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IMPACT OF PHYSICAL ACTIVITY ON FUNCTIONAL RECOVERY AFTER BREAST CANCER SURGERY: A NARRATIVE REVIEW

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ABSTRACT

Background: Breast cancer is the most frequently diagnosed malignancy among women worldwide, with surgical intervention remaining the cornerstone of curative treatment. Despite improved survival rates, breast cancer surgery is associated with postoperative functional impairments - including restricted shoulder range of motion, pain, lymphoedema, and muscle weakness - that may compromise health-related quality of life.

Objective: To evaluate and synthesise the available evidence regarding the role of physical activity in improving functional recovery after breast cancer surgery, with attention to shoulder mobility, upper limb function, lymphoedema management, and quality of life.

Methods: A literature search of PubMed/MEDLINE, Scopus, and Web of Science was conducted for studies published between 2012 and 2026. Eligible publications included randomised clinical trials, observational studies, systematic reviews, and meta-analyses. Findings were synthesised qualitatively in accordance with the SANRA recommendations.

Results: Structured physical activity programmes are associated with improvements in shoulder mobility, upper limb function, and psychological well-being. Meta-analytic data confirm significant improvements in shoulder flexion (SMD 0.59), abduction (SMD 1.01), and upper limb function (SMD 0.87). Evidence indicates that appropriately prescribed exercise does not increase lymphoedema risk (RR 0.71, 95% CI 0.53–0.96) and may confer a protective effect. Some studies of very early unrestricted mobilisation reported short-term differences in wound outcomes, underscoring the importance of programme timing.

Conclusions: Physical activity constitutes a safe and effective component of postoperative rehabilitation following breast cancer surgery. Integration of individualised, evidence-informed exercise programmes into clinical pathways is strongly recommended.

KEYWORDS

Breast Cancer, Physical Activity, Rehabilitation, Breast Surgery, Recovery, Lymphoedema, Quality of Life

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1. Introduction

1.1. Epidemiology of Breast Cancer

Breast cancer is the most commonly diagnosed malignancy among women globally, with an estimated 2.3 million new cases in 2020 (Arnold et al. 2022; Lei et al. 2021; Hu et al. 2019). Incidence rates vary considerably by geographic region and level of human development, with analyses of population-based registries demonstrating marked disparities in both incidence and mortality according to sociodemographic indices (Arnold et al. 2022; Hu et al. 2019), and projections indicate a 47% increase in new cases by 2040 (Arnold et al. 2022). Substantial improvements in survival have been achieved, particularly in high-income countries where five-year net survival now exceeds 85–90% (Amato et al. 2023; Allemani et al. 2018). The CONCORD-3 programme confirmed these figures across 66 countries (Allemani et al. 2018). The growing population of survivors has shifted attention towards long-term outcomes and health-related quality of life (Mokhtari-Hessari and Montazeri 2020). Furthermore, regular physical activity has been shown to reduce breast cancer risk by modulating hormonal, metabolic, and immune pathways (Zukierski et al. 2025).

1.2. Surgical Treatment of Breast Cancer

The two principal surgical approaches - mastectomy and breast-conserving surgery - are complemented by axillary staging procedures that significantly influence postoperative morbidity (Myung et al. 2018; Mohamed et al. 2025; Koehler et al. 2018). Axillary lymph node dissection is associated with markedly higher rates of lymphoedema, shoulder dysfunction, and chronic pain than sentinel lymph node biopsy (Mohamed et al. 2025; Koehler et al. 2018). Breast reconstruction may further contribute to shoulder strength deficits, particularly when pectoralis major involvement is substantial (Myung et al. 2018). These surgical considerations directly determine the nature and intensity of rehabilitation required (Table 2).

1.3. Postoperative Functional Impairments

Shoulder range of motion restriction is among the most prevalent complications, with prospective data demonstrating that the cumulative prevalence of axillary web syndrome reaches 50% at 18 months, and physical impairments of any type affect 66-97% of patients (Koehler et al. 2018). Koehler et al. demonstrated that AWS is not self-limiting, can persist for at least 18 months, develop beyond the early postoperative period, and recur after resolution (Koehler et al. 2018). AWS was identified as an independent risk factor for long-term reduced function (OR 9.60, $p=0.05$) (Koehler et al. 2018). Lymphoedema severity correlates with impaired shoulder function and altered muscle activation patterns (Mohamed et al. 2025; Rezende et al. 2024), while scapulothoracic impairments and chronic neuropathic pain further complicate recovery (Rezende et al. 2024; Mafu et al. 2018). Ultrasonographic assessment has revealed persistent alterations in shoulder soft-tissue architecture among breast cancer survivors, further corroborating the clinical significance of these impairments (Gala-Alarcón et al. 2021).

1.4. Importance of Physical Activity and Aim

Physical activity is increasingly recognised as a fundamental component of cancer care, with evidence supporting its role in improving physiological, psychological, and cognitive outcomes across diverse cancer populations (Mokhtari-Hessari and Montazeri 2020; Xu et al. 2024; Anderson et al. 2012; Cemaga et al. 2026). Meta-analytic evidence demonstrates that exercise significantly improves shoulder flexion (SMD 0.59), abduction (SMD 1.01), and overall upper limb function (SMD 0.87) (Xu et al. 2024). The aim of this narrative review is to evaluate and synthesise the available evidence regarding the impact of physical activity on functional recovery following breast cancer surgery, examining shoulder mobility, upper-limb function, lymphoedema, pain, and HRQoL.

2. Methods

2.1. Study Design and Reporting Framework

This study was designed as a narrative review, conducted in accordance with the Scale for the Assessment of Narrative Review Articles (SANRA) recommendations. A narrative approach was selected to enable interpretive synthesis across heterogeneous study designs, interventions, and populations.

2.2. Data Sources and Search Strategy

A literature search was conducted using PubMed/MEDLINE, Scopus, and Web of Science, combining MeSH terms and free-text keywords. Reference lists of eligible studies were hand-searched.

2.3. Inclusion and Exclusion Criteria

Studies published in English between 2012 and 2026 addressing exercise and postoperative functional recovery were eligible. RCTs, cohort studies, systematic reviews, and meta-analyses were included. Earlier landmark studies of enduring relevance were retained. Case reports, editorials, and non-relevant publications were excluded.

2.4. Data Extraction and Synthesis

Data extraction focused on study design, population, intervention, outcomes, and principal findings. No formal risk-of-bias instrument was applied. Findings were synthesised qualitatively and organised by clinical domain. To address the limitations of this approach, individual studies are characterised in Table 1 with notation of study design and an indicative assessment of evidence level.

2.5. Methodological Considerations

The search was limited to three databases and English-language publications. The included literature was heterogeneous in exercise modality, timing, and outcome assessment. As no formal quality appraisal tool was used, conclusions should be interpreted as an informed thematic synthesis rather than a graded evidence statement.

3. Results

The characteristics of the key studies contributing to this review are summarised in Table 1.

Table 1. Characteristics of key studies included in this review.

Author, Year	Design	N	Intervention	Key outcomes	Evidence Level
Koehler et al., 2018 (Koehler et al. 2018)	Prospective cohort	36	Non-intervention; AWS assessment at 2, 4, 12 wk and 18 mo post-surgery	AWS prevalence 50% at 18 mo; AWS= risk factor for reduced function (OR 9.6; $p=0,05$); physical impairments 66-97%	Moderate
Anderson et al. (RESTORE) 2012 (Anderson et al. 2012)	RCT	104	Supervised exercise (2x/wk: 30min walking + 20 min strength + stretching) + lymphoedema education; 4-12 wk post-surgery; 18-mo follow-up	6 MWT: +34,3 m vs control ($p=0,01$); FACT-B: no significant difference ($p=0,57$); arm volume: no adverse effect ($p=0,54$)	Moderate (RCT, single-centre)
Heiman et al. (PhysSURG-B), 2021 (Heiman et al. 2021)	RCT, multicentre	400	Non-supervised aerobic PA recommendation (30 min/day), ~2 wk pre- and 4 wk post-surgery	Physical recovery 75-100%: RR 1,03 (0,95-1,13), NS; mental recovery: RR 1,05 (0,93-1,17), NS; CCI 4,2 vs 4,7, NS	High (RCT, n=400, multicentre)
Klein et al., 2021 (Klein et al. 2021)	Prospective cohort	157	Preoperative PA levels (inactive, light, moderate, vigorous); 6-mo follow-up	Moderate-vigorous PA: QuickDASH 2,2 vs 7,0 ($p<0,001$); ABD 159,5° vs 152,2° ($p=0,008$); vigorous PA ↑ AWS risk ($p=0,041$) but ↓ chronic pain ($p=0,007$)	Moderate (cohort)
Redemski et al., 2022 (Redemski et al. 2022)	SR + MA	2442	Early ROM (<3 days post-op) vx delayed ROM or usual care; 20 RCTs	Flexion ROM: improved (post-2000 studies); TDT + 1.2 days ($p<0,05$) but NS in recent studies; lymphoedema RR 3,7 short-term only; GRADE: low-very low	High (SR + MA with GRADE)

Author, Year	Design	N	Intervention	Key outcomes	Evidence Level
Xu et al., 2024 (Xu et al. 2024)	SR + MA	2171	Physical exercise vs control; 25 RCTs; subgroup analyses by type, frequency, duration, timing	Flexion SMD=0,59 (p<0,001); abduction SMD=1,01 (p<0,001); UL function SMD=0,87 (p<0,001); resistance exercise most effective; early (<2 wk) initiation beneficial; GRADE: high (flexion), moderate (abduction, UL function)	High (SR + MA with GRADE)
Plinsinga et al., 2026 (Plinsinga et al. 2026)	SR + MA	2739	Exercise vs no exercise for CRL incidence; 17 RCTs; subgroup by mode, supervision, node dissection	CRL incidence: RR 0.71 (0.53-.,96); >5 nodes removed: RR 0.50 (0.24-1.02); all nodes may benefit; GRADE: low	High (SR + MA with GRADE, INSPECT-SR)

3.1. Effects of Breast Cancer Surgery on Physical Function

The reviewed literature documents a substantial burden of functional impairment. Koehler et al. (Koehler et al. 2018) reported that the cumulative prevalence of AWS was 50% at 18 months following surgery, with 41% of women still presenting with AWS at that time point. Women with AWS had statistically reduced shoulder abduction (AROM 108° vs 135° at 2 weeks, $p<0.05$) and were at significantly higher risk of long-term functional impairment. Importantly, the overall prevalence of one or more physical impairments ranged from 66% to 97% depending on the assessment time point, yet only 36% of women received any rehabilitation intervention during the first 18 months (Koehler et al. 2018). Klein et al. (Klein et al. 2021) demonstrated that mastectomy resulted in greater functional limitation (QuickDASH 7.2 vs 3.6), more pain (NPRS 1.1 vs 0.5), and decreased shoulder flexion (147.9° vs 156.7°) compared with lumpectomy at six months, while axillary lymph node dissection was associated with significantly worse outcomes than sentinel lymph node biopsy across all functional measures (Klein et al. 2021).

3.2. Physical Activity in Early Postoperative Recovery

The RESTORE trial (Anderson et al. 2012) demonstrated that a supervised, multicomponent exercise programme initiated 4–12 weeks after surgery resulted in a significant improvement in physical function as measured by the 6-minute walk test (593.2 m vs 558.9 m, adjusted difference +34.3 m, $p=0.01$), with no adverse effect on arm volume (Anderson et al. 2012). However, no significant improvement was observed in health-related quality of life as measured by the FACT-B (115.8 vs 114.4, $p=0.57$), possibly reflecting a ceiling effect in a population with moderate-to-high baseline HRQoL and early-stage disease (Anderson et al. 2012).

The PhysSURG-B trial (Heiman et al. 2021), a multicentre RCT of 400 women, evaluated the effect of non-supervised aerobic physical activity recommendations (30 min/day) before and after breast cancer surgery. The trial did not demonstrate a statistically significant improvement in the primary outcome of self-reported physical recovery at four weeks (RR 1.03, 95% CI 0.95-1.13). Approximately 88% of participants in both groups achieved 75–100% recovery, suggesting a ceiling effect. Adherence was suboptimal, with only 54% reporting adequate preoperative activity (Heiman et al. 2021). The trial nonetheless confirmed the feasibility and safety of perioperative physical activity recommendations, with no increase in complications (CCI 4.2 vs 4.7) (Heiman et al. 2021).

Redemski et al. (Redemski et al. 2022), in a systematic review and meta-analysis of 20 RCTs ($n=2442$), found that early unrestricted ROM exercises (initiated within 3 days of surgery) improved flexion ROM compared with delayed programmes, particularly in studies published after 2000. However, early exercise was associated with longer drainage time (+1.2 days) and higher short-term haematoma risk (RR 1.6), although these differences were not observed in more recent studies employing contemporary surgical techniques. The quality of evidence was generally low to very low according to GRADE (Redemski et al. 2022).

3.3. Long-Term Effects of Physical Activity

Klein et al. (Klein et al. 2021) provided dose–response evidence from a prospective cohort of 157 patients. At six months, women performing moderate-to-vigorous physical activity demonstrated significantly better outcomes across all functional measures compared with inactive or lightly active women: QuickDASH 2.2 vs 7.0 ($p<0.001$), shoulder abduction 159.5° vs 152.2° ($p=0.008$), flexion 159.0° vs 150.7° ($p=0.007$), and self-efficacy 9.5 vs 8.8 ($p=0.002$) (Klein et al. 2021). Higher training frequency was also associated with fewer sick days ($p=0.047$) and greater return to prior employment ($p<0.001$). Notably, physical activity did not influence acute postoperative pain at any time point (Klein et al. 2021).

3.4. Physical Activity and Lymphoedema

The relationship between exercise and lymphoedema has undergone a substantial conceptual shift. Xu et al. (Xu et al. 2024) confirmed that exercise interventions improved postoperative shoulder mobility and upper-limb function without evidence of increased lymphoedema risk. Plinsinga et al. (Plinsinga et al. 2026), in the most comprehensive meta-analysis to date (17 RCTs, n=2739), provided the first Level I evidence that exercise may reduce the risk of cancer-related lymphoedema (RR 0.71, 95% CI 0.53-0.96). In women with five or more lymph nodes removed, the risk reduction was more pronounced (RR 0.50, 95% CI 0.24-1.02). All exercise modes appeared beneficial, and even unsupervised programmes showed favourable effects (Plinsinga et al. 2026).

However, these findings require contextualisation. Redemski et al. (Redemski et al. 2022) found that early unrestricted ROM was associated with a 3.7-fold higher short-term risk of lymphoedema compared with delayed ROM, although this difference was not sustained at longer follow-up. Klein et al. (Klein et al. 2021) reported that vigorous physical activity increased the risk of axillary web syndrome ($p=0.041$), though it simultaneously reduced the incidence of chronic pain ($p=0.007$). These nuances underscore the importance of graded progression, symptom monitoring, and individualised prescription rather than blanket recommendations (Redemski et al. 2022; Klein et al. 2021; Plinsinga et al. 2026).

3.5. Impact on Quality of Life

Review-level evidence identifies physical activity as one of the most consistent modifiable determinants of HRQoL in breast cancer survivors (Mokhtari-Hessari and Montazeri 2020). The RESTORE trial demonstrated improvement in physical function but not in FACT-B scores, suggesting that exercise benefits may be domain-specific rather than uniformly reflected in composite HRQoL instruments (Anderson et al. 2012). Klein et al. confirmed that higher physical activity intensity and frequency were associated with greater self-efficacy and return to employment (Klein et al. 2021).

3.6. Barriers to Physical Activity

Common barriers include kinesiophobia, concern about lymphoedema, pain, fatigue, inadequate professional guidance, and limited access to rehabilitation (Mokhtari-Hessari and Montazeri 2020; Klein et al. 2021). Long-term physical activity trends indicate that many breast cancer survivors fail to return to pre-diagnosis activity levels, with declines persisting years after treatment (Mason et al. 2013). System-level barriers including rural residence, inconsistent referral pathways, and absence of standardised protocols are equally important (Mokhtari-Hessari and Montazeri 2020).

3.7. Role of Multidisciplinary Care

Optimal recovery requires coordinated multidisciplinary care. The substantial gap between the prevalence of physical impairments (66–97%) and the proportion of women receiving rehabilitation (36%) documented by Koehler et al. (Koehler et al. 2018) highlights the urgent need for systematic referral and pathway-based rehabilitation protocols.

Table 2. Rehabilitation considerations according to surgical technique and axillary management.

Surgical Technique	Expected Functional Impact	Key Rehabilitation Considerations	Supporting Evidence
BCS + SLNB	Lower risk of shoulder restriction; AWS prevalence ~43%; lymphoedema risk 5-7%; rapid recovery expected	Early unrestricted ROM generally safe; standard exercise counselling; lower surveillance intensity for lymphoedema	Koehler (Koehler et al. 2018), Redemski (Redemski et al. 2022), Heiman (Heiman et al. 2021)
Mastectomy + ALND	Higher risk of shoulder dysfunction; AWS prevalence ~75-86%; lymphoedema risk substantially elevated; greater pain burden	Graded progression of ROM; compression garment consideration; intensive lymphoedema surveillance; supervised exercise may be preferred initially	Koehler (Koehler et al. 2018), Klein (Klein et al. 2021), Plinsinga (Plinsinga et al. 2026), Redemski (Redemski et al. 2022)
Mastectomy + reconstruction (implant-based)	Deficits in shoulder flexion and abduction strength; pectoralis major involvement limits early loading	Delayed progression of resistance exercise targeting pectoralis; focus on scapular stabilisation; individualised timeline based on surgical healing	Myung (Myung et al. 2018), Xu (Xu et al. 2024)
Any surgery + adjuvant RT	Increased risk of chronic pain, fibrosis and late-onset shoulder restriction; potential exacerbation of lymphoedema risk	Long-term exercise maintenance; ongoing ROM monitoring; attention to soft-tissue extensibility; combined aerobic and resistance programmes	Klein (Klein et al. 2021), Mokhtari-Hessari (Mokhtari-Hessari and Montazeri 2020), Xu (Xu et al. 2024)

4. Discussion

The evidence reviewed supports physical activity as a safe and clinically beneficial component of recovery after breast cancer surgery. The strongest quantitative evidence comes from the meta-analyses of Xu et al. (Xu et al. 2024) and Plinsinga et al. (Plinsinga et al. 2026), which demonstrate consistent improvements in shoulder mobility and upper limb function, and a protective effect against lymphoedema development, respectively. The randomised trials of RESTORE (Anderson et al. 2012) and PhysSURG-B (Heiman et al. 2021) contribute important data on feasibility and safety, though both highlight methodological challenges: RESTORE demonstrated functional gains without HRQoL improvement, while PhysSURG-B showed no significant benefit from unsupervised activity recommendations alone, likely reflecting a ceiling effect and suboptimal adherence.

The timing of exercise initiation deserves emphasis. Xu et al. (Xu et al. 2024) found that interventions started within two weeks of surgery yielded significant functional improvements, while later initiation did not. Redemski et al. (Redemski et al. 2022) added nuance by demonstrating that very early unrestricted mobilisation, while improving ROM, may be associated with short-term wound-related complications in older study populations. In contemporary surgical practice, these concerns appear less relevant, but graded progression remains prudent.

The lymphoedema evidence has evolved substantially. Plinsinga et al. (Plinsinga et al. 2026) now provide Level I evidence that exercise reduces CRL risk (RR 0.71). This represents a paradigm shift from historical activity restriction guidelines. However, it remains good clinical practice to prescribe exercise with attention to symptom monitoring and graded loading, particularly in patients with extensive nodal dissection or adjuvant radiotherapy (Redemski et al. 2022; Klein et al. 2021; Plinsinga et al. 2026).

Several limitations apply to the available evidence and to this review. Exercise protocols are heterogeneous in type, intensity, duration, and supervision. Sample sizes remain modest in many trials. Most data come from high-income settings. This narrative review did not include formal risk-of-bias assessment, and conclusions should be interpreted as a clinically informed synthesis. The gap between efficacy evidence and routine implementation remains substantial and requires attention to referral culture, reimbursement models, and community-based delivery pathways.

5. Practical Implications

Early rehabilitation protocols should be incorporated into breast cancer surgical pathways, with flexibility for differences in surgical technique, axillary management, reconstruction type, and baseline function (Table 2). Prehabilitation should be considered when feasible, as higher preoperative activity levels are consistently associated with more favourable recovery (Klein et al. 2021; Heiman et al. 2021). Patient education should explicitly address outdated fears regarding lymphoedema, explaining the contemporary evidence that structured exercise is not a risk factor for its development and may reduce its incidence (Xu et al. 2024; Plinsinga et al. 2026).

Exercise prescription should be comprehensive, combining shoulder mobility restoration, progressive resistance strengthening of the upper limb and periscapular musculature, and general aerobic conditioning. Xu et al. (Xu et al. 2024) demonstrated that resistance exercise was the most effective single modality, optimal exercise frequency was two to three sessions per week, and the optimal intervention duration was 8–12 weeks. Initiation within two weeks of surgery yielded the most significant improvements in upper limb function (Xu et al. 2024). Access pathways should extend beyond tertiary centres to include community-based supervised programmes where appropriate governance and referral structures exist.

Future pathway development should incorporate measurable quality indicators including time to physiotherapy review, recovery of shoulder ROM at defined milestones, patient-reported function, return to daily activities, and systematic lymphoedema surveillance.

6. Conclusions

Physical activity should be regarded as an integral component of postoperative care after breast cancer surgery. Meta-analytic evidence demonstrates significant improvements in shoulder flexion, abduction, and upper limb function, with high-to-moderate quality of evidence (Xu et al. 2024). Contemporary Level I evidence indicates that exercise reduces the risk of cancer-related lymphoedema (RR 0.71) (Plinsinga et al. 2026), representing a definitive shift from historical activity restriction paradigms. The RESTORE and PhysSURG-B trials confirm the feasibility and safety of perioperative exercise, though they also illustrate the challenges of translating exercise recommendations into measurable HRQoL gains (Anderson et al. 2012; Heiman et al. 2021).

The most defensible recommendation is the routine integration of individualised, evidence-informed, and progressively dosed exercise into multidisciplinary breast cancer care, tailored to surgical technique, axillary management, and individual patient characteristics. Further research should focus on standardising exercise protocols, evaluating long-term outcomes and cost-effectiveness, and ensuring equitable implementation across diverse healthcare settings.

Author's Contribution:

Conceptualization: Filip Bednarek, Olga Plinta, Alicja Hojda

Methodology: Olga Plinta, Alicja Hojda

Software: Filip Bednarek, Olga Plinta

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REFERENCES

1. Arnold, M., Morgan, E., Rumgay, H., et al. (2022). Current and future burden of breast cancer: global statistics for 2020 and 2040. *Breast*, 66, 15–23. <https://doi.org/10.1016/j.breast.2022.08.010>
2. Lei, S., Zheng, R., Zhang, S., et al. (2021). Global patterns of breast cancer incidence and mortality: a population-based cancer registry data analysis from 2000 to 2020. *Cancer Commun (Lond)*, 41(11), 1183–1194. <https://doi.org/10.1002/cac2.12207>
3. Hu, K., Ding, P., Wu, Y., et al. (2019). Global patterns and trends in the breast cancer incidence and mortality according to sociodemographic indices. *BMJ Open*, 9(10), e028461. <https://doi.org/10.1136/bmjopen-2018-028461>
4. Amato, O., Guarneri, V., & Girardi, F. (2023). Epidemiology trends and progress in breast cancer survival: earlier diagnosis, new therapeutics. *Curr Opin Oncol*, 35(6), 612–619. <https://doi.org/10.1097/CCO.0000000000000992>
5. Allemani, C., Matsuda, T., Di Carlo, V., et al. (2018). Global surveillance of trends in cancer survival 2000–14 (CONCORD-3). *Lancet*, 391(10125), 1023–1075. [https://doi.org/10.1016/S0140-6736\(17\)33326-3](https://doi.org/10.1016/S0140-6736(17)33326-3)
6. Mokhtari-Hessari, P., & Montazeri, A. (2020). Health-related quality of life in breast cancer patients: review of reviews from 2008 to 2018. *Health Qual Life Outcomes*, 18, 338. <https://doi.org/10.1186/s12955-020-01591-x>
7. Myung, Y., Choi, Y., Kwon, H., & Heo, C. Y. (2018). Quantitative analysis of shoulder function and strength after breast reconstruction. *Arch Plast Surg*, 45(1), 37–44. <https://doi.org/10.5999/aps.2017.01004>
8. Mohamed, M. H., Radwan, R. E., ElMeligie, M. M., et al. (2025). The impact of lymphedema severity on shoulder joint function and muscle activation patterns in breast cancer survivors. *Support Care Cancer*, 33(1), 37. <https://doi.org/10.1007/s00520-024-09093-0>
9. Koehler, L. A., Hunter, D. W., Blaes, A. H., & Haddad, T. C. (2018). Function, shoulder motion, pain, and lymphedema in breast cancer with and without axillary web syndrome: an 18-month follow-up. *Phys Ther*, 98(6), 518–527. <https://doi.org/10.1093/ptj/pzy010>
10. Gala-Alarcón, P., Prieto-Gómez, V., Bailón-Cerezo, J., et al. (2021). Changes in shoulder outcomes using ultrasonographic assessment of breast cancer survivors. *Sci Rep*, 11, 23016. <https://doi.org/10.1038/s41598-021-02454-7>
11. Rezende, M. S., Rossi, D. M., Ribeiro de Lima, A. M., et al. (2024). Shoulder and scapulothoracic impairments in women with breast cancer-related lymphedema. *J Bodyw Mov Ther*, 37, 177–182. <https://doi.org/10.1016/j.jbmt.2023.11.012>
12. Mafu, T. S., September, A. V., & Shamley, D. (2018). The potential role of angiogenesis in the development of shoulder pain, shoulder dysfunction, and lymphedema after breast cancer treatment. *Cancer Manag Res*, 10, 81–90. <https://doi.org/10.2147/CMAR.S151387>
13. Xu, Q., Liu, C., Jia, S., et al. (2024). Effect of physical exercise on postoperative shoulder mobility and upper limb function in patients with breast cancer: a systematic review and meta-analysis. *Gland Surg*, 13(8), 1494–1510. <https://doi.org/10.21037/gs-24-178>
14. Anderson, R. T., Kimmick, G. G., McCoy, T. P., et al. (2012). A randomized trial of exercise on well-being and function following breast cancer surgery: the RESTORE trial. *J Cancer Surviv*, 6(2), 172–181. <https://doi.org/10.1007/s11764-011-0208-4>
15. Redemski, T., Hamilton, D. G., Schuler, S., et al. (2022). Rehabilitation for women undergoing breast cancer surgery: a systematic review and meta-analysis. *Clin Breast Cancer*, 22(7), 650–665. <https://doi.org/10.1016/j.clbc.2022.06.002>
16. Klein, I., Kalichman, L., Chen, N., & Susmallian, S. (2021). Effect of physical activity levels on oncological breast surgery recovery: a prospective cohort study. *Sci Rep*, 11(1), 10432. <https://doi.org/10.1038/s41598-021-89882-9>
17. Heiman, J., Onerup, A., Wessman, C., et al. (2021). Recovery after breast cancer surgery following recommended pre and postoperative physical activity: (PhysSURG-B) randomized clinical trial. *Br J Surg*, 108(1), 32–39. <https://doi.org/10.1093/bjs/znaa013>
18. Plinsinga, M. L., Baker, B., Spence, R. R., et al. (2026). A systematic review and meta-analysis evaluating the effect of exercise on the development of cancer-related lymphedema. *JNCI Cancer Spectr*, 10(2), pkag013.
19. Mason, C., Alfano, C. M., Wilder Smith, A., et al. (2013). Long-term physical activity trends in breast cancer survivors. *Cancer Epidemiol Biomarkers Prev*, 22(6), 1153–1161. <https://doi.org/10.1158/1055-9965.EPI-13-0141>
20. Zukierski, K., Jarych, W., Michalak, K., et al. (2025). The impact of physical activity on breast cancer prevention. *Quality in Sport*, 41, 60255. <https://doi.org/10.12775/QS.2025.41.60255>
21. Cemaga, R., Hebda, P., Czapliński, M., et al. (2026). The role of physical activity in the prevention and management of various cancers. *J Educ Health Sport*, 88, 68346. <https://doi.org/10.12775/JEHS.2026.88.68346>