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Systematic review

Finding the right time to initiate exercise rehabilitation following a cancer diagnosis: A systematic review and meta-analysis

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Abstract

Objective To determine the effect of earlier vs. later initiation of exercise rehabilitation on patient and health service outcomes in individuals with cancer.
Data sources CINAHL, Embase, MEDLINE and PubMed were searched until October 2025.
Study selection/eligibility criteria Randomised controlled trials including adults and/or children with cancer that compared exercise rehabilitation initiated at different times were eligible. The primary outcome was physical activity. Secondary outcomes included cardiorespiratory fitness, walking capacity, fatigue and quality of life; and health service outcomes such as hospital length of stay.
Data extraction and data synthesis Outcome data were extracted, and the methodological quality assessed using PEDro. Clinically homogenous data were combined in meta-analyses; overall quality of evidence was assessed using the Grading of Recommendations, Assessment, Development, and Evaluations approach.
Results Fifteen trials involving 1270 participants most commonly with breast (n = 6), colorectal (n = 3) and haematological (n = 3) cancers were included. There was low to moderate certainty evidence demonstrating similar improvements in physical activity (SMD –0.03, 95% CI –0.60 to 0.54), fitness (SMD 0.17, 95% CI –0.14 to 0.48), walking capacity (SMD 0.78, 95% CI –0.6 to 0.54), fatigue (SMD –0.11, 95% CI –0.55 to 0.33) and quality of life (SMD 0.17, 95% CI –0.17 to 0.50) when comparing earlier to later initiation. No differences were found in hospital length of stay (MD 0 days, 95% CI –0.9 to 0.9).
Conclusion People with cancer can achieve comparable health benefits, regardless of when exercise rehabilitation is initiated.

Systematic review registration number PROSPERO Registration Number CRD42024518878.

Contribution of Paper

- People with cancer achieve comparable improvements in health outcomes regardless of when exercise rehabilitation is initiated.
- Clinicians and health services should provide flexible exercise rehabilitation timing options for people with cancer.

Keywords: Cancer; Exercise; Rehabilitation; Timing; Physical activity; Health services

Introduction

Exercise is an important, safe and effective intervention to optimise health outcomes in people with cancer [1]. People who are physically active after diagnosis may also improve survival by up to 50% [2]. With a 75% increase in new cancer diagnoses and a $25.2 trillion cost to the global

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economy predicted by 2050 [3,4], exercise is recommended to reduce the societal, public health and economic impact of cancer worldwide [1].

Exercise may be introduced at different times during cancer care. People with cancer may be provided with exercise rehabilitation before, during or after treatment. There are different aims and benefits of initiating exercise at each stage; prehabilitation prior to surgery has been associated with improved postoperative outcomes [5], exercise during periods of medical treatment can mitigate treatment-related side effects and maintain function [6], and initiating exercise after treatment completion may rebuild a person's functional capacity and quality of life [7]. Exercise rehabilitation delivered at different times supports people to improve their physical activity levels, which is recognised as a key factor in reducing cancer recurrence and improving long-term survival outcomes [1,2].

While exercise is well-established as an intervention that offers health benefits at various stages of cancer care, little is known about the optimal time for rehabilitation. Initiating exercise at different times could result in different magnitude of effects on physical activity alongside function, quality of life, cancer treatment tolerance and management of treatment-related side effects [7]. Previous systematic reviews have demonstrated that exercise rehabilitation, initiated at any time along the cancer treatment pathway is more effective than usual care without exercise. However, no reviews to date have directly compared the effectiveness of initiating exercise rehabilitation earlier vs. later [2,7]. Given that physical activity is a key determinant of survival and functional health outcomes in cancer populations [1,2], comparing the effects of exercise rehabilitation initiated at different times on physical activity will provide valuable insight for people with cancer, clinicians and health services. This comparison will help evaluate the optimal timing of exercise interventions to maximise physical activity levels and optimise other key health outcomes.

Therefore, the research question for this systematic review was:

How does the timing of the initiation of exercise rehabilitation for people with cancer affect patient and health service outcomes?

Method

This systematic review was registered prospectively in PROSPERO (registration number CRD42024518878) and is reported consistent with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [8].

Search strategy

Trials were identified through electronic database searching of CINAHL, Embase, MEDLINE and PubMed from the earliest available date to October 2025. The search strategy identified trials comparing exercise rehabilitation at different times during cancer care. Synonyms and MeSH terms related to 'cancer', 'exercise rehabilitation', 'timing' and 'treatment' were combined using Boolean operators (Appendix 1). Relevant filters were applied to identify randomised controlled trials. The search was supplemented by citation tracking of included trials using Google Scholar and checking reference lists of included trials.

Selection criteria

Titles and abstracts of trials retrieved from database searches were imported into Covidence and screened independently by two reviewers using predefined criteria. Full texts were obtained when eligibility was unclear, and discrepancies were resolved through discussion or by a third reviewer if consensus was not achieved. Randomised controlled trials that enrolled adults and/or children with cancer at any stage of care were included if they compared exercise rehabilitation initiated at different times (e.g. late vs. early initiated rehabilitation). Studies published in languages other than English were included. Google Translate was used to translate studies, allowing their eligibility to be assessed.

Consistent with the definitions of exercise [9] and cancer rehabilitation [10], exercise rehabilitation had to include planned, structured aerobic and/or resistance training aimed at reducing impairments or improving activity and/or participation outcomes for people with cancer. Exercise interventions had to be supervised by a health professional by any modality, be time-limited and could be offered in any setting, over more than one session. Rehabilitation programs could include exercise only or exercise as part of a multidisciplinary approach, but had to be delivered at a defined point during cancer care: before treatment, during active treatment (chemotherapy, radiotherapy, surgery), early after treatment (<3 months post-treatment), or later after treatment (>3 months post-treatment). Trials were excluded if they delivered non-exercise, peer-led or self-management interventions only, or alternative exercise rehabilitation programs such as yoga, Pilates, Qi-Gong or Tai-Chi. Interventions that involved alternative exercise modalities (e.g. yoga, Pilates, Qi-Gong, Tai Chi) were excluded as the focus of this review was on exercise programs incorporating aerobic and/or resistance training that have been recommended by international guidelines [1] and typical of exercise interventions led by health professionals worldwide [11].

Non-randomised studies of intervention, reviews, meta-analyses, observational studies, case reports, treatment protocols, models, incomplete studies, conference abstracts and dissertations were excluded.

The primary outcome was physical activity measured post-intervention due to its association with key health benefits for people with cancer [12]. Secondary outcomes included physical function (e.g. strength, cardiorespiratory fitness, fatigue), participation (health-related quality of life and survival/recurrence of cancer), and health service outcomes (healthcare-related costs, hospital length of stay, readmissions, and healthcare service utilisation.

Assessment of methodological quality within studies

Trials were assessed for methodological quality using the PEDro scale (Physiotherapy Evidence Database) by two reviewers independently [13]. The PEDro scale is a valid unidimensional measure of methodological quality of clinical trials that has moderate levels of interrater reliability (intraclass correlation coefficient = 0.68) [14]. Trials scoring below 6 were considered lower quality with a greater risk of bias [15]. Discrepancies were resolved through consensus or with a third reviewer.

Data extraction

A table was designed to extract relevant data on trial characteristics using the Cochrane Effective Practice and Organisation of Care (EPOC) good practice data collection form as a guide [16]. Extracted trial data included i) study demographics, ii) intervention characteristics including timing of initiation, exercise mode and dosage [17,18] and iii) post-exercise outcomes. Data extraction was completed independently by a second reviewer**.** Authors were contacted to obtain missing data.

Data analysis

Post-intervention means and standard deviations (SD) were pooled in meta-analyses for clinically homogenous outcomes. If change scores were presented, post-intervention means were derived from baseline data and the post-intervention SD was imputed [19]. Meta-analyses were performed using a random effects model with standardised mean difference (SMD) for continuous data with outcomes measured on different scales, or weighted mean difference (MD) for same-unit measurements using IBM SPSS Statistics (Version 29). Positive effect sizes favoured later initiation of exercise and the strength of the effect was determined descriptively with 0.2 considered small, 0.5 as moderate and 0.8 as a large effect [20]. Statistical heterogeneity was described with the I^2 statistic and sensitivity analyses were performed if $I^2 > 50\%$ [19]. Results were summarised descriptively when data could not be pooled for meta-analysis. Average age was weighted by the number of participants in each trial.

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was applied to each meta-analysis to determine the level of certainty in the estimate of effect. Since all included studies were randomised controlled trials, certainty of evidence started at high and was downgraded one level based on predetermined criteria: i) risk of bias (PEDro score < 6 for majority of trials in the meta-analysis) [15], ii) inconsistency ($I^2 > 50\%$), iii) large (SMD confidence interval > 0.8 or MD confidence interval exceeding the minimum clinically important difference) or imprecise confidence intervals (confidence intervals crossed zero), iv) indirect comparisons between populations, interventions or outcomes, or v) funnel plot asymmetry if ≥10 trials were included in the meta-analysis (publication bias) [8,15,21].

Results

Study selection

Database searches identified 5010 articles for screening (Fig. 1), with four additional articles from citation tracking and two through checking reference lists of included trials. After full-text assessment, 20 articles reporting data from 15 randomised controlled trials were included. Four authors responded to requests for missing data [22–25].

Methodological quality

Trials were published between 2008 and 2023 and had a mean PEDro score of 6 out of 10, ranging from 4 [26] to 7 [27–29] (Appendix 2). Reviewer agreement was 'substantial' (κ = 0.68, 95% CI 0.20–1.00). Eight out of 15 trials reported allocation concealment, [22–24,27–31] six trials reported assessor blinding [27,29,30,32–34], and nine trials reported intention-to-treat analysis [23–25,28,29,31,32,34,35].

Participants

The 15 trials included 1270 participants, with a weighted mean age of 61 years and 58% (n = 779) were women (Table 1). Six trials included participants with a primary diagnosis of breast cancer (Fig. 2) [22,24,25,28,31,35]. The remaining nine trials included participants with a combination of colorectal (n = 3) [27,30,31], haematological (n = 3) [24,31,36], head and neck (n = 3) [26,32,33], lung (n = 1) [29], prostate (n = 2) [23,37] and testicular (n = 1) cancers [31]. Most participants received chemotherapy and/or radiotherapy. Three trials recruited participants awaiting cancer surgery [23,27,30].

Exercise timing and delivery

Across the 15 trials, exercise rehabilitation was initiated and compared: i) before vs. after treatment (prehabilitation vs. rehabilitation) (n = 3) [23,27,30], ii) early during vs.

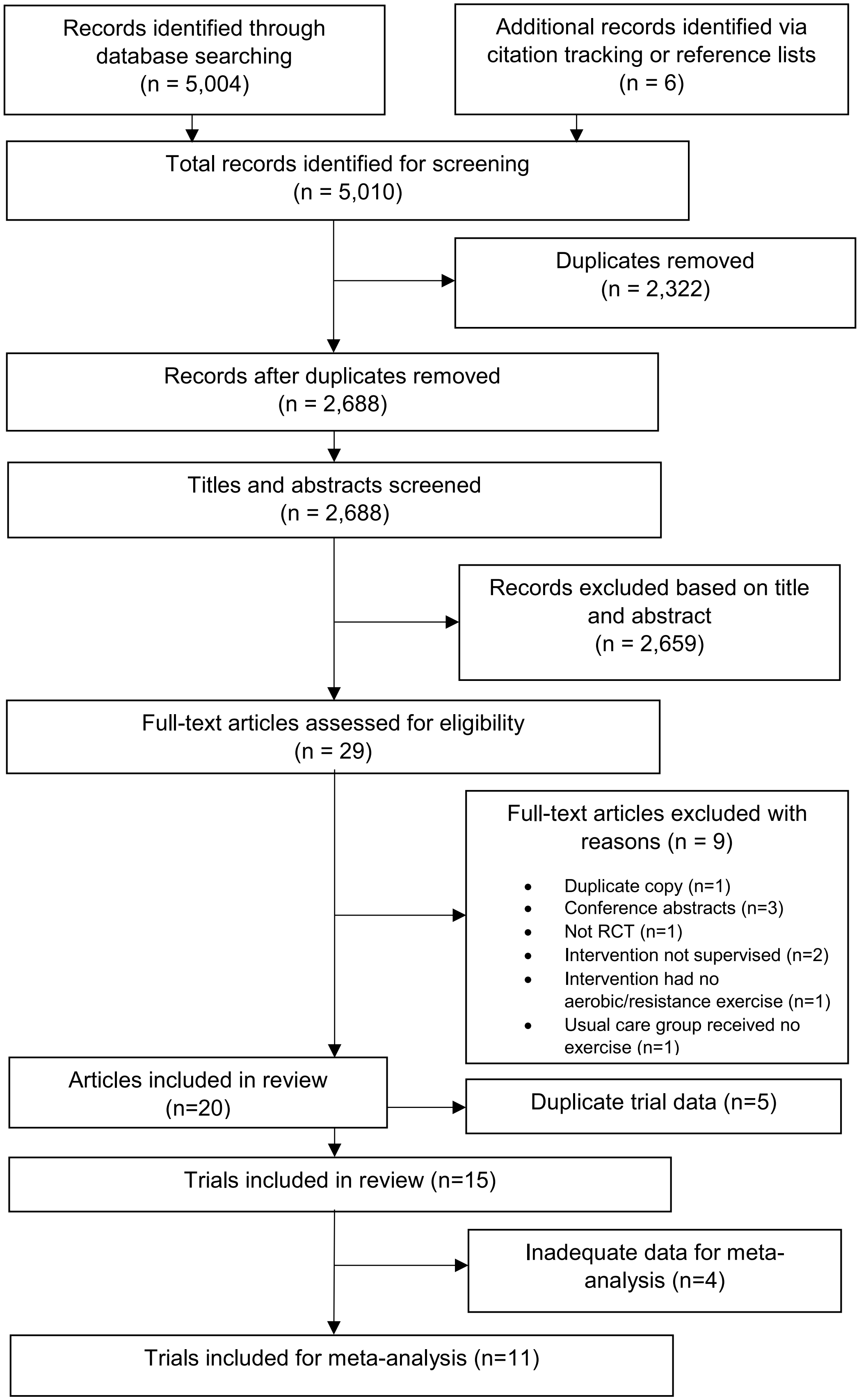

Fig. 1. Flow of trials through the review.

Table 1
Trial characteristics.

Study (country)	PEDro Score	Participants Age range Mean (SD)	Early group	Late Group	Cancer Treatment	Exercise Interventions Compared	Outcomes	Timing of Outcomes	Adverse Events (Probably related to exercise)
Bland et al. 2019 [21] Canada	6	Women with stage I–III breast cancer n = 27	51(8)	50(11)	Surgery Chemotherapy Radiotherapy Targeted therapy	During (n = 12) vs. after treatment (n = 15)	Patient-reported CIPN; Health related quality of life; Chemotherapy completion rate	Before and after intervention	NR
Capozzi et al. 2016 [31] Canada	6	Adults with stage I–IV head and neck cancer n = 60, 37% female Age range 56(9)			Surgery Radiotherapy Chemotherapy	During (n = 31) vs. after treatment (n = 29)	Body composition; Strength; Functional walking capacity; Flexibility; Depression Nutrition; Physical activity; QoL	Before and after intervention	NR
Carli et al. 2020 [29] Canada	6	Adults with stage 0–IV colorectal cancer n = 110, 53% female	78(7*)	82(7*)	Chemotherapy Surgery	Before (n = 55) vs. after treatment (n = 55)	Functional walking capacity; Anxiety, Depression; Physical Activity; QoL; CCI; No. of complications; Primary LOS; Total LOS; No. of emergency department visits; No. of hospital readmissions	Before and after intervention	NR
Furzer et al. 2016 [35] Australia	6	Adults with haematological cancer n = 37, % female NR	48(12)	50(14)	Chemotherapy Radiotherapy Stem cell transplant	Early after treatment (n = 18) vs. late after treatment (n = 19)	Body composition; Bone mineral density at spine and hip (DXA), Muscle strength; Fatigue; Anxiety; Depression; Physical activity; QoL	Before and after intervention	NR
Gillis et al. 2014 [26] Canada	7	Adults with stage I–III colorectal cancer n = 77, 38% female	66(14)	66(14)	Chemotherapy Surgery	Before and after surgery (n = 38) vs. after surgery (n = 39)	Functional walking capacity; Physical activity; QoL; Anxiety; Depression; Whole lean body mass (DXA); Muscle strength; Functional performance	Before surgery 4 weeks after surgery 8 weeks after surgery	NR
Lønbro et al. 2013 [32] Denmark	6	Adults with stage I–IV head and neck cancer n = 41, 17% female	55(7)	58(7)	Chemotherapy Radiotherapy	Early after treatment (n = 20) vs. late after treatment (n = 21)	Lean body mass; Muscle strength; Functional performance; QoL	Before and after intervention	Nil
Milne et al. 2008 [27] Australia	7	Women with stage I–II breast cancer n = 58 Age range 55(8)			Chemotherapy Radiotherapy Surgery Hormone Therapy	Early after treatment (n = 29) vs. late after treatment (n = 29)	Fatigue; Aerobic fitness; Strength; QoL; Social physique anxiety; Self-determination in exercise; Psychological needs	Before, during and after intervention	NR
Quist et al. 2018 [28] Denmark	7	Adults with stage I–IV NSCLC n = 211, 55% female	66, SD NR	65, SD NR	Surgery Chemotherapy	Early after treatment (n = 110) vs. late after treatment (n = 101)	Change in maximum oxygen consumption; Functional capacity; Lung capacity; Muscle strength; Anxiety; Depression; QoL; General wellbeing; Social support; Physical activity Sommer et al. 2020 HRQoL	Before surgery 2, 8, 14, 26, 52 weeks after surgery	NR
Sandmæl et al. 2017 [25] Norway	4	Adults with head and neck cancer, stages NR n = 41, 39% female	62(2)	64(2)	Radiotherapy Chemotherapy	During treatment (n = 20) vs. after treatment (n = 21)	Skeletal muscle mass; Body weight; HRQoL	Before radiotherapy Immediately, 2 months and 1 year after radiotherapy	NR

Table 1 (*Continued*)

Study (country)	PEDro Score	Participants Age range Mean (SD)		Cancer Treatment	Exercise Interventions Compared	Outcomes	Timing of Outcomes	Adverse Events (Probably related to exercise)
		Early group	Late Group					
Schneider et al. 2023 [23] Switzerland	7	Adults with stage I–IV breast cancer or lymphoma n = 57, 93% female		Chemotherapy	During treatment (n = 28) vs. after treatment (n = 29)	Cardiac function; Cardiorespiratory fitness; Body composition; Physical activity; HRQoL; Fatigue	Before and after intervention	Nil
		50(6)	46(6)					
Scott et al. 2023 [24] USA	5	Women with stage I–III breast cancer n = 158 (including 2 other groups: usual care n = 39; exercise during and after treatment n = 39)		Chemotherapy	During treatment (n = 40) vs. after treatment (n = 40)	Cardiorespiratory fitness; Cardiac function; QoL; Fatigue; Pain; Sleep; Physical function	Before and after intervention	Nil
		50(11)	46(10)					
Singh et al. 2023 [22] Australia	6	Men with stage I–III prostate cancer n = 38		Surgery	Before surgery (n = 17) vs. after surgery (n = 21)	Muscle strength; Physical function; Fatigue; BMI; Body composition; Urinary incontinence; Physical activity; Hospital LOS	Before surgery 6, 12 weeks after surgery	Nil
		62(8)	65(6)					
Taaffe et al. 2019 [33], Newton et al. 2020 [36], Taaffe et al. 2025 Australia	6	Men with stage I–II prostate cancer n = 104		Radiotherapy Surgery Hormone Therapy	During treatment (n = 54) vs. after treatment (n = 50)	Muscle strength; Gait speed; Dynamic balance; Cardiorespiratory fitness; Walking endurance; Lower body power; Lower body function; BMI; Body fat percentage; Taaffe et al. 2019 Soft-tissue composition and muscle density; Physical activity Taaffe et al. 2025 HRQoL	Before and after intervention	Nil
		69(6)	68(8)					
Van der Schoot et al. 2022 [30] Netherlands	6	Adults with breast, colon, testicular cancers or lymphoma n = 266, %58 female		Chemotherapy Radiotherapy Surgery	During treatment (n = 133) vs. after treatment (n = 133)	Cardiorespiratory fitness; Muscle strength; Fatigue; Self-efficacy; Physical activity; QoL	Before chemotherapy Immediately, 3–6 months, 1 year after chemotherapy	n = 1
		46(10)	48(10)					
Vincent et al. 2020 [34] France	5	Women with stage I–III breast cancer, n = 94 (including 1 other group: exercise during and after treatment n = 31)		Chemotherapy Surgery	During treatment (n = 32) vs. after treatment (n = 31)	Cardiorespiratory fitness; Muscle strength; Fatigue; Self-efficacy; Physical activity; QoL; Cardiorespiratory fitness; Muscle strength; Functional walking capacity; Body composition; Fatigue; Anxiety; Depression; Physical activity; QoL	Before and after intervention	n = 3
		57(7)	50(6)					

SD standard deviation, NR not recorded, CIPN chemotherapy induced peripheral neuropathy, QoL quality of life, HRQoL health-related quality of life, CCI comprehensive complication index, LOS length of stay, BMI body mass index

* Calculated from median and IQR.

Cancer Type	Study	Time Period of Comparison for Exercise			
		Before Treatment	During Treatment	Early After Treatment	Late After Treatment
Breast	Bland et al 2019		✓	✓	
	Milne et al 2007			✓	✓
	Schneider et al 2023		✓	✓	
	Scott et al 2023		✓	✓	
	van der Schoot et al 2022		✓	✓	
	Vincent et al 2020		✓	✓	
Colorectal	Carli et al 2020	✓		✓	
	Gillis et al 2014	✓		✓	
	van der Schoot et al 2022		✓	✓	
Haematological	Furzer et al 2016			✓	✓
	Schneider et al 2023		✓	✓	
	van der Schoot et al 2022		✓	✓	
Head and Neck	Capozzi et al 2016		✓	✓	
	Lonbro et al 2013			✓	✓
	Sandmæl et al 2017		✓	✓	
Prostate	Newton et al 2020		✓	✓	
	Singh et al 2023	✓		✓	
Lung	Quist et al 2018			✓	✓
Testicular	van der Schoot et al 2022			✓	✓

Fig. 2. Time period of comparison for exercise rehabilitation delivery across trials included in this review.

later during treatment (n = 1) [34], iii) during vs. after treatment (n = 7) [22,24–26,31,32,35], and iv) early after vs. late after treatment completion (n = 4) (Fig. 2) [28,29,33,36].

Exercise typically comprised moderate intensity aerobic and resistance training sessions lasting 30–60 min, supervised in-person, within an outpatient setting, 2–3 times a week (Table 2). Some trials included independent home-based exercise [27,35,36] or additional counselling [24,26,27,29,30,32]. Exercise initiated before surgery (prehabilitation) was delivered for a period of 4–6 weeks while most exercise initiated later, during or after treatment, lasted 6–12 weeks. Three trials delivered exercise rehabilitation for a period of 6 months [31,35,37].

Adverse events

Seven of 15 trials reported on safety (Table 1) [23–25,31,33,35,37]. Five trials reported no adverse events related to exercise initiated at any time [23–25,33,37]. Two trials reported adverse events probably related to exercise, including one event of vasovagal syncope experienced by a participant on treatment [31], and three minor muscle injuries experienced on or after treatment [35].

Outcomes

All trials measured outcomes immediately following exercise completion and five trials measured longer-term outcomes, ranging from 2 months to 6 months after exercise completion (Table 1) [23,27,29,31,32].

Patient health outcomes

Primary outcome: physical activity

Immediately post exercise rehabilitation

Physical activity was measured in 10 trials (Table 1) with six providing sufficient data to pool. Meta-analysis of six trials [24,27,30–32,36] with 518 participants found low certainty evidence of no difference in immediate post-intervention physical activity levels between early vs. later exercise initiation (SMD –0.03, 95% CI –0.60 to 0.54, I^2 = 89%) (Fig. 3, Table 3). Of four trials not included in the meta-analysis, two trials reported no between-group differences [34,35] and two trials did not report post intervention physical activity data (Appendix 4) [23,29].

Longer term follow-up

Meta-analysis of two trials [27,31] including 282 participants at least 2 months post intervention found little or no difference in longer-term physical activity levels between early vs. later exercise initiation (SMD –0.15, 95% CI –0.38 to 0.08, I^2 = 0%). The certainty of evidence was high (Table 3).

Secondary outcomes

Patient health outcomes

Little or no differences were found between groups initiating exercise earlier or later for functional walking capacity [29,30,32,35], cardiorespiratory fitness [24,25,29,31,35,36], upper [23,29,31,32] and lower limb [23,29,31,35,37] strength,

Table 2
Program characteristics.

Study	Program Setting, Mode of Delivery, Individual/Group	Exercise Frequency, Intensity, Type, Time (FITT)	Timing of exercise commencement	Non-exercise Component	Disciplines Involved	Duration
Bland et al. 2019	Outpatient: Supervised; In-person; Individual Home: Unsupervised	Outpatient: F: 3 days/week; I: Periodised; T: Aerobic, resistance; T: 25–40 min Home: F: 2 days/week; I: BORG RPE 12–14; T: Aerobic; T: 15–30 min	During vs. after chemotherapy	Nil	Research staff trained in exercise delivery	8–12 weeks
Capozzi et al. 2016	Outpatient: Supervised; In-person; Group Home: Unsupervised	Outpatient: F: 2 days/week; I: Moderate; T: Resistance; T: NR Home: F: 2 days/week; I: Moderate; T: Resistance; T: NR	During vs. early after radiotherapy ± chemo-therapy	6 education sessions: behaviour change support, nutrition screening, social support	Exercise physiologist Personal trainer	12 weeks
Carli et al. 2020	Outpatient: Hospital unit; Supervised; In-person; Individual Home: Unsupervised	Outpatient: F: 1 day/week; I: Moderate; T: Aerobic; resistance, stretches; T: 60 min Home: F: Daily (aerobic), 3 days (resistance)/week; I: Moderate; T: Aerobic (walk), resistance; T: 30 min	Before vs. after surgery	Nutritional counselling, behaviour change counselling	Kinesiologist Nutritional Counsellor Nurse	4 weeks
Furzer et al. 2016	Gym: Supervised (Initial 2 sessions, further 2 sessions at 6-week point); In-person Email/phone/online follow up	F: 3 days/week; I: Periodised; T: Aerobic, resistance; T: 10–30 min	Early after vs. late after chemotherapy	Nil	Exercise physiologist	12 weeks
Gillis et al. 2014	Home: Supervised via weekly phone follow up	F: 3+ days/week; I: Periodised; T: Aerobic, resistance; T: 50 min	Before and after surgery vs. early after surgery	Nutritional counselling, psychological counselling (anxiety coping and motivation strategies)	Kinesiologist Dietitian Psychologist	Before and After: 12 weeks Early After: 8 weeks
Lonbro et al. 2013	Gym Supervised: 5 sessions Unsupervised: All other sessions	F: 2–3days/week; I: 2–3 sets, 8–15RM; T: Resistance; T: NR	Early after vs. late after chemotherapy ± radiotherapy	Nil	NR	12 weeks
Milne et al. 2007	Outpatient: Supervised; In-person; Group	F: 3 days/week; I: Periodised; T: Aerobic, resistance; T:20 min (aerobic), NR (resistance)	Early after vs. late after surgery/chemotherapy/ radiotherapy/hormone therapy	Nil	Exercise physiologist	12 weeks
Quist et al. 2018	Outpatient: Supervised; In-person; Group	F: 2 days/week; I: Periodised 50–60% HRmax to 70–90% HRmax; T: Aerobic, resistance; T: 60 min	Early after vs. late after surgery	Individual counselling, health-promoting behaviours group education	Physiotherapists Specialised cancer nurses	12 weeks
Sandmæl et al. 2017	During treatment: Outpatient; Hospital; Supervised; In-person After treatment: Inpatient, Rehabilitation center; Supervised; In-person; Individual/Group NR	Early group: F: 2 days/week; I: 3–4 sets, 6–12RM; T: Resistance; T: 30 min Late group: 3 ×45 min per week with additional voluntary sessions	During vs. early after radiotherapy	Early group: Oral nutrition supplements and advice Late group: Oral nutrition supplements, nutritional counselling, group education	During treatment: Physiotherapist After treatment: Physiotherapist and exercise therapist plus various others for education	During treatment: 6 weeks After treatment: 3 weeks
Schneider et al. 2023	Outpatient: Supervised; In-person; Group Home: Unsupervised; Individual*	F: 3 days/week; I: Individualised to achieve BORG 13 and 40 min duration (aerobic), 2–3 sets of 8–12 reps, 70–80%1RM and 40–45 min duration (strength); T: Aerobic, resistance; T: 90 min (30 min aerobic, 40–45 min resistance)*	During vs. early after chemotherapy	Counselling on physical activity, psychological aspects, nutrition, cardiovascular risk factors, pain management	Exercise therapists	12 weeks

Table 2 (*Continued*)

Study	Program Setting, Mode of Delivery, Individual/Group	Exercise Frequency, Intensity, Type, Time (FITT)	Timing of exercise commencement	Non-exercise Component	Disciplines Involved	Duration
Scott et al. 2023	Outpatient: Supervised; In-person; Individual	F: 3 days/week; I: 55–100% VO2peak; T: Aerobic; T: 20–55 min	During vs. early after chemotherapy	Nil	NR	During treatment: 14–20 weeks After treatment: 14–20 weeks
Singh et al. 2023	Outpatient: Supervised; In-person; Group	F: 3 days/week; I: 60–80% HRmax. 2–4 sets, 6–12RM; T: Aerobic, resistance; T: 90 min	Before vs. early after surgery	Nil	Exercise physiologist	6 weeks
Taaffe et al. 2019	Outpatient: Supervised; In-person; Group Home: Unsupervised; Individual	Outpatient: F: 3 days/week; I: 6–12RM, 2–4 sets per exercise (resistance), 60–85%HRmax (aerobic); T: Aerobic, resistance, impact loading; T: 60 min Home: F: 2 days/week; I: NR; T: Aerobic, impact-loading; T: NR	Early during vs. late during androgen deprivation therapy	Nil	Exercise physiologist	6 months
Van der Schoot et al. 2022	Outpatient: Supervised; In-person; Home: Unsupervised; Individual/ Group NR	Outpatient: F: 3 days/week; I: moderate to high; T: Aerobic, resistance; T: 60 min Home: F: 3 days/week; I: NR; T: Aerobic; T: NR	During vs. early after chemotherapy	Nil	Physiotherapist	24 weeks
Vincent et al. 2020	Home: Supervised; Phone; Individual	F: ≥2 days/week aerobic, 1 day/week resistance; I: 60–70% VO2peak; T: Aerobic, resistance; T: ≥20 min	During vs. after vs. during and after chemotherapy treatment	Nil	Exercise specialist	During: 6 months After: 6 months During and After 12 months

* During COVID-19 restrictions, exercise sessions were modified to a 2–3 days/week (1 supervised, 2 unsupervised), I: NR, T: Aerobic (nordic walking), resistance, T: 150 min/week (moderate physical activity), 2 strength sessions/week.

lower limb endurance [23,32,33,37], lean body mass [23,32–36], health-related quality of life [23,27–31,33,35,36,38,39], anxiety [27,29,30,35,36], depression [27,29,30,35,36], and fatigue [23,28,29,31,35,36] immediately post-intervention or at longer-term follow up (two to six months post intervention) (Table 3).

Similar results of no differences between groups were found in sensitivity analyses excluding prehabilitation trials and sub-group analyses for people with breast cancer and those undergoing surgery (Appendix 3).

Health service outcomes

Three trials comparing exercise initiated before and after surgery examined the effect of exercise timing on hospital acute length of stay and total length of stay, including readmissions. Two trials were pooled for meta-analysis [27,30]. Moderate certainty evidence showed no difference in acute length of stay (MD 0.00 days, 95% CI –0.90 to 0.90, $I^2 = 0\%$) or total length of stay inclusive of any readmissions

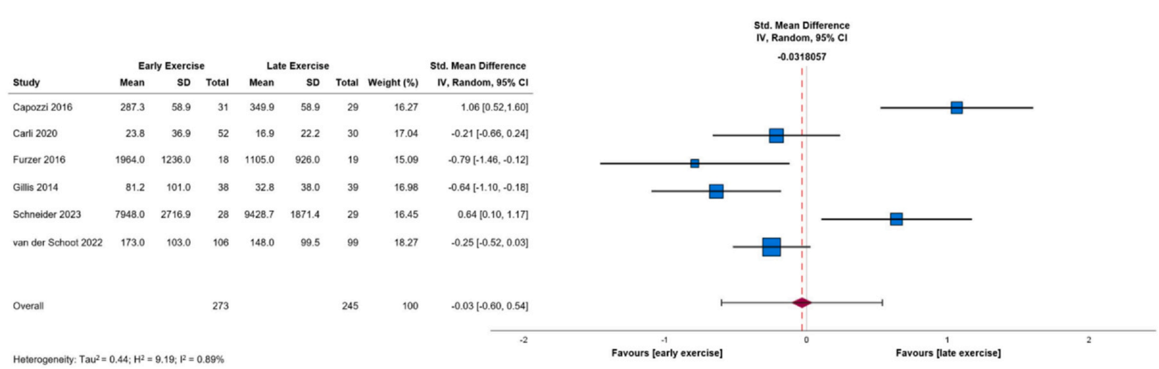

Fig. 3. Meta-analysis of the effect of early vs. late exercise rehabilitation on physical activity.

Table 3
Summary of findings based on GRADE certainty of evidence assessment (positive effect sizes favours late initiation of exercise).

Outcome	No. of RCTs	n =	SMD or WMD (95% CI) (Positive effect favours late initiation of exercise)	I^2	MCID	Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias^	Certainty of evidence (GRADE)
Immediately post exercise											
Physical Activity[a]	6	518	SMD −0.03 (95% CI −0.6 to 0.54)	89%	N/A	0	0	-1[#]	-1[*]	0	Low
Functional Walking Capacity (6 min Walk Test)	4	444	SMD 0.78 (95% CI −0.67–2.24) MD 21.14 (95% CI −31.26 to 73.55)	97% 93%	54–80	0	0	-1[#]	-1[*]	0	Low
Cardiorespiratory Fitness[b]	6	545	SMD 0.17 (95%CI −0.14 to 0.48)	66%	N/A	0	0	0	0	0	High
Upper Limb Strength[c]	4	575	SMD 0.26 (95% CI −0.39 to 0.9)	89%	N/A	0	0	-1[#]	-1[*]	0	Low
Lower Limb Strength[d]	6	719	SMD 0.02 (95% CI −0.15 to 0.19)	0%	N/A	0	0	0	0	0	High
Lower Limb Endurance(30 second sit to stand test)	4	243	SMD 0.88 (95% CI −0.23 to 1.99) MD 1.33 (95% CI −0.18 to 2.47)	93%80%	≥2	0	0	-1[#]	-1[*]	0	Low
Health-related Quality of Life: Global Function[e]	11	914	SMD 0.17 (95% CI −0.17 to 0.50)	83%	N/A	0	0	-1[#]	-1[*]	0	Low
Health-related Quality of Life: Physical Functioning	3	370	MD −2.08 (95%CI −4.87 to 0.72)	0%	2–7	0	0	0	-1[*]	0	Moderate
Health-related Quality of Life: Emotional Functioning	3	363	MD −1.35 (95% CI −7.56 to 4.86)	51%	6–9	0	0	0	-1[*]	0	Moderate
Anxiety(Hospital Anxiety and Depression Scale)	5	498	SMD −0.01 (95% CI −0.30 to 0.28)MD −0.04 (95% CI −1.15 to 1.06)	43%44%	-1.8 to −1.3	0	0	0	-1[*]	0	Moderate
Depression(Hospital Anxiety and Depression Scale)	5	498	SMD −0.08 (95% CI −0.29 to 0.14)MD −0.16 (95% CI −0.78 to 0.46)	0%0%	-1.7 to −1.5	0	0	0	-1[*]	0	Moderate
Fatigue[f]	6	673	SMD −0.11 (95% CI −0.55 to 0.33)	81%	N/A	0	0	-1[#]	-1[*]	0	Low
Lean Body Mass	6	343	SMD −0.94 (95% CI −2.02 to 0.14)	95%	N/A	0	0	-1[#]	-1[*]	0	Low
Primary Length of Stay	2	187	SMD 0 (95% CI −0.3 to 0.3) MD 0 (95% CI −0.86 to 0.86)	0%0%	N/A	0	0	0	-1[*]	0	Moderate
Total Length of Stay	2	187	SMD −0.26 (95% CI −0.56 to 0.03)MD −1.0 (95% CI −2.12 to 0.12)	0%0%	N/A	0	0	0	-1[*]	0	Moderate
Longer Term Follow Up											
Physical Activity[g]	2	282	SMD −0.15 (95% CI −0.38 to 0.08)	0%	N/A	0	0	0	0	0	High
Cardiorespiratory Fitness[h]	2	411	SMD 0.07 (95% CI −0.39 to 0.52)	82%	N/A	0	0	-1[#]	-1[*]	0	Low
Upper Limb Strength[i]	3	339	SMD 0 (95% CI −0.22 to 0.21)	0%	N/A	0	0	0	0	0	High
Lower Limb Strength[j]	3	339	SMD 0.02 (95% CI −0.19 to 0.23)	0%	N/A	0	0	0	0	0	High
Health-related Quality of Life: Global Function[k]	4	424	SMD 0.03 (95% CI −0.16 to 0.22)	0%	N/A	0	0	0	0	0	High
Anxiety(Hospital Anxiety and Depression Scale)	2	187	SMD −0.23 (95% CI −0.52 to 0.06)	0%	-1.8 to −1.3	0	0	0	0	0	High
Depression (Hospital Anxiety and Depression Scale)	2	187	SMD −0.08 (95% CI −0.37 to 0.21)	0%	-1.7 to −1.5	0	0	0	0	0	High

Table 3 (*Continued*)

Outcome	No. of RCTs	n =	SMD or WMD (95% CI) (Positive effect favours late initiation of exercise)	I^2	MCID	Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias^	Certainty of evidence (GRADE)
Fatigue[l]	3	348	SMD 0.05 (95% CI −0.16 to 0.26)	0%	N/A	0	0	0	0	0	High

[a] Physical activity measures: CHAMPS - Community Healthy Activities Model Program for Seniors Physical Activity Questionnaire, Godin-Shephard Leisure-Time Physical Activity Questionnaire, PASE – Physical Activity Scale for the Elderly.
[b] Cardiorespiratory fitness measures: Aerobic power index, VO_{2peak}.
[c] Upper limb strength measures: Chest press, biceps strength, grip strength.
[d] Lower limb strength measures: Leg press, Knee extension.
[e] Health related quality of life measures: EORTC QLQ-C30, FACT-G, SF-36.
[f] Fatigue measures: EORTC QLQ-C30, MFI, SCFS.
[g] Physical activity measures: CHAMPS - Community Healthy Activities Model Program for Seniors Physical Activity Questionnaire, PASE – Physical Activity Scale for the Elderly.
[h] Cardiorespiratory fitness measures: VO_{2peak}.
[i] Upper limb strength measures.
[j] Lower limb strength measures.
[k] Health related quality of life measures: EORTC QLQ-C30; SF-36.
[l] Fatigue measures: EORTC QLQ-C30, MFI. Reasons for downgrade: 0 = not downgraded.
[#] Downgraded one place due to heterogeneity.
[*] Downgraded due to wide confidence interval.
^ Funnel plots not completed due to < 10 studies in meta-analysis; +Downgraded one place as most trials scored < 6 on PEDro.

within 30 days following discharge (MD −1.0 day, 95% CI −2.1 to 0.10, I^2 = 0%) between groups initiating exercise earlier or later (Table 3).

Discussion

We found low to high certainty evidence demonstrating people with cancer can achieve comparable short- and longer-term health benefits, regardless of when they initiate exercise rehabilitation. Exercise rehabilitation was safe throughout all phases of treatment, with few adverse events reported. No previous reviews have directly compared outcomes based on the timing of exercise rehabilitation. This review contributes to the literature by directly comparing how the timing of exercise rehabilitation influences patient and health service outcomes following a cancer diagnosis.

Considering outcomes were similar regardless of exercise timing, health service providers should be confident to offer flexibility in the timing of exercise rehabilitation for people with cancer. People with cancer are often encouraged to start exercising as early as possible following a cancer diagnosis but can feel too overwhelmed to do so. As people with cancer navigate through varied, complex disease and treatment trajectories that may inhibit participation in exercise, they may struggle to participate in structured exercise due to fatigue, low mood and competing medical demands. However, people who initiate exercise later along their cancer treatment pathway can still achieve comparable health outcomes to those who initiated exercise earlier. Therefore, a more important focus may be on optimising patient engagement and access to exercise rehabilitation throughout cancer care.

While this review aimed to evaluate the effect of exercise rehabilitation on physical activity as the primary outcome, the results indicated no differences in physical activity improvements when exercise rehabilitation was initiated earlier or later. A potential explanation for this lack of reported change may be the sole reliance on self-reported measures to assess physical activity in all trials included in this review, which are subject to limitations such as recall bias and therefore a source of error [40]. In contrast, accelerometry may offer a more objective measurement of physical activity, which may provide a more accurate representation of physical activity levels.

Timing of exercise rehabilitation may be an important consideration for people with advanced or metastatic cancer, a group often excluded from exercise services due to their disease status, but no trials in this review included this population. Recent international quality survivorship care standards for people affected by advanced or metastatic cancer advocate for early integration of survivorship care, including exercise, within their palliative care [41]. People with metastatic cancer may live for years with periods of disease stability, during which exercise rehabilitation can improve health outcomes, and minimise symptom burden [41].

In health services with limited resources, understanding the impact of timing of rehabilitation can help health organisations optimise service allocation. No trials evaluated healthcare related costs and just three [23,27,30] evaluated hospital length of stay, finding no difference when prehabilitation was compared to rehabilitation. These preliminary findings suggest that hospitals could allocate limited resources to either prehabilitation or rehabilitation, focussing on patient needs and staffing resources. Hospitals may also consider establishing stronger referral pathways with community-based health services to shift aspects of exercise rehabilitation into the community, making more efficient use of available resources.

Strengths and limitations

This systematic review was prospectively registered and reported in accordance with PRISMA guidelines and only included randomised controlled trials thereby reducing the risk of bias, increasing confidence in the results. The GRADE approach was used to assess the certainty of evidence. The overall methodological quality of included trials was good [42]. This review included participants with any cancer diagnosis and at various stages along the treatment continuum, increasing the generalisability and relevance of the findings.

There were some limitations to this review. Clinical heterogeneity across cancer types, treatments and interventions may limit the specificity of our results. While this review included all cancer types, stages and treatments, it is possible the effect of exercise timing may be different across tumour-specific cancer care pathways. Prehabilitation is increasingly being provided as a strategy to improve post-treatment outcomes for people receiving treatment such as stem cell transplants for haematological cancers. However, the prehabilitation trials included in this review were conducted in surgical populations. Advanced or metastatic cancers were underrepresented, and only one trial investigated lung cancer [29]. Given lung cancer has the highest incidence of new cases and is the leading cause of cancer death worldwide [4], more research on timing of exercise is needed in this population. We did not consider the impact of adherence to exercise across different times. Previous studies have reported suboptimal participation rates and considerable variation in patient engagement to exercise [43,44]. Evaluating adherence to exercise may be an important consideration in determining the optimal time to start exercise rehabilitation. By comparing the impact of exercise adherence over different timeframes, future research could provide valuable insights into the optimal time for exercise interventions to be initiated to maximise participation and effectiveness.

High statistical heterogeneity contributed to uncertainty in several meta-analyses. There were a small number of studies included in some analyses and the meta-analysis of physical activity relied exclusively on self-reported data. To reduce the risk of recall bias, objective measures of physical activity should be used in future cancer exercise trials.

Conclusion

In conclusion, there was low to high certainty evidence demonstrating people with cancer can achieve similar improvements in short- and longer-term health outcomes including physical activity, strength, cardiorespiratory fitness, functional walking capacity, fatigue, anxiety, depression, and quality of life (global, physical and emotional functioning domains) regardless of when they initiate exercise rehabilitation.

CRediT authorship contribution statement

GA Tan: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization. **NF Taylor, CL Peiris, KE Harding, AM Dennett:** Conceptualization, Methodology, Formal analysis, Supervision, Writing – review & editing.

Ethical Approval

No ethical approval was required for this study.

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Data statement

Data from this study is available from the corresponding author on reasonable request and following appropriate ethical approval.

Conflict of Interest

The authors have no conflicts of interest to declare.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.physio.2026.101876.

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