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The Role of Physical Exercise During Chemotherapy in Women with Breast Cancer: A Narrative Review

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Abstract

Background. Breast cancer is the most frequently diagnosed malignancy in women worldwide. Advances in oncologic therapy have markedly improved survival, yet chemotherapy and other treatments produce adverse effects such as fatigue, cancer-related cognitive impairment, and reduced quality of life.

Aim. To synthesize recent evidence on the impact of structured exercise interventions on physical fitness, cognitive function, and health-related quality of life (HRQOL) in women undergoing or recovering from breast-cancer treatment.

Methods. A structured literature search of PubMed, PEDro, and Scopus identified English-language studies published in the past ten years that evaluated exercise programs in adult women receiving or having completed chemotherapy. Trials were screened for outcomes related to cardiorespiratory fitness, muscle strength, fatigue, cognition and HRQOL as well as biological mechanisms and limitations.

Results. The majority of randomized controlled trials reported that supervised aerobic, resistance, or combined exercise programs significantly attenuated fatigue and enhanced HRQOL (Ficarra et al., 2022). Meta-analyses confirm a small but reliable improvement in cognitive function across diverse exercise modalities (Hung et al., 2025). Exercise also

produced clinically meaningful gains in cardiorespiratory fitness, muscle strength, and shoulder range of motion, while being safe with few serious adverse events.

Conclusions. Structured, supervised exercise initiated early during chemotherapy is safe and yields consistent benefits in physical fitness, cognition, and HRQOL for women with breast cancer. Standardized protocols and larger, high-quality RCTs are needed to refine dosage guidelines and elucidate underlying molecular mechanisms.

Keywords: breast cancer, exercise oncology, chemotherapy, fatigue, cognitive function, quality of life

1. Introduction

Breast cancer remains a major global health challenge, representing the most frequently diagnosed malignancy in women and accounting for millions of new cases and deaths each year. Survival improvements have shifted clinical emphasis toward long-term health-related quality of life (HRQOL) among survivors. Consequently, the growing population of women living after a breast cancer diagnosis underscores the need for effective management of therapy-induced side effects. Chemotherapy, while life-saving, commonly induces fatigue, reduced physical fitness, cardiotoxicity, and cognitive impairment (Ficarra et al., 2022). Physical exercise has emerged as a promising non-pharmacological strategy. Structured aerobic, resistance, or combined programs consistently attenuate fatigue and enhance HRQOL in patients receiving or completing chemotherapy (Nero et al., 2025; Dong et al., 2024). Meta-analyses of randomized trials report moderate reductions in fatigue (SMD ≈ -0.40) and small but significant improvements in cognitive function ($g \approx 0.22$) (Zhao et al., 2023). Emerging evidence also suggests that exercise may modulate molecular and immunological pathways influencing tumor progression and treatment tolerance (Xue et al., 2025). Given the expanding literature, a comprehensive synthesis of current evidence is warranted to clarify the effects of exercise on physical fitness, cognition, and QoL in women undergoing or recovering from breast-cancer therapy.

2. Methods

A structured literature search was conducted using the PubMed, PEDro, and Scopus databases to identify studies investigating the effects of exercise interventions in women with breast cancer undergoing or having completed chemotherapy. The search included English-language articles published between 2015 and 2025.

Eligible studies included adult female participants diagnosed with breast cancer and evaluated structured exercise interventions (aerobic, resistance, or combined). Outcomes of interest were cardiorespiratory fitness, muscle strength, cancer-related fatigue, cognitive function, and health-related quality of life (HRQOL). Priority was given to randomized controlled trials, systematic reviews, and meta-analyses to ensure high-quality evidence. Studies not focused on exercise interventions or lacking breast cancer-specific data were excluded.

3. Chemotherapy in Breast Cancer: Impact on Quality of Life and Functional Outcomes

Chemotherapy targets rapidly dividing tumor cells but also damages normal tissues, producing a spectrum of adverse effects that impair physical, psychological, and functional health in breast-cancer patients. The most common acute toxicities include nausea, dysgeusia, peripheral neuropathy, loss of appetite, myalgia, and peripheral edema, each contributing to a measurable decline in health-related quality of life (HRQOL) (Prieto-Callejero et al., 2020). Cancer-related fatigue is pervasive, often moderate to severe during treatment, and is accompanied by sleep disturbances, pain, anxiety, and depression, further diminishing daily functioning . Systematic assessments reveal substantial reductions in global health, physical, role, and social functioning during chemotherapy, with patients reporting lower scores across multiple HRQOL domains (Brandberg et al., 2020) . Baseline low physical functioning and high fatigue independently predict higher odds of treatment-related adverse events, underscoring the importance of pre-treatment functional status (Licaj et al., 2023). Specific regimens are associated with greater symptom bother and prolonged HRQOL impairment up to two years post-therapy (Henry et al., 2022). Additionally, chemotherapy-induced cognitive dysfunction affects processing speed, attention, and memory, with incomplete recovery observed weeks after treatment completion (Rodríguez Martin et al., 2020). Collectively, these side effects highlight the need for supportive interventions to mitigate toxicity and preserve quality of life during and after chemotherapy.

4. Biological Mechanisms Underlying the Effects of Exercise During Chemotherapy in Breast Cancer Patients

4.1. Hormonal Modulation

Physical exercise can alter the endocrine milieu that drives breast-cancer growth, especially the circulating sex-steroid hormones that act as ligands for estrogen- and progesterone-receptor pathways. Aerobic and resistance training have been shown to lower circulating estradiol and increase sex-hormone-binding globulin (SHBG), thereby reducing the bioavailable fraction of estrogen that can stimulate tumor cells. Simultaneously, exercise-induced reductions in adiposity diminish aromatase activity in adipose tissue, further decreasing peripheral estrogen synthesis. Progesterone levels may also decline with regular moderate-intensity activity, although the evidence is less consistent; the net effect is a shift toward a less proliferative hormonal environment. In contrast, androgen concentrations (testosterone and dehydroepiandrosterone-sulfate) often rise modestly after exercise, and the increased androgen-to-estrogen ratio can antagonize estrogen-driven signaling pathways. Mechanistically, exercise activates hypothalamic-pituitary-adrenal (HPA) axis stress responses that transiently increase cortisol, which in turn suppresses gonadotropin-releasing hormone (GnRH) and downstream ovarian steroidogenesis. Chronic adaptations, such as improved insulin sensitivity and reduced inflammatory cytokines (IL-6, TNF-α), also dampen estrogen production by limiting insulin-like growth factor-1 (IGF-1) signaling. Clinically, these hormonal shifts translate into lower recurrence risk and improved disease-free survival in hormone-receptor-positive breast-cancer patients who engage in structured exercise programs during and after treatment (Rocha-Rodrigues et al., 2021).

4.2. Immune System Activation

Exercise performed during chemotherapy activates several arms of the immune system in breast-cancer patients. Acute bouts of moderate-intensity activity increase total leukocyte counts and specifically raise circulating $CD56^{+}CD16^{+}$ natural-killer (NK) cells and $CD8^{+}$ cytotoxic T-cells, with these elevations returning to baseline within 30 min post-exercise (Koivula et al., 2024). In supervised 12-week endurance or resistance programs, overall immune-cell numbers ($CD3^{+}$ T cells, NK cells, B cells) still decline because of chemotherapy, but the reduction in NK-cell degranulation is prevented; the exercise group shows preserved $CD107a^{+}$ NK cells compared with a control decline (Toffoli et al., 2021). A pilot study of a six-week aerobic-resistance regimen demonstrated that participants had significantly higher NK-cell CD107a expression after co-culture with K562 tumour cells ($\beta = 1038.5$, $p = 0.04$) and

a trend toward increased tumour-cell lysis, indicating enhanced NK-cell cytotoxic function (Ubink et al., 2025). Eight weeks of combined training also increased the proportion of regulatory NK cells and lowered the $CD4^+/CD8^+$ ratio, reflecting a shift toward a more anti-tumour immune profile (Echarri et al., 2023). Collectively, these findings suggest that exercise during chemotherapy bolsters innate and adaptive cytotoxic effectors, mitigates chemotherapy-induced immunosuppression, and may improve clinical outcomes.

4.3. Anti-Inflammatory Effects

Exercise performed concurrently with chemotherapy can dampen the inflammatory milieu that fuels tumour progression and treatment-related toxicity in breast-cancer patients. Systematic reviews of randomized trials report that aerobic, resistance, or combined programmes lower circulating interleukin-1β, interleukin-6, interleukin-8, interleukin-10, tumour-necrosis-factor-α (TNF-α) and C-reactive protein (CRP) levels compared with usual care. A meta-analysis of 22 studies ($n \approx 968$) confirmed a modest but significant reduction in these biomarkers after structured exercise (Bettariga et al., 2025). Acute bouts of moderate-intensity exercise (≈ 60 % VO_2max, 45 min) increase the anti-inflammatory cytokine IL-6 transiently while producing non-significant declines in CRP, suggesting a shift toward a regulatory response (Duggan et al., 2025). Exercise also modulates cellular immunity: trials show decreased serum IL-15, macrophage-migration-inhibitory factor, and reduced TNF-α expression in NK and NKT cells, together lowering the IL-10/TNF-α ratio, which may improve immune surveillance (Khalfoun et al., 2025). Mechanistically, physical activity attenuates systemic IL-6 and TNF-α production, restores muscle-derived myokine balance, and mitigates chemotherapy-induced oxidative stress, collectively curbing chronic inflammation (Rusu et al., 2025). These anti-inflammatory effects contribute to better treatment tolerance, fewer dose delays, and potentially lower recurrence risk when exercise is integrated into neoadjuvant or adjuvant chemotherapy regimens.

4.4. Metabolic Reprogramming

Exercise performed alongside chemotherapy can reshape the metabolic milieu of women with breast cancer, but the magnitude of re-programming depends on the exercise protocol and duration. An acute-exercise study in healthy women—many of whom were of breast-cancer-relevant age—demonstrated rapid, sizable shifts in metabolic and inflammatory markers after a single 45-minute bout at 60 % VO_2max, including a + 17 % rise in MCP-1, a + 103 % increase in IL-6, and elevated glucose (+ 8.8 %) and insulin (+ 82 %) levels within

45 minutes (Duggan et al., 2025). These short-term responses suggest that exercise can transiently drive carbohydrate utilization and inflammatory signaling, pathways that are also implicated in tumour metabolism. A high-intensity interval training (HIIT) program conducted during chemotherapy improved cancer-related fatigue, quality of life, and muscle strength, yet the study did not report metabolomic outcomes, leaving the underlying metabolic shifts speculative (Mijwel et al., 2019). Collectively, the evidence indicates that while single bouts of moderate-intensity exercise provoke immediate metabolic re-wiring—enhancing glucose uptake and cytokine release—sustained aerobic programs during chemotherapy may produce subtler, possibly tissue-specific changes that are not captured by peripheral metabolite profiling.

4.5. Cardiovascular Protection

Anthracycline-based chemotherapy is well known for inducing cardiotoxicity, yet regular exercise can attenuate this risk by enhancing cardiac performance and lowering cardiovascular complications in breast-cancer patients (Chiang et al., 2023). Designing isocaloric training programs that differentiate between aerobic, resistance, or combined modalities—and pairing them with appropriate nutritional support—helps optimize peak oxygen uptake (VO_2peak) and its determinants (heart rate, stroke volume, arteriovenous oxygen extraction), thereby improving overall quality of life (Li et al., 2024) . Physical activity performed before, during, or after treatment also appears to raise cardiac tolerance to toxic agents, yielding favorable changes in subclinical and clinical cardiac metrics. At the molecular level, exercise up-regulates stress-response proteins, boosts antioxidant defenses (e.g., superoxide dismutase and glutathione), reduces lipid peroxidation, and shifts the Bax/Bcl-2 ratio toward cell survival. Additionally, exercise helps preserve the normal distribution of myosin heavy-chain isoforms, further supporting myocardial integrity (Tranchita et al., 2022). Given that cardiovascular disease has emerged as the leading cause of mortality among long-term breast-cancer survivors, incorporating tailored exercise regimens into standard oncology care is increasingly recognized as a vital strategy for mitigating treatment-related heart damage.

5. Integrative Benefits of Structured Exercise

Chemotherapy commonly produces fatigue, anorexia, anemia, neutropenia, thrombocytopenia, peripheral neuropathy and, in some regimens, cardiotoxicity, while hormone therapy can cause weight gain, arthralgia, myalgia, bone loss, adverse lipid changes and cardiovascular effects. Radiation adds risks of cardiac-pulmonary injury, lymphedema, brachial-plexus neuropathy and secondary malignancies. These physical burdens are frequently accompanied by emotional

sequelae—depression, anxiety, diminished self-esteem and altered body image—particularly in breast-cancer patients where issues of femininity, sexuality and maternity are salient. Physical activity is safe across the cancer-treatment continuum and consistently improves quality of life, global functional capacity and psychological wellbeing. A 6-week supervised multimodal exercise program produced clinically meaningful gains in fatigue, global quality of life, functional capacity and muscle strength versus usual care in patients undergoing active treatment (Cano-Uceda et al., 2025). Narrative and systematic reviews confirm that exercise—whether walking, cycling, resistance training or yoga—mitigates a wide range of treatment-related toxicities, reduces cancer-related fatigue and should be initiated as early as possible, continuing as a lifelong habit (Kleckner et al., 2017). Moreover, exercise lowers anxiety and depression scores, with trials showing significantly better psychological outcomes in exercise groups compared with controls. Pain, reported by 30-60 % of breast-cancer patients, also diminishes with regular training, leading to greater strength, cardiorespiratory fitness and flexibility, and to shorter hospital stays, improved sleep and reduced nausea/vomiting (Kleckner et al., 2017). Collectively, these data support incorporating structured exercise into standard oncologic care to counteract both the somatic and emotional sequelae of cancer therapy.

6. Individualized Exercise Approaches for Breast Cancer Patients During and After Treatment

There is no single universally applicable exercise program for women with breast cancer, as patients differ substantially in age, disease stage, comorbidities, treatment regimens, physical capacity, and prior activity levels. Consequently, exercise prescriptions should be highly individualized, taking into account baseline fitness, current treatment phase, symptom burden, and patient preferences (Lahart et al., 2018).

A wide spectrum of exercise modalities has been evaluated, including aerobic activities (e.g., walking and cycling), resistance training, and mind–body approaches such as Pilates, Tai Chi, and yoga. These interventions may be implemented in supervised clinical or group-based settings, as well as through structured home-based programs, depending on patient needs, accessibility, and available resources (Nero et al., 2025). Resistance training has emerged as a particularly important component of exercise interventions due to its ability to counteract treatment-induced muscle loss and reduce cancer-related fatigue. Evidence from randomized controlled trials and meta-analyses demonstrates that combined aerobic–resistance programs are not only safe but also more effective than aerobic exercise alone, particularly for improving muscle strength and reducing fatigue (Cano-Uceda et al., 2025; Zhao et al., 2023). In addition

to conventional exercise modalities, mind–body interventions have also been associated with beneficial outcomes. Pilates has been associated with improvements in muscular strength, flexibility, fatigue, and overall quality of life, while Tai Chi has demonstrated positive effects on fatigue, body composition, cognitive function, and psychological well-being. Similarly, yoga interventions have been shown to improve both physical functioning and emotional health outcomes (Dong et al., 2024). Current international physical activity guidelines recommend that cancer survivors engage in at least 150 minutes of moderate-intensity physical activity per week, complemented by resistance training performed at least twice weekly. Exercise intensity may be prescribed using objective methods such as heart rate reserve or metabolic equivalents, as well as subjective measures including the Borg Rating of Perceived Exertion scale (Lahart et al., 2018). Importantly, the selection of exercise modalities should prioritize patient preference and enjoyment—such as Pilates, Tai Chi, yoga, Nordic walking, or dance—as these factors are associated with improved long-term adherence. Exercise intensity and progression should be carefully adjusted to the individual to optimize both safety and therapeutic outcomes. Furthermore, multidisciplinary collaboration among oncologists, physiotherapists, and exercise specialists is essential to ensure safe, effective, and sustainable implementation of exercise interventions within routine oncologic care (Li et al., 2024).

7. Exercise Prescription for Women Undergoing Chemotherapy

A structured and individualized exercise prescription is critical to maximize the therapeutic benefits of physical activity while ensuring patient safety during chemotherapy. The FITT principle—Frequency, Intensity, Time, and Type—offers a practical, evidence-based framework for tailoring exercise interventions to individual patient characteristics and clinical status (Li et al., 2024).

Frequency: Patients are generally advised to engage in physical activity 3–5 times per week, with aerobic exercise performed on most days and resistance training incorporated 2–3 times weekly. Adequate recovery—typically at least 48 hours between resistance sessions targeting the same muscle groups—is recommended to prevent overtraining and support adaptation (Lahart et al., 2018).

Intensity: Exercise should typically be performed at moderate intensity, corresponding to approximately 50–70% of maximal heart rate (HRmax) or 40–60% of heart rate reserve (HRR). Intensity may also be monitored using the Borg Rating of Perceived Exertion scale, targeting a range of 12–14. In selected patients with sufficient baseline fitness and appropriate medical clearance, short intervals of higher-intensity exercise may be introduced cautiously.

Importantly, intensity should be adjusted dynamically in response to treatment-related symptoms such as fatigue, anemia, or acute toxicity (Lahart et al., 2018; Li et al., 2024).

Time (Duration): A total of 90–150 minutes per week of moderate-intensity aerobic activity is recommended, ideally distributed across sessions lasting 20–45 minutes. For patients with reduced functional capacity, shorter bouts (e.g., 10–15 minutes) performed multiple times per day may improve feasibility and adherence. Resistance training should include 1–3 sets of 8–15 repetitions for major muscle groups, with gradual progression based on individual tolerance and clinical status (Kleckner et al., 2017; Lahart et al., 2018).

8. Contraindications and Safety Considerations

Exercise during chemotherapy is generally safe, yet several clinical conditions demand pre-screening and tailored programming. Women with unstable cardiovascular disease—recent myocardial infarction, uncontrolled hypertension (>170/100 mm Hg), severe arrhythmia, or unstable angina—should obtain cardio-oncology clearance before initiating activity because exertion can exacerbate cardiac stress and precipitate events (Li et al., 2024). Severe anemia (hemoglobin < 8 g/dL) limits oxygen delivery and may cause dizziness or syncope; aerobic intensity should be reduced until hemoglobin improves (Lahart et al 2018). Hematologic thresholds are critical: platelet counts $<20 \times 10^3/\mu L$ typically preclude resistance training, while counts $20–50 \times 10^3/\mu L$ allow only light-impact activities such as walking; platelets $<10 \times 10^3/\mu L$ require complete exercise restriction, and neutrophil counts $<1.0 \times 10^3/\mu L$ should delay sessions until immune recovery (Li et al 2024). Bone metastases or marked skeletal fragility contraindicate high-impact or heavy-load resistance work because of fracture risk; low-impact aerobic or resistance-band exercises are preferred after imaging assessment (Amin et al., 2024). Recent major surgery (< 6 weeks) and pronounced peripheral neuropathy also necessitate a gradual, supervised re-introduction of activity, emphasizing gentle range-of-motion and balance training to avoid tissue strain or falls (Górecki et al., 2025). Continuous symptom monitoring—heart rate, blood pressure, Borg perceived exertion (12–14), pain, dyspnea, and fatigue—should occur before, during, and after each session; any alarming signs (e.g., chest pain, severe dyspnea, uncontrolled hypertension) require immediate cessation and medical evaluation (Lahart et al 2018). Implementing a standardized pre-participation questionnaire, at least one supervised weekly session, and progression increments ≤ 10 % per week ensures individualized safety while preserving the documented benefits of exercise on fatigue, quality of life, and treatment tolerance.

9. Limitations of the Review

Despite the growing body of evidence supporting the benefits of exercise in breast cancer patients undergoing chemotherapy, several limitations should be acknowledged. First, there is substantial heterogeneity among studies in terms of exercise type, intensity, frequency, and duration, which complicates direct comparisons and limits the ability to define an optimal exercise prescription. Second, many studies include relatively small sample sizes, reducing statistical power and generalizability of findings.

Additionally, variability in patient characteristics—such as age, cancer stage, treatment regimens, and baseline physical fitness—further contributes to inconsistent outcomes across trials. Adherence to exercise interventions is also inconsistently reported and may influence the observed effectiveness.

Another important limitation is the relatively short follow-up period in most studies, which restricts conclusions regarding long-term outcomes, including survival, recurrence risk, and sustained quality of life improvements. Furthermore, while mechanistic studies suggest beneficial effects on immune, hormonal, and inflammatory pathways, these findings are not yet fully translated into clinically meaningful oncological endpoints. These limitations highlight the need for large-scale, well-designed randomized controlled trials with standardized protocols and long-term follow-up.

10. Conclusion

Evidence from recent randomized trials, systematic reviews, and meta-analyses consistently demonstrates that structured exercise programs—whether aerobic, resistance, or combined—provide substantive benefits for women undergoing chemotherapy for breast cancer. Exercise markedly improves cardiorespiratory fitness and muscular strength, thereby counteracting treatment-induced deconditioning. It also produces clinically meaningful reductions in cancer-related fatigue and mitigates chemotherapy-associated cognitive decline, enhancing patients' ability to engage in daily activities and adhere to treatment schedules. Improvements in health-related quality of life, encompassing physical, emotional, and social domains, are repeatedly reported, suggesting that exercise serves as a potent psychosocial support during a period of heightened vulnerability. Emerging data indicate that regular physical activity may favorably influence survival and disease-free intervals, likely through modulation of inflammatory, immune, and metabolic pathways implicated in tumor progression and treatment tolerance. Collectively, these findings support the integration of supervised, individualized exercise prescriptions into standard oncologic care for breast-cancer patients receiving

chemotherapy. Future research should aim to identify optimal exercise dose, timing, and modality, and to elucidate the mechanistic underpinnings of its oncological benefits, thereby refining guidelines for routine clinical implementation.

Disclosure

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Declaration of the Use of Generative Artificial Intelligence and AI-Assisted Technologies in the Writing Process

During the preparation of this manuscript, the authors used Jenn AI to support literature synthesis, structure the manuscript, and assist in drafting the initial text. All generated content was then reviewed and revised by the authors, who remain fully responsible for the final version and its scientific content.

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