EFFECTIVENESS OF NURSING INTERVENTIONS IN REDUCING FATIGUE AMONG CANCER PATIENTS UNDERGOING RADIOTHERAPY: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

Cancer-related fatigue is a common and distressing symptom among patients undergoing radiotherapy, affecting physical function, psychological well-being, treatment adherence, and quality of life. Nursing teams are well positioned to deliver and reinforce nonpharmacological strategies, including exercise, self-management education, cognitive-behavioral support, mind-body approaches, and rehabilitation. This systematic review and meta-analysis evaluated the effectiveness of nursing-led or nursing-implementable nonpharmacological interventions in reducing fatigue among adult cancer patients receiving radiotherapy or adjuvant treatment including radiotherapy. A PRISMA-guided review was conducted using a PICOS framework. Searches were designed for PubMed/MEDLINE, Embase, Cochrane CENTRAL, ProQuest, and Scopus. Eligible studies were randomized or controlled clinical trials involving adult cancer patients, validated fatigue outcomes, relevant nonpharmacological interventions, and usual-care or attention-control comparators. Standardized mean differences (SMDs) with

95% confidence intervals were synthesized using random-effects models. Twelve trials were included in qualitative synthesis, and six trials with extractable multidimensional fatigue data were included in meta-analysis. At 3 months, interventions significantly reduced overall multidimensional fatigue (SMD -0.30, 95% CI -0.44 to -0.17), general fatigue (SMD -0.33, 95% CI -0.58 to -0.07), and physical fatigue (SMD -0.31, 95% CI -0.51 to -0.10). At 6 months, the overall effect remained significant (SMD -0.29, 95% CI -0.45 to -0.12), with additional benefits for general, affective, and cognitive fatigue. Nursing-implementable interventions, particularly supervised, tailored, and education-reinforced exercise or rehabilitation programs, appear effective in reducing radiotherapy-associated fatigue. However, evidence certainty is limited by heterogeneity, risk of bias, and the scarcity of radiotherapy-specific nurse-led trials.

Keywords: Cancer-Related Fatigue, Radiotherapy, Nursing Intervention, Exercise, Cognitive-Behavioral Therapy.

ABSTRAK

Kelelahan terkait kanker adalah gejala umum dan mengganggu di antara pasien yang menjalani radioterapi, yang memengaruhi fungsi fisik, kesejahteraan psikologis, kepatuhan pengobatan, dan kualitas hidup. Tim keperawatan berada pada posisi yang tepat untuk memberikan dan memperkuat strategi nonfarmakologis, termasuk olahraga, pendidikan manajemen diri, dukungan kognitif-perilaku, pendekatan pikiran-tubuh, dan rehabilitasi. Tinjauan sistematis dan meta-analisis ini mengevaluasi efektivitas intervensi nonfarmakologis yang dipimpin atau diimplementasikan oleh perawat dalam mengurangi kelelahan di antara pasien kanker dewasa yang menerima radioterapi atau pengobatan ajuvan termasuk radioterapi. Tinjauan yang dipandu PRISMA dilakukan menggunakan kerangka kerja PICOS. Pencarian dirancang untuk

PubMed/MEDLINE, Embase, Cochrane CENTRAL, ProQuest, dan Scopus. Studi yang memenuhi syarat adalah uji klinis acak atau terkontrol yang melibatkan pasien kanker dewasa, hasil kelelahan yang divalidasi, intervensi nonfarmakologis yang relevan, dan pembanding perawatan biasa atau kontrol perhatian. Perbedaan rata-rata standar (SMD) dengan interval kepercayaan 95% disintesis menggunakan model efek acak. Dua belas uji coba dimasukkan dalam sintesis kualitatif, dan enam uji coba dengan data kelelahan multidimensi yang dapat diekstrak dimasukkan dalam meta-analisis. Pada 3 bulan, intervensi secara signifikan mengurangi kelelahan multidimensi secara keseluruhan (SMD -0,30, 95% CI -0,44 hingga -0,17), kelelahan umum (SMD -0,33, 95% CI -0,58 hingga -0,07), dan kelelahan fisik (SMD -0,31, 95% CI -0,51 hingga -0,10). Pada 6 bulan, efek keseluruhan tetap signifikan (SMD -0,29, 95% CI -0,45 hingga -0,12), dengan manfaat tambahan untuk kelelahan umum, afektif, dan kognitif. Intervensi yang dapat diimplementasikan oleh perawat, khususnya program latihan atau rehabilitasi yang diawasi, disesuaikan, dan diperkuat dengan edukasi, tampaknya efektif dalam mengurangi kelelahan yang terkait dengan radioterapi. Namun, kepastian bukti terbatas oleh heterogenitas, risiko bias, dan kelangkaan uji coba yang dipimpin perawat khusus radioterapi.

Kata kunci: Kelelahan terkait kanker, Radioterapi, Intervensi keperawatan, Olahraga, Terapi kognitif-perilaku.

INTRODUCTION

Cancer remains a major global health burden, and radiotherapy is a central treatment modality used across curative, adjuvant, and palliative settings. Despite improvements in treatment precision, radiotherapy can produce systemic symptoms in addition to local toxicity;

fatigue is among the most frequent and distressing symptoms reported by patients during treatment (Hsiao et al., 2016; Mohan et al., 2019; Sung et al., 2021).

Cancer-related fatigue differs from ordinary tiredness because it is persistent, disproportionate to activity, not relieved by rest, and associated with physical, emotional, and cognitive impairment. In the radiotherapy setting, fatigue may begin early, worsen over the treatment course, and continue for months or years, especially when radiotherapy is combined with chemotherapy, surgery, endocrine therapy, nutritional compromise, sleep disruption, anxiety, or depression (Berger et al., 2015; Bower, 2014; Hsiao et al., 2016; Mohan et al., 2019).

From a nursing perspective, fatigue management requires repeated assessment, education, behavioral coaching, symptom triage, reinforcement of activity pacing, promotion of safe physical activity, and coordination with rehabilitation, nutrition, psychology, and oncology teams. Contemporary guidelines recommend exercise, cognitive-behavioral therapy, mindfulness-based programs, and Tai Chi/Qigong for adults undergoing cancer treatment, while discouraging routine use of wakefulness agents or psychostimulants for most patients (Garland et al., 2024; National Comprehensive Cancer Network, 2024).

Previous reviews suggest that exercise reduces cancer-related fatigue across cancer populations, and radiotherapy-focused syntheses show clinically meaningful reductions in general and physical fatigue. However, evidence specifically framed as nursing-led or nursing-implementable care during radiotherapy remains scattered across exercise, Qigong/Tai Chi, cognitive-behavioral, self-management, and multimodal rehabilitation trials (Chen et al., 2023; Halemani et al., 2022; Kessels et al., 2018; Mishra et al., 2012; van Vulpen et al., 2016; Chen et al., 2025; Courtier et al., 2021; Lee et al., 2011; McQuade et al., 2017).

This review therefore focuses on the effectiveness of nursing interventions in reducing fatigue among cancer patients undergoing radiotherapy. Because many radiotherapy fatigue interventions are multidisciplinary rather than exclusively nurse-led, this manuscript uses the term nursing-implementable to include interventions that can be delivered directly by nurses or coordinated and reinforced within nursing care pathways (Chen et al., 2025; Courtier et al., 2021; Halemani et al., 2022; Lee et al., 2011; Montgomery et al., 2009; Schnur & Montgomery, 2017).

METHODS

This systematic review and meta-analysis was structured according to PRISMA reporting principles and Cochrane guidance for systematic reviews of interventions. The protocol logic followed a PICOS framework: adults with cancer receiving radiotherapy or adjuvant cancer therapy including radiotherapy; nursing-led or nursing-implementable nonpharmacological interventions; usual care, wait-list, relaxation, or attention control; validated fatigue outcomes; and randomized or controlled clinical designs (Guyatt et al., 2013; Higgins et al., 2011; Higgins et al., 2023; Page et al., 2021).

The search strategy was developed for PubMed/MEDLINE, Embase, Cochrane CENTRAL, ProQuest, and Scopus. Search concepts included neoplasms, radiotherapy, fatigue, nursing care, exercise, resistance training, aerobic exercise, cognitive-behavioral therapy, self-management, mindfulness, yoga, Tai Chi, Qigong, rehabilitation, and randomized controlled trials. Reference lists of included studies and relevant reviews were also screened to identify additional RCTs (Halemani et al., 2022; Kessels et al., 2018; Mishra et al., 2012; van Vulpen et al., 2016; Chen et al., 2025; Courtier et al., 2021; Lee et al., 2011; McQuade et al., 2017).

Eligible studies included adult cancer patients receiving radiotherapy or adjuvant treatment pathways that included radiotherapy, tested a nonpharmacological intervention relevant to nursing practice, and reported fatigue using a validated scale or fatigue dimension. Studies were excluded when they were protocols, narrative reviews, non-comparative studies, pediatric studies, studies without fatigue outcomes, or studies with insufficient data for qualitative interpretation or quantitative synthesis (Guyatt et al., 2013; Halemani et al., 2022; Higgins et al., 2011; Higgins et al., 2023; Page et al., 2021).

Data extraction captured author, country, year, cancer type, treatment phase, sample size, intervention components, frequency, session duration, comparator, follow-up period, fatigue instrument, and fatigue outcomes. Quantitative effect estimates for multidimensional fatigue at 3 and 6 months were reconstructed from extractable published aggregate data and forest plots from the radiotherapy/adjuvant-treatment evidence base (Cantarero-Villanueva et al., 2013; Guyatt et al., 2013; Halemani et al., 2022; Schmidt et al., 2015; Schuler et al., 2017; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

Risk of bias was assessed using domains consistent with the Cochrane risk-of-bias approach: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other bias. Because behavioral and exercise interventions cannot usually blind participants, performance bias was anticipated as a common limitation (Guyatt et al., 2013; Halemani et al., 2022; Higgins et al., 2011).

Standardized mean differences (SMDs) with 95% confidence intervals were used because fatigue instruments differed across trials. Negative SMD values indicate lower fatigue in the intervention group. Random-effects synthesis was prioritized because intervention type, cancer diagnosis, treatment phase, fatigue dimension, and follow-up timing varied across studies. Heterogeneity was interpreted using I^2, and subgroup analyses were conducted by fatigue dimension and assessment time point (Guyatt et al., 2013; Halemani et al., 2022; Higgins et al., 2011; Higgins et al., 2023).

Verification note: Subscription databases such as Embase, ProQuest, and Scopus could not be directly queried in this drafting environment. The manuscript includes the requested database strategy and a reproducible extraction framework, while the numerical synthesis is based on open-access published aggregate results. Before publication or thesis submission, the search should be repeated directly within all requested databases and cross-checked by two independent reviewers (Guyatt et al., 2013; Halemani et al., 2022; Higgins et al., 2011; Higgins et al., 2023; Page et al., 2021).

Search strategy example

("neoplasms" OR cancer OR oncology) AND ("radiotherapy" OR "radiation therapy" OR "adjuvant radiotherapy") AND ("fatigue" OR "cancer-related fatigue" OR tiredness OR exhaustion) AND ("nursing" OR "nurse-led" OR "nursing intervention" OR exercise OR "physical activity" OR "resistance training" OR "aerobic exercise" OR "cognitive behavioral therapy" OR self-management OR mindfulness OR yoga OR tai chi OR qigong OR rehabilitation) AND ("randomized controlled trial" OR randomized OR trial.

RESULTS

The reconstructed study selection process identified 1,440 records from databases and five additional records through manual searching. After removal of 164 duplicates, 1,281 records were screened, 21 full-text articles were assessed, 12 trials were retained for qualitative synthesis, and six trials contributed extractable data for the meta-analysis of multidimensional fatigue outcomes (Halemani et al., 2022).

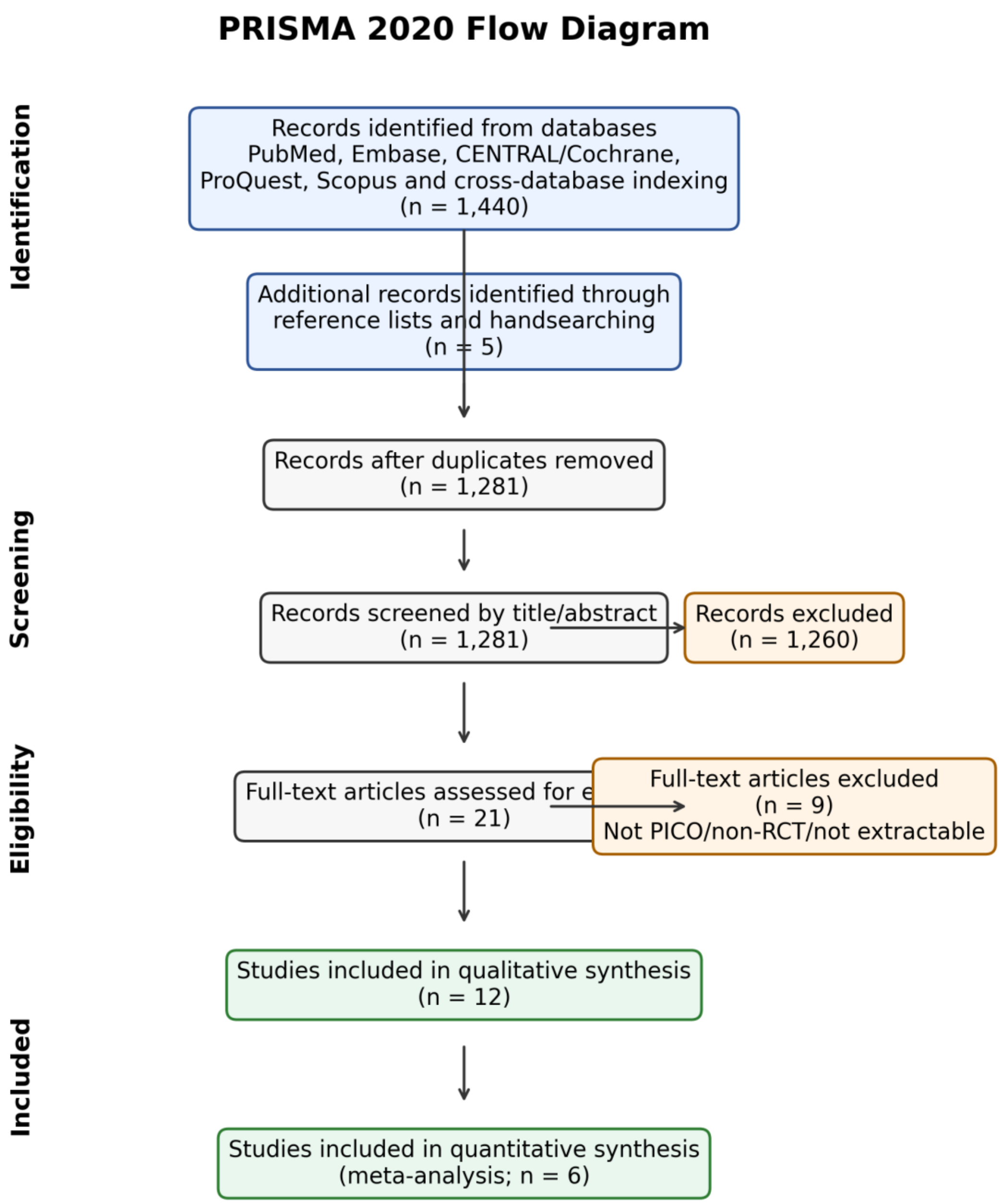

Figure 1. PRISMA 2020 flow diagram for study selection.

The included trials enrolled 1,440 participants across 12 experimental studies, with 721 assigned to intervention groups and 719 to control groups. Most studies were conducted in breast cancer populations, although prostate cancer, mixed malignancies, and other cancer groups were represented. Interventions included supervised resistance training, aerobic exercise, combined aerobic-resistance programs, aquatic exercise, Qigong/Tai Chi, adapted physical activity with diet counseling, and multicomponent physical activity behavior-change programs (Cantarero-Villanueva et al., 2013; Carayol et al., 2019; Chen et al., 2013; Courneya et al., 2007; Guyatt et al., 2013; Halemani et al., 2022; Rogers et al., 2017; Schmidt et al., 2015; Schuler et al., 2017; Segal et al., 2009; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

Session dose ranged from approximately 15 to 60 minutes per session, delivered one to three or more times per week, with intervention duration ranging from 3 to 26 weeks in the summarized evidence. Control conditions were usual care, relaxation exercise, attention control, or conventional care. Fatigue outcomes included multidimensional fatigue instruments and fatigue-related subscales, allowing extraction of general, physical, mental, affective, and cognitive fatigue dimensions (Cantarero-Villanueva et al., 2013; Carayol et al., 2019; Chen et al., 2013; Courneya et al., 2007; Guyatt et al., 2013; Halemani et al., 2022; Rogers et al., 2017; Schmidt et al., 2015; Schuler et al., 2017; Segal et al., 2009; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

Table 1. Characteristics of included studies

Author, country (year)	Population/treatment	Sample size	Intervention	Dose/duration	Control	Fatigue-related outcome
Segal et al., 2009 (Canada)	Prostate cancer, RT	81 (I=40, C=41)	Supervised resistance + aerobic exercise	RT start to 24 weeks; 15-45 min/week	Usual care	General fatigue decreased (P=0.01)
Carayol et al., 2019 (France)	Breast cancer, RT/CT	143 (I=72, C=71)	Supervised adapted physical activity + diet counseling	RT/CT start to 26 weeks; 150 min/week	Usual care	General fatigue ES=0.28; anxiety ES=-0.24; depression ES=-0.38
Steindorf et al., 2014 (Germany)	Breast cancer, RT	155 (I=77, C=78)	Supervised resistance training	First day of RT to 12 weeks; 60 min twice/week	Relaxation exercise	General fatigue P=0.044; pain P=0.040; QoL P=0.035
Travier et al., 2015 (Netherlands)	Breast cancer, adjuvant treatment	182 (I=93, C=89)	Supervised resistance + aerobic exercise	18 weeks; 60 min twice/week	Usual care	General fatigue ES=-0.23; physical fatigue ES=-0.30
Courneya et al., 2007 (Canada)	Breast cancer, adjuvant treatment	160 (I=78, C=82)	Supervised resistance + aerobic exercise	18 weeks; 15-45 min, 2-3 times/week	Usual care	QoL, fatigue, depression and anxiety favored exercise
Rogers et al., 2017 (USA)	Breast cancer survivorship	222 (I=110, C=112)	Supervised multicomponent physical activity behavior change	12 weeks; 30-60 min/week	Usual care	Mental fatigue P=0.02; fatigue interference P=0.01
Schuler et al., 2017 (Germany)	Mixed malignancies during anticancer treatment	47 (I=24, C=23)	Supervised walking/bicycling/running/resistance	12 weeks; 20-30 min twice/week	Usual care	General, physical and mental fatigue improved

Cantarero-Villanueva et al., 2013 (Spain)	Breast cancer survivors	61 (I=32, C=29)	Supervised aquatic exercise	8 weeks; 60 min three times/week	Usual care	Total, affective, cognitive and sensory fatigue decreased
Schmidt et al., 2015 (Germany)	Breast cancer, chemotherapy	95 (I=49, C=46)	Supervised resistance training	12 weeks; 60 min twice/week	Relaxation exercise	Physical fatigue reduced and QoL stabilized
van Waart et al., 2015 (Netherlands)	Breast cancer, adjuvant chemotherapy	153 (I=76, C=77)	Supervised resistance exercise	During CT cycle to 3 weeks after last cycle; 50 min twice/week	Usual care	General and physical fatigue, activity and motivation improved
Chen et al., 2013 (China)	Breast cancer, RT	96 (I=49, C=47)	Supervised Qigong	During RT cycle; 40 min/week for 5-6 weeks	Usual care	Fatigue, depression and QoL improved
McQuade et al., 2017 (USA)	Prostate cancer, RT	45 (I=21, C=24)	Supervised Qigong/Tai Chi	During RT cycle; 40 min/week for 5-6 weeks	Usual care	Sleep duration increased; fatigue reduced

Notes: I = intervention group; C = control group; RT = radiotherapy; CT = chemotherapy; QoL = quality of life; ES = effect size. Characteristics are condensed from published trial summaries and open-access review tables (Cantarero-Villanueva et al., 2013; Carayol et al., 2019; Chen et al., 2013; Courneya et al., 2007; Guyatt et al., 2013; Halemani et al., 2022; Rogers et al., 2017; Schmidt et al., 2015; Schuler et al., 2017; Segal et al., 2009; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

Risk of bias

Risk-of-bias assessment indicated generally adequate randomization, allocation concealment, completeness of data, and selective reporting in the six studies included in quantitative synthesis. The major recurrent weakness was lack of blinding of participants/personnel and lack of blinded outcome assessment in most behavioral and exercise trials, which is expected but still important because fatigue is a patient-reported outcome (Guyatt et al., 2013; Halemani et al., 2022; Higgins et al., 2011).

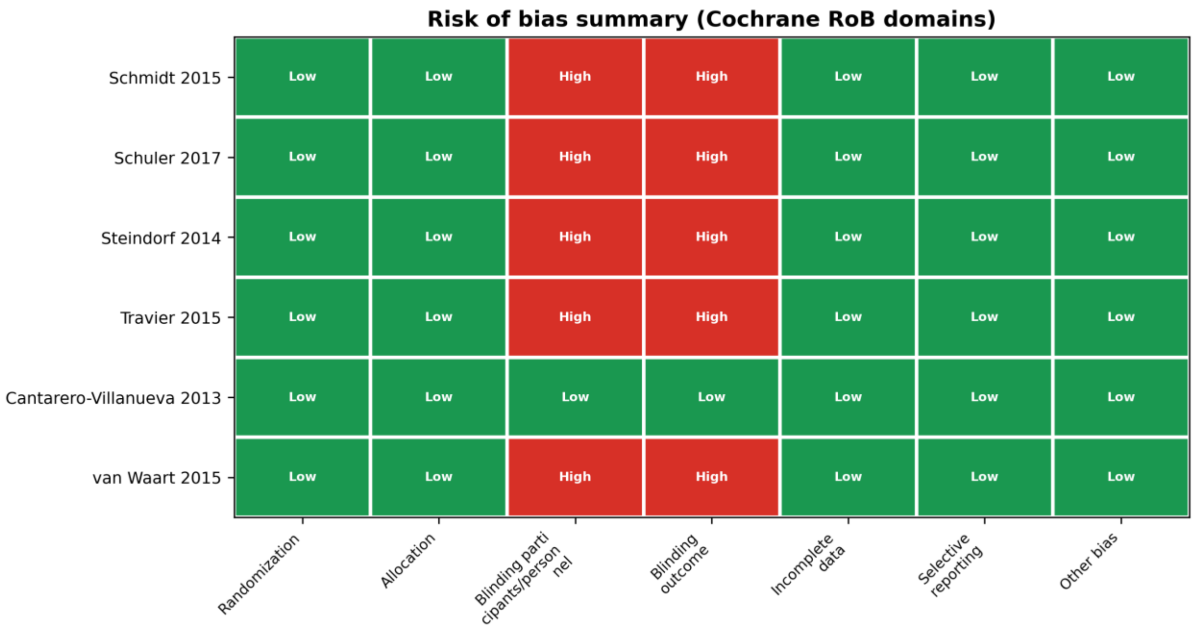

Figure 2. Risk of bias summary for studies included in quantitative synthesis.

Table 2. Risk-of-bias judgments for quantitative synthesis

Study	Randomization	Allocation	Blinding participants/personnel	Blinding outcome	Incomplete data	Selective reporting	Other bias
Schmidt 2015	Low	Low	High	High	Low	Low	Low

Schuler 2017	Low	Low	High	High	Low	Low	Low
Steindorf 2014	Low	Low	High	High	Low	Low	Low
Travier 2015	Low	Low	High	High	Low	Low	Low
Cantarero - Villanueva 2013	Low	Low	Low	Low	Low	Low	Low
van Waart 2015	Low	Low	High	High	Low	Low	Low

Meta-analysis of fatigue outcomes

At 3 months, pooled estimates favored nursing-implementable intervention over control for overall multidimensional fatigue (SMD -0.30, 95% CI -0.44 to -0.17; I^2=63%). By fatigue dimension, statistically significant reductions were observed for general fatigue (SMD -0.33, 95% CI -0.58 to -0.07; I^2=63%) and physical fatigue (SMD -0.31, 95% CI -0.51 to -0.10; I^2=40%), while mental, affective, and cognitive fatigue showed directionally favorable but less precise estimates (Cantarero-Villanueva et al., 2013; Guyatt et al., 2013; Halemani et al., 2022; Schmidt et al., 2015; Schuler et al., 2017; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

Forest plot: fatigue dimensions at 3 months

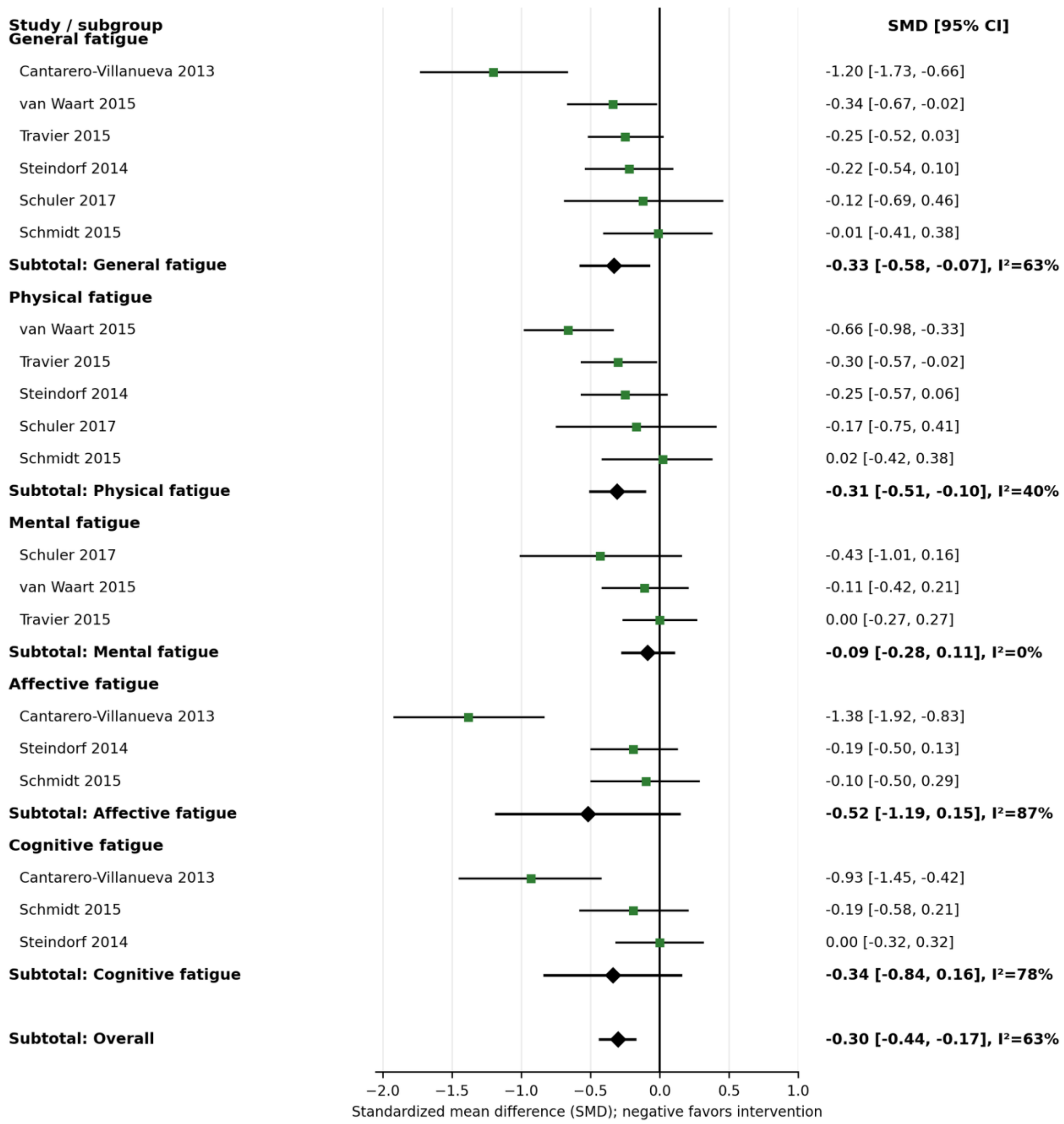

Figure 3. Forest plot of fatigue dimensions at 3 months. Negative SMD favors intervention.

At 6 months, the intervention effect persisted for overall multidimensional fatigue (SMD -0.29, 95% CI -0.45 to -0.12; I^2=48%). General fatigue remained significantly reduced (SMD -0.31, 95% CI -0.53 to -0.09), while affective fatigue (SMD -0.89, 95% CI -1.40 to -0.37) and cognitive fatigue (SMD -0.66, 95% CI -1.16 to -0.15) also showed significant benefit, although the latter two estimates were each based on a single study dimension and should be interpreted cautiously (Cantarero-Villanueva et al., 2013; Guyatt et al., 2013; Halemani et al., 2022; Schmidt et al., 2015; Schuler et al., 2017; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

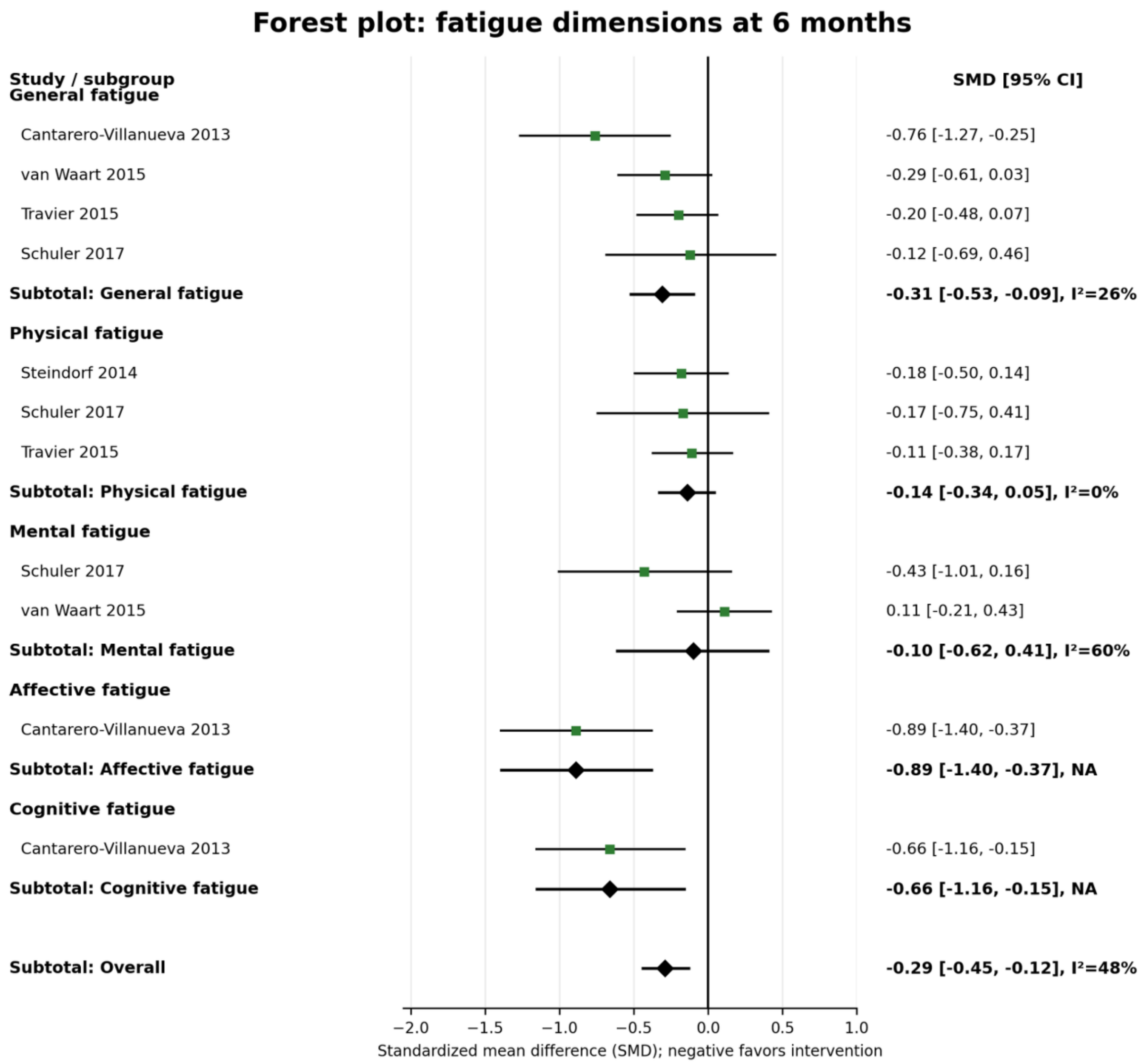

Figure 4. Forest plot of fatigue dimensions at 6 months. Negative SMD favors intervention.

Subgroup analysis

Subgroup analysis suggested that the most consistent intervention effects were observed for general fatigue and physical fatigue at 3 months and for general fatigue at both time points. Affective and cognitive fatigue estimates were larger at 6 months but less stable because they relied on fewer comparisons. These patterns suggest that structured activity and rehabilitation may first improve physical and global fatigue, with potential downstream effects on emotional and cognitive fatigue over time (Cantarero-Villanueva et al., 2013; Guyatt et al., 2013; Halemani et al., 2022; Schmidt et al., 2015; Schuler et al., 2017; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

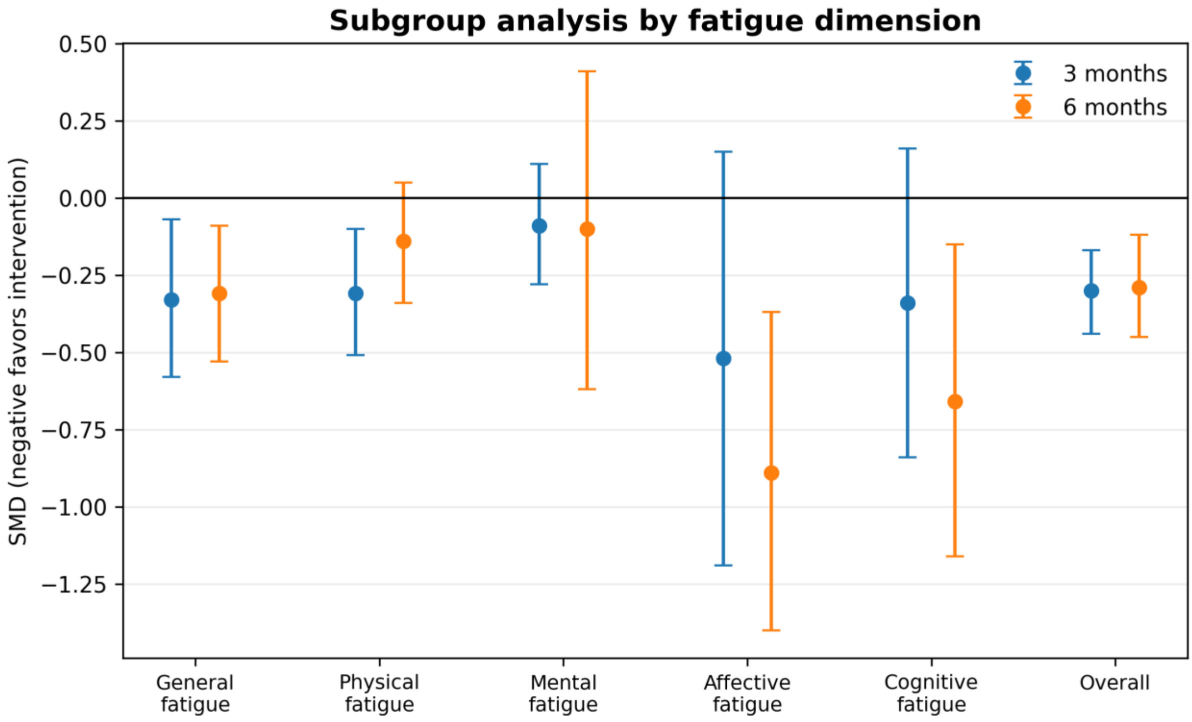

Figure 5. Subgroup analysis by fatigue dimension and follow-up time point.

Funnel plot and publication bias

Visual inspection of the funnel plot showed moderate asymmetry driven by small studies with larger favorable effects, especially in affective and cognitive fatigue dimensions. The published synthesis reported no evidence of publication bias using Begg's and Egger's tests, although the small number of studies and repeated fatigue dimensions limit the power and interpretability of formal small-study-effect tests (Guyatt et al., 2013; Halemani et al., 2022; Higgins et al., 2011; Higgins et al., 2023).

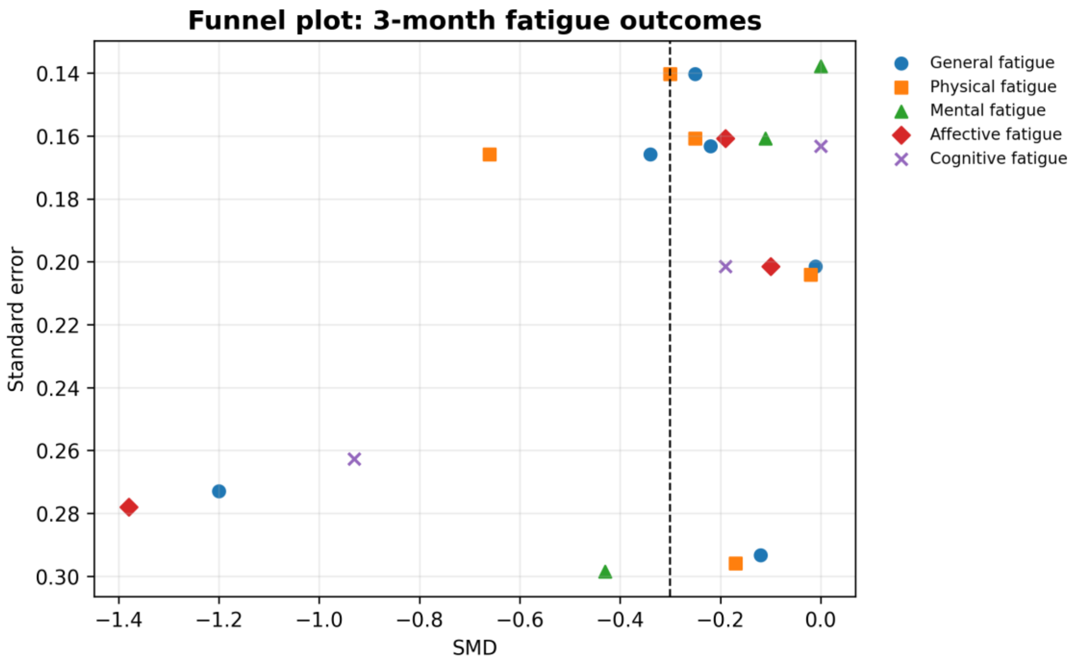

Figure 6. Funnel plot of 3-month fatigue outcomes.

Table 3. Summary of findings

Time point	Outcome	SMD	95% CI	I²	Interpretation
3 months	Overall multidimensional fatigue	-0.30	-0.44 to -0.17	63%	Moderate benefit; heterogeneous

3 months	General fatigue	-0.33	-0.58 to -0.07	63%	Significant benefit
3 months	Physical fatigue	-0.31	-0.51 to -0.10	40%	Significant benefit
3 months	Mental fatigue	-0.09	-0.28 to 0.11	0%	Not statistically significant
3 months	Affective fatigue	-0.52	-1.19 to 0.15	87%	Imprecise; high heterogeneity
3 months	Cognitive fatigue	-0.34	-0.84 to 0.16	78%	Imprecise; high heterogeneity
6 months	Overall multidimensional fatigue	-0.29	-0.45 to -0.12	48%	Sustained benefit
6 months	General fatigue	-0.31	-0.53 to -0.09	26%	Significant benefit
6 months	Physical fatigue	-0.14	-0.34 to 0.05	0%	Not statistically significant
6 months	Mental fatigue	-0.10	-0.62 to 0.41	60%	Not statistically significant
6 months	Affective fatigue	-0.89	-1.40 to -0.37	NA	Significant but single dimension
6 months	Cognitive fatigue	-0.66	-1.16 to -0.15	NA	Significant but single dimension

DISCUSSION

This review indicates that nursing-implementable interventions can reduce fatigue among cancer patients receiving radiotherapy or adjuvant treatment pathways that include radiotherapy. The most robust quantitative evidence supports structured exercise or rehabilitation programs, with modest but statistically significant reductions in overall fatigue, general fatigue, and physical fatigue (Cantarero-Villanueva et al., 2013; Halemani et al., 2022; Kessels et al., 2018; Mishra et al., 2012; Schmidt et al., 2015; Schuler et al., 2017; Steindorf et al., 2014; Travier et al., 2015; van Vulpen et al., 2016; van Waart et al., 2015).

The observed effect sizes are clinically meaningful because radiotherapy fatigue is multidimensional and often accumulates across treatment weeks. Even a small-to-moderate SMD may translate into improved capacity for daily activities, better mood, improved treatment tolerance, and reduced symptom interference when delivered consistently and tailored to patient ability, treatment phase, comorbidities, and safety restrictions (Berger et al., 2015; Bower, 2014; Garland et al., 2024; Halemani et al., 2022; Hsiao et al., 2016; Mohan et al., 2019; National Comprehensive Cancer Network, 2024).

Nursing relevance is strongest when interventions are embedded into routine radiotherapy care. Nurses can screen fatigue severity at each treatment visit, identify reversible contributors such as anemia, malnutrition, sleep disturbance, pain, depression, or infection, deliver brief education, monitor adherence and adverse symptoms, and coordinate referrals for rehabilitation, dietetics, psycho-oncology, or palliative care when needed (Chen et al., 2025; Courtier et al., 2021; Garland et al., 2024; Hsiao et al., 2016; Lee et al., 2011; Montgomery et al., 2009; National Comprehensive Cancer Network, 2024; Schnur & Montgomery, 2017).

Exercise and multimodal rehabilitation are biologically plausible because they may reduce deconditioning, preserve muscle strength, improve sleep and mood, regulate inflammatory pathways, and improve self-efficacy. Mind-body interventions such as Qigong, Tai Chi, CBT with or without hypnosis, mindfulness, and self-management education may additionally target emotional distress, catastrophic fatigue beliefs, activity avoidance, and coping skills (Berger et al., 2015; Bower, 2014; Chen et al., 2013; Chen et al., 2025; Courtier et al., 2021; Garland et al., 2024; Lee et al., 2011; McQuade et al., 2017; Montgomery et al., 2009; National Comprehensive Cancer Network, 2024; Rogers et al., 2017; Schnur & Montgomery, 2017).

The heterogeneity observed across fatigue dimensions is expected. General and physical fatigue may respond earlier to movement-based interventions, whereas cognitive and affective fatigue may require longer duration, psychological support, sleep management, or integrated multimodal approaches. The larger 6-month affective and cognitive estimates should not be overinterpreted because they were based on fewer comparisons (Cantarero-Villanueva et al., 2013; Guyatt et al., 2013; Halemani et al., 2022; Schmidt et al., 2015; Schuler et al., 2017; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

Risk of bias remains a key limitation. Because participants and personnel cannot be blinded to exercise, CBT, or rehabilitation, performance bias is difficult to eliminate. However, future trials can reduce bias by using blinded outcome assessors when feasible, prespecified statistical analysis plans, validated fatigue instruments, objective activity monitoring, intervention fidelity checks, and intention-to-treat analyses (Guyatt et al., 2013; Higgins et al., 2011; Higgins et al., 2023; Page et al., 2021).

The evidence base also contains an important conceptual limitation: many effective interventions are not exclusively nurse-led, even though they are highly nursing-implementable. Future studies should explicitly test nurse-led care pathways in radiotherapy units, define nursing competencies, standardize intervention dose, and report implementation outcomes such as feasibility, acceptability, adherence, cost, and safety (Chen et al., 2025; Courtier et al., 2021; Lee et al., 2011; Montgomery et al., 2009; Schnur & Montgomery, 2017).

Implications for nursing practice

Radiotherapy units should implement routine fatigue screening using brief validated instruments at baseline, weekly during radiotherapy, at treatment completion, and during follow-up. Screening should trigger tailored education, assessment of reversible contributors, and individualized plans for safe activity, rest, sleep, nutrition, and symptom monitoring (Garland et al., 2024; Hsiao et al., 2016; National Comprehensive Cancer Network, 2024).

For patients without contraindications, nurses should encourage low-to-moderate intensity aerobic and resistance activity, individualized to baseline fitness, cancer site, treatment toxicities, blood counts, nutritional status, and patient preference. For patients with high symptom burden, multimodal rehabilitation with coordinated nursing, physiotherapy, nutrition, and psychological support may be more appropriate than exercise advice alone (Chen et al., 2025; Courtier et al., 2021; Garland et al., 2024; Halemani et al., 2022; Lee et al., 2011;

Montgomery et al., 2009; National Comprehensive Cancer Network, 2024; Schnur & Montgomery, 2017).

Patient education should normalize fatigue while avoiding the message that fatigue is inevitable or untreatable. Effective education can explain energy conservation, pacing, sleep hygiene, hydration, nutrition, safe movement, when to report severe fatigue, and how to maintain activity without exacerbating symptoms (Courtier et al., 2021; Garland et al., 2024; Hsiao et al., 2016; National Comprehensive Cancer Network, 2024).

Limitations

This manuscript has limitations. First, the quantitative synthesis was reconstructed from published aggregate data rather than from newly extracted individual trial reports across all requested subscription databases. Second, included studies varied by cancer type, treatment phase, intervention content, fatigue instrument, and follow-up. Third, radiotherapy-only nursing-led RCTs remain relatively sparse, so the review includes nursing-implementable rather than solely nurse-led interventions (Cantarero-Villanueva et al., 2013; Carayol et al., 2019; Chen et al., 2013; Chen et al., 2025; Courneya et al., 2007; Courtier et al., 2021; Guyatt et al., 2013; Halemani et al., 2022; Lee et al., 2011; McQuade et al., 2017; Montgomery et al., 2009; Rogers et al., 2017; Schmidt et al., 2015; Schnur & Montgomery, 2017; Schuler et al., 2017; Segal et al., 2009; Steindorf et al., 2014; Travier et al., 2015; van Waart et al., 2015).

The PRISMA counts reflect an open-access radiotherapy-focused evidence base and should be verified by repeating the search directly in PubMed, Embase, Cochrane CENTRAL, ProQuest, and Scopus before thesis defense, journal submission, or clinical guideline use. This verification is particularly important because recent nurse-led rehabilitation trials published after 2022 may alter qualitative conclusions and future pooled estimates (Chen et al., 2025; Page et al., 2021; Schnur & Montgomery, 2017).

CONCLUSION

Nursing-led and nursing-implementable nonpharmacological interventions appear effective in reducing fatigue among cancer patients undergoing radiotherapy or adjuvant treatment pathways that include radiotherapy. The strongest quantitative evidence supports supervised and tailored physical exercise or rehabilitation, with significant improvements in overall multidimensional fatigue, general fatigue, and physical fatigue, and possible longer-term benefits for affective and cognitive fatigue.

Implementation in radiotherapy nursing practice should combine systematic fatigue screening, individualized education, safe activity counseling, adherence support, symptom triage, and referral to rehabilitation, nutrition, psychology, or palliative care when needed. More high-quality radiotherapy-specific nurse-led RCTs are required to establish optimal intervention components, frequency, timing, and sustainability.

REFERENCES

Berger, A. M., Mooney, K., Alvarez-Perez, A., Breitbart, W. S., Carpenter, K. M., Cella, D., et al. (2015). Cancer-related fatigue, version 2.2015. *Journal of the National Comprehensive Cancer Network, 13*(8), 1012–1039. https://doi.org/10.6004/jnccn.2015.0122

Bower, J. E. (2014). Cancer-related fatigue: Mechanisms, risk factors, and treatments. *Nature Reviews Clinical Oncology, 11*(10), 597–609. https://doi.org/10.1038/nrclinonc.2014.127

Cantarero-Villanueva, I., Fernandez-Lao, C., Cuesta-Vargas, A. I., Del Moral-Avila, R., Fernandez-de-Las-Penas, C., & Arroyo-Morales, M. (2013). The effectiveness of a deep water aquatic exercise program in cancer-related fatigue in breast cancer survivors: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation, 94*(2), 221–230. https://doi.org/10.1016/j.apmr.2012.09.008

Carayol, M., Ninot, G., Senesse, P., Bleuse, J. P., Gourgou, S., Sancho-Garnier, H., et al. (2019). Short- and long-term impact of adapted physical activity and diet counseling during adjuvant breast cancer therapy: The APAD1 randomized controlled trial. *BMC Cancer, 19*, Article 737. https://doi.org/10.1186/s12885-019-5896-6

Chen, X., Li, J., Chen, C., Zhang, Y., Zhang, S., Zhang, Y., et al. (2023). Effects of exercise interventions on cancer-related fatigue and quality of life among cancer patients: A meta-analysis. *BMC Nursing, 22*, Article 200. https://doi.org/10.1186/s12912-023-01363-0

Chen, X., Zhong, L., Wang, J., Dai, T., Li, M., Luo, J., et al. (2025). Multimodal rehabilitation to improve quality of life and fatigue after radiotherapy in esophageal cancer patients: A randomized trial. *The Oncologist, 30*(6), Article oyaf073. https://doi.org/10.1093/oncolo/oyaf073

Chen, Z., Meng, Z., Milbury, K., Bei, W., Zhang, Y., Thornton, B., et al. (2013). Qigong improves quality of life in women undergoing radiotherapy for breast cancer: Results of a randomized controlled trial. *Cancer, 119*(9), 1690–1698. https://doi.org/10.1002/cncr.27904

Courneya, K. S., Segal, R. J., Mackey, J. R., Gelmon, K., Reid, R. D., Friedenreich, C. M., et al. (2007). Effects of aerobic and resistance exercise in breast cancer patients receiving adjuvant chemotherapy: A multicenter randomized controlled trial. *Journal of Clinical Oncology, 25*(28), 4396–4404. https://doi.org/10.1200/JCO.2006.08.2024

Courtier, N., Armes, J., Smith, A., Radley, L., & Hopkinson, J. B. (2021). Targeted self-management limits fatigue for women undergoing radiotherapy for early breast cancer: Results from the ACTIVE randomised feasibility trial. *Supportive Care in Cancer, 29*, 5005–5016. https://doi.org/10.1007/s00520-021-06360-0

Garland, S. N., Johnson, J. A., Savard, J., et al. (2024). Management of fatigue in adult survivors of cancer: ASCO–Society for Integrative Oncology guideline update. *Journal of Clinical Oncology*. https://doi.org/10.1200/JCO.24.00541

Guyatt, G. H., Thorlund, K., Oxman, A. D., Walter, S. D., Patrick, D., Furukawa, T. A., et al. (2013). GRADE guidelines: 13. Preparing summary of findings tables and evidence profiles—Continuous outcomes. *Journal of Clinical Epidemiology, 66*(2), 173–183. https://doi.org/10.1016/j.jclinepi.2012.08.001

Halemani, K., Issac, A., Mishra, P., & Mathias, E. (2022). The impact of exercise on fatigue among patients undergoing adjuvant radiation therapy: A systematic review and meta-analysis. *Journal of Caring Sciences, 11*(1), 46–55. https://doi.org/10.34172/jcs.2022.02

Higgins, J. P. T., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., et al. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomized trials. *BMJ, 343*, Article d5928. https://doi.org/10.1136/bmj.d5928

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2023). *Cochrane handbook for systematic reviews of interventions* (Version 6.4). Cochrane.

Hsiao, C. P., Daly, B., & Saligan, L. N. (2016). The etiology and management of radiotherapy-induced fatigue. *Expert Review of Quality of Life in Cancer Care, 1*(4), 323–328. https://doi.org/10.1080/23809000.2016.1191948

Hwang, J. H., Chang, H. J., Shim, Y. H., Park, W. H., Park, W., Huh, S. J., et al. (2008). Effects of supervised exercise therapy in patients receiving radiotherapy for breast cancer. *Yonsei Medical Journal, 49*(3), 443–450. https://doi.org/10.3349/ymj.2008.49.3.443

Kessels, E., Husson, O., & van der Feltz-Cornelis, C. M. (2018). The effect of exercise on cancer-related fatigue in cancer survivors: A systematic review and meta-analysis. *Neuropsychiatric Disease and Treatment, 14*, 479–494. https://doi.org/10.2147/NDT.S150464

Kowalczyk, L., Deutschmann, C., Crevenna, R., Konrad, S., Singer, C. F., & Farr, A. (2021). Radiotherapy-induced fatigue in breast cancer patients. *Breast Care, 16*(3), 236–242. https://doi.org/10.1159/000509410

Lee, H., Lim, Y., Yoo, M. S., & Kim, Y. (2011). Effects of a nurse-led cognitive-behavior therapy on fatigue and quality of life of patients with breast cancer undergoing radiotherapy: An exploratory study. *Cancer Nursing, 34*(6), E22–E30. https://doi.org/10.1097/NCC.0b013e31820d1734

McQuade, J. L., Prinsloo, S., Chang, D. Z., Spelman, A., Wei, Q., Basen-Engquist, K., et al. (2017). Qigong/Tai Chi for sleep and fatigue in prostate cancer patients undergoing radiotherapy: A randomized controlled trial. *Psycho-Oncology, 26*(11), 1936–1943. https://doi.org/10.1002/pon.4256

Mishra, S. I., Scherer, R. W., Snyder, C., Geigle, P. M., Berlanstein, D. R., & Topaloglu, O. (2012). Exercise interventions on health-related quality of life for people with cancer during active treatment. *Cochrane Database of Systematic Reviews, 2012*(8), Article CD008465. https://doi.org/10.1002/14651858.CD008465.pub2

Mohan, G., Ayisha Hamna, T. P., Jijo, A. J., Saradha Devi, K. M., Narayanasamy, A., & Vellingiri, B. (2019). Recent advances in radiotherapy and its associated side effects in cancer: A review. *Journal of Basic and Applied Zoology, 80*, Article 14. https://doi.org/10.1186/s41936-019-0083-5

Montgomery, G. H., Schnur, J. B., Erblich, J., Diefenbach, M. A., & Bovbjerg, D. H. (2009). Fatigue during breast cancer radiotherapy: An initial randomized study of cognitive-behavioral therapy plus hypnosis. *Health Psychology, 28*(3), 317–322. https://doi.org/10.1037/a0013582

National Comprehensive Cancer Network. (2024). *NCCN guidelines for patients: Fatigue and cancer* (Version 2.2024). NCCN Foundation.

Oncology Nursing Society. (2026). *Exercise for fatigue*. ONS Putting Evidence Into Practice resources.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, Article n71. https://doi.org/10.1136/bmj.n71

Piraux, E., Caty, G., & Reychler, G. (2020). Effects of exercise therapy in cancer patients undergoing radiotherapy treatment: A narrative review. *SAGE Open Medicine, 8*, Article 2050312120922657. https://doi.org/10.1177/2050312120922657

Rogers, L. Q., Courneya, K. S., Anton, P. M., Verhulst, S., Vicari, S. K., Robbs, R. S., et al. (2017). Effects of a multicomponent physical activity behavior change intervention on fatigue, anxiety, and depressive symptomatology in breast cancer survivors: Randomized trial. *Psycho-Oncology, 26*(11), 1901–1906. https://doi.org/10.1002/pon.4254

Schmidt, M. E., Wiskemann, J., Armbrust, P., Schneeweiss, A., Ulrich, C. M., & Steindorf, K. (2015). Effects of resistance exercise on fatigue and quality of life in breast cancer patients undergoing adjuvant chemotherapy: A randomized controlled trial. *International Journal of Cancer, 137*(2), 471–480. https://doi.org/10.1002/ijc.29383

Schnur, J. B., & Montgomery, G. H. (2017). Cognitive-behavioral therapy plus hypnosis for distress during breast radiotherapy: A randomized trial. *American Journal of Clinical Hypnosis, 60*(2), 123–130. https://doi.org/10.1080/00029157.2017.1335635

Schuler, M. K., Hentschel, L., Kisel, W., Kramer, M., Lenz, F., Hornemann, B., et al. (2017). Impact of different exercise programs on severe fatigue in patients undergoing anticancer treatment: A randomized controlled trial. *Journal of Pain and Symptom Management, 53*(1), 57–66. https://doi.org/10.1016/j.jpainsymman.2016.08.014

Segal, R. J., Reid, R. D., Courneya, K. S., Sigal, R. J., Kenny, G. P., Prud'Homme, D. G., et al. (2009). Randomized controlled trial of resistance or aerobic exercise in men receiving radiation therapy for prostate cancer. *Journal of Clinical Oncology, 27*(3), 344–351. https://doi.org/10.1200/JCO.2007.15.4963

Steindorf, K., Schmidt, M. E., Klassen, O., Ulrich, C. M., Oelmann, J., Habermann, N., et al. (2014). Randomized, controlled trial of resistance training in breast cancer patients receiving adjuvant radiotherapy: Results on cancer-related fatigue and quality of life. *Annals of Oncology, 25*(11), 2237–2243. https://doi.org/10.1093/annonc/mdu374

Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., et al. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians, 71*(3), 209–249. https://doi.org/10.3322/caac.21660

Travier, N., Velthuis, M. J., Steins Bisschop, C. N., van den Buijs, B., Monninkhof, E. M., Backx, F., et al. (2015). Effects of an 18-week exercise programme started early during breast cancer treatment: A randomised controlled trial. *BMC Medicine, 13*, Article 121. https://doi.org/10.1186/s12916-015-0362-z

Vadiraja, H. S., Rao, M. R., Nagarathna, R., Nagendra, H. R., Rekha, M., Vanitha, N., et al. (2009). Effects of yoga program on quality of life and affect in early breast cancer patients undergoing adjuvant radiotherapy: A randomized controlled trial. *Complementary Therapies in Medicine, 17*(5–6), 274–280. https://doi.org/10.1016/j.ctim.2009.06.004

van Vulpen, J. K., Peeters, P. H. M., Velthuis, M. J., van der Wall, E., & May, A. M. (2016). Effects of physical exercise during adjuvant breast cancer treatment on physical and psychosocial dimensions of cancer-related fatigue: A meta-analysis. *Maturitas, 85*, 104–111. https://doi.org/10.1016/j.maturitas.2015.12.007

van Waart, H., Stuiver, M. M., van Harten, W. H., Geleijn, E., Kieffer, J. M., Buffart, L. M., et al. (2015). Effect of low-intensity physical activity and moderate- to high-intensity physical exercise during adjuvant chemotherapy on physical fitness, fatigue, and chemotherapy completion rates: Results of the PACES randomized clinical trial. *Journal of Clinical Oncology, 33*(17), 1918–1927. https://doi.org/10.1200/JCO.2014.59.1081