled trials(RCTs) on the improvement of upper limb dysfunction by the nursing intervention model. Nonrandomized controlled studies case reports,case series and reviews will not be included in this study.

Information sources Related studies in the following databass will be searched from January 1, 2005 to May 1, 2025:PubMed, Embase, Web of Science, Cochrane Library, China National Knowledge Infrastructure (CNKI), VIP, Wanfang, and China Biomedical Literature Database.

Main outcome(s) (4) incidence and onset time of upper limb dysfunction, as well as specific manifestations, including (but not limited to) restricted shoulder joint mobility, decreased muscle strength or grip strength, pain, fatigue, lymphedema, functional scores, and axillary web syndrome. Studies reporting at least one of these outcomes will be included.

Data management Before starting the data extraction process, two authors collaboratively developed a structured table to systematically record essential information from the selected studies. One author extracted the data using a predefined standardized form, and a second author verified the data for accuracy. Whenever inconsistencies or disagreements emerged concerning the extracted data, a third author was brought in to mediate, ensuring that the compiled information was precise and accepted by all authors involved. If the reported data were inadequate or ambiguous, the corresponding author of the publication was contacted by email for clarification. The key details include: (1) study characteristics such as author, year, country, design, study design, kind of control group and evaluation time of intervention; (2) participant characteristics, including population size, age, educational background, eligibility criteria, the severity of LARS upon participant inclusion, and number of dropouts; (3) intervention characteristics, including type of intervention, intervention program, intervention duration, and intervention provider; (4) outcomes, including the instrument used, scores (means, standard deviations, and sample size), or if means and standard deviations are unavailable, other pertinent information for estimating an effect size.

Quality assessment / Risk of bias analysis The quality assessment of the included studies will be performed separately by two authors. If disagreements arise, a third author will be involved to assist in resolving the issues and reach an agreement. The Cochrane Risk of Bias Tool2.0 will be employed to assess randomized controlled trials. If three areas are deemed high risk, the overall bias in this study is considered high.

Strategy of data synthesis The included studies will be categorized based on the type of LARS intervention strategies. For each group, we will summarize the demographic characteristics, intervention details, limb function outcome measures, and other key findings. For dichotomous data, we will compute the risk ratio with 95% confidence intervals (CI), and for continuous data, we will determine the mean differences (SMD) with95% CIs. $P < 0.05$ will be considered statistically significant. If there is no significant clinical heterogeneity, we will synthesize and present the results on the efficacy of limb function outcome interventions using forest plots generated with Review Manager (RevMan V.5.3). The outcomes of each intervention strategy will be subtotaled and totaled based on the various study types. Nonetheless, we will refrain from pooling the data if significant clinical heterogeneity is detected. To assess statistical heterogeneity among the included studies, the Chi-squared (I^2) test will be utilized. $P < 0.1$ or $I2 \geq 50\%$ will be interpreted as high heterogeneity. To synthesize the data, we will employ a random-effects model, acknowledging

the likelihood of multiple sources of heterogeneity, regardless of statistical heterogeneity.

Subgroup analysis If sufficient data are available, we will investigate whether the effects of interventions differ among various intervention types and across different outcome measurement methods. Subgroup differences will be tested using interaction tests within Review Manager (RevMan), and results will be interpreted with caution due to the risk of false positives from multiple comparisons.

Sensitivity analysis Sensitivity analyses will be conducted to assess the robustness of the pooled results. Primary analyses will be repeated by sequentially excluding studies with high risk of bias, unpublished data, or studies with missing or imputed outcome data. Where applicable, we will also assess the impact of excluding studies with small sample sizes or using alternative statistical models (e.g., fixed-effect vs. random-effects models). If the pooled results remain consistent, the findings will be considered robust.

Country(ies) involved China.

Keywords Breast Neoplasms; Upper Extremity; nursing intervention, rehabilitation, functional outcome; randomized controlled trial

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