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Interventions for promoting habitual exercise in people living with and beyond cancer (Review)

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[Intervention Review]

Interventions for promoting habitual exercise in people living with and beyond cancer

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ABSTRACT

Background

This is an updated version of the original Cochrane Review published in the Cochrane Library 2013, Issue 9. Despite good evidence for the health benefits of regular exercise for people living with or beyond cancer, understanding how to promote sustainable exercise behaviour change in sedentary cancer survivors, particularly over the long term, is not as well understood. A large majority of people living with or recovering from cancer do not meet current exercise recommendations. Hence, reviewing the evidence on how to promote and sustain exercise behaviour is important for understanding the most effective strategies to ensure benefit in the patient population and identify research gaps.

Objectives

To assess the effects of interventions designed to promote exercise behaviour in sedentary people living with and beyond cancer and to address the following secondary questions: Which interventions are most effective in improving aerobic fitness and skeletal muscle strength and endurance? Which interventions are most effective in improving exercise behaviour amongst patients with different cancers? Which interventions are most likely to promote long-term (12 months or longer) exercise behaviour? What frequency of contact with exercise professionals and/or healthcare professionals is associated with increased exercise behaviour? What theoretical basis is most often associated with better behavioural outcomes? What behaviour change techniques (BCTs) are most often associated with increased exercise behaviour? What adverse effects are attributed to different exercise interventions?

Search methods

We used standard methodological procedures expected by Cochrane. We updated our 2013 Cochrane systematic review by updating the searches of the following electronic databases: Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library, MEDLINE, Embase, AMED, CINAHL, PsycLIT/PsycINFO, SportDiscus and PEDro up to May 2018. We also searched the grey literature, trial registries, wrote to leading experts in the field and searched reference lists of included studies and other related recent systematic reviews.

Selection criteria

We included only randomised controlled trials (RCTs) that compared an exercise intervention with usual care or 'waiting list' control in sedentary people over the age of 18 with a homogenous primary cancer diagnosis.

Data collection and analysis

In the update, review authors independently screened all titles and abstracts to identify studies that might meet the inclusion criteria, or that could not be safely excluded without assessment of the full text (e.g. when no abstract is available). We extracted data from all eligible papers with at least two members of the author team working independently (RT, LS and RG). We coded BCTs according to the CALO-RE taxonomy. Risk of bias was assessed using the Cochrane's tool for assessing risk of bias. When possible, and if appropriate, we performed a fixed-effect meta-analysis of study outcomes. If statistical heterogeneity was noted, a meta-analysis was performed using a random-effects model. For continuous outcomes (e.g. cardiorespiratory fitness), we extracted the final value, the standard deviation (SD) of the outcome of interest and the number of participants assessed at follow-up in each treatment arm, to estimate the standardised mean difference (SMD) between treatment arms. SMD was used, as investigators used heterogeneous methods to assess individual outcomes. If a meta-analysis was not possible or was not appropriate, we narratively synthesised studies. The quality of the evidence was assessed using the GRADE approach with the GRADE profiler.

Main results

We included 23 studies in this review, involving a total of 1372 participants (an addition of 10 studies, 724 participants from the original review); 227 full texts were screened in the update and 377 full texts were screened in the original review leaving 35 publications from a total of 23 unique studies included in the review. We planned to include all cancers, but only studies involving breast, prostate, colorectal and lung cancer met the inclusion criteria. Thirteen studies incorporated a target level of exercise that could meet current recommendations for moderate-intensity aerobic exercise (i.e.150 minutes per week); or resistance exercise (i.e. strength training exercises at least two days per week).

Adherence to exercise interventions, which is crucial for understanding treatment dose, is still reported inconsistently. Eight studies reported intervention adherence of 75% or greater to an exercise prescription that met current guidelines. These studies all included a component of supervision: in our analysis of BCTs we designated these studies as 'Tier 1 trials'. Six studies reported intervention adherence of 75% or greater to an aerobic exercise goal that was less than the current guideline recommendations: in our analysis of BCTs we designated these studies as 'Tier 2 trials.' A hierarchy of BCTs was developed for Tier 1 and Tier 2 trials, with programme goal setting, setting of graded tasks and instruction of how to perform behaviour being amongst the most frequent BCTs. Despite the uncertainty surrounding adherence in some of the included studies, interventions resulted in improvements in aerobic exercise tolerance at eight to 12 weeks (SMD 0.54, 95% CI 0.37 to 0.70; 604 participants, 10 studies; low-quality evidence) versus usual care. At six months, aerobic exercise tolerance was also improved (SMD 0.56, 95% CI 0.39 to 0.72; 591 participants; 7 studies; low-quality evidence).

Authors' conclusions

Since the last version of this review, none of the new relevant studies have provided additional information to change the conclusions. We have found some improved understanding of how to encourage previously inactive cancer survivors to achieve international physical activity guidelines. Goal setting, setting of graded tasks and instruction of how to perform behaviour, feature in interventions that meet recommendations targets and report adherence of 75% or more. However, long-term follow-up data are still limited, and the majority of studies are in white women with breast cancer. There are still a considerable number of published studies with numerous and varied issues related to high risk of bias and poor reporting standards. Additionally, the meta-analyses were often graded as consisting of low- to very low-certainty evidence. A very small number of serious adverse effects were reported amongst the studies, providing reassurance exercise is safe for this population.

PLAIN LANGUAGE SUMMARY

Interventions for promoting habitual exercise in people living with and beyond cancer

The issue
Being regularly active can bring a range of health benefits for people living with and beyond cancer, including improved quality of life and physical function. Being physically active might also reduce the risk of cancer recurrence and of dying from cancer. Because most cancer survivors are not regularly physically active, there is a need to understand how best to promote and sustain physical activity in this population.

The aim of the review
To understand what are the most effective ways to improve and sustain exercise behaviour in people living with and beyond cancer.

Study characteristics
We included only studies that compared an exercise intervention with a usual care comparison or 'waiting list' control. Only studies that included sedentary people over the age of 18 with the same cancer diagnosis were eligible. Participants must have been allocated to exercise or usual care at random. We searched for evidence from research databases from 1946 to May 2018.

What are the main findings?

We included 23 studies involving 1372 participants in total. Evidence suggests that exercise studies that incorporate an element of supervision can help cancer survivors. However, we still have a poor understanding of how to promote exercise long term (over six months). There is some concern that research is not being reported as clearly as it should be. We found that setting goals, graded physical activity tasks and providing instructions on how to perform the exercises could help people to do beneficial amounts of exercise. In addition, we found some evidence that in people who do meet recommended exercise levels, get fitter for up to six months.

Quality of the evidence

The main problems that we found regarding the quality of studies in this review included: not knowing how study investigators conducted randomisation for the trials and not knowing whether investigators who were doing trial assessments knew to which group the person they were assessing had been randomly assigned. The quality of the evidence from these studies was found to be low due to the majority of the trials often containing a low number of participants.

What are the conclusions?

The main conclusions from this review are that exercise is generally safe for cancer survivors. We have a better understanding of how to encourage cancer survivors to meet current exercise recommendations. However, there is still a lack of evidence of how to encourage exercise in cancer survivors over six months.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Exercise interventions compared to usual care for promoting habitual exercise in people living with and beyond cancer to improve aerobic exercise tolerance

Exercise interventions compared to usual care for promoting habitual exercise in people living with and beyond cancer to improve aerobic exercise tolerance

Outcomes	№ of participants (studies) Follow-up	Certainty of the evidence (GRADE)	Anticipated absolute effects* (95% CI)	
			Risk with usual care	Risk difference with exercise interventions
Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up)	604 (10 RCTs)	⊕⊕⊖⊖ LOW [1 2]	The mean aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up) was 0	SMD 0.54 higher (0.37 higher to 0.70 higher)
Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up sensitivity analysis)	201 (4 RCTs)	⊕⊕⊖⊖ LOW [2 3]	The mean aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up sensitivity analysis) was 0	SMD 0.85 higher (0.56 higher to 1.14 higher)
Aerobic exercise tolerance (all cancers: 6 months)	591 (7 RCTs)	⊕⊕⊖⊖ LOW [1 2]	The mean aerobic exercise tolerance (all cancers: 6 months) was 0	SMD 0.56 higher (0.39 higher to 0.72 higher)
Aerobic exercise tolerance (breast cancer: 8-12 weeks of follow-up)	441 (6 RCTs)	⊕⊖⊖⊖ VERY LOW [1 2 4]	The mean aerobic exercise tolerance (breast cancer: 8-12 weeks of follow-up) was 0	SMD 0.57 higher (0.22 higher to 0.93 higher)
Aerobic exercise tolerance (all cancers: combination of supervised and home-based exercise: 8 to 12 weeks of follow-up)	357 (4 RCTs)	⊕⊖⊖⊖ VERY LOW [2 3 4]	The mean aerobic exercise tolerance (all cancers: combination of supervised and home-based exercise: 8 to 12 weeks of follow-up) was 0	SMD 0.53 higher (0.01 higher to 1.04 higher)
Aerobic exercise tolerance (all cancers: home-based exercise: 8 to 12 weeks of follow-up)	155 (3 RCTs)	⊕⊖⊖⊖ VERY LOW [1 2 3]	The mean aerobic exercise tolerance (all cancers: home-based exercise: 8 to 12 weeks of follow-up) was 0	SMD 0.70 higher (0.37 higher to 1.03 higher)
Aerobic exercise tolerance (all cancers:supervised exercise: 8 to 12 weeks of follow-up)	92 (3 RCTs)	⊕⊖⊖⊖ VERY LOW [2 3 5]	The mean aerobic exercise tolerance (all cancers:supervised exercise: 8 to 12 weeks of follow-up) was 0	SMD 1.07 higher (0.26 higher to 1.89 higher)

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: Confidence interval; **SMD:** standarised mean difference

GRADE Working Group grades of evidence
High-certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate-certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low-certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low-certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1] Some concerns with high number of participants lost to follow-up, selective reporting of data and other risks of bias
[2] Concerns over number of small studies included with positive results
[3] Low number of participants in the studies overall and large confidence intervals
[4] Some concerns over variations in effect sizes, the test for heterogeneity is significant and I^2 value is high (> 50)
[5] Some concerns over the variations in effect sizes.

BACKGROUND

This review is an update of a previously published review in the Cochrane Database of Systematic Reviews (2013, Issue 9) Bourke 2013.

Description of the condition

Cancer is a major public health issue. In 2015, there were 17.5 million cases of cancer globally, 8.7 million deaths and the disease is estimated to be responsible for 208 million disability adjusted life years (Global Burden of Disease Cancer Collaboration 2017). Age-standardised cancer mortality rates are decreasing (in the Western hemisphere), which is encouraging progress (Hashim 2016). However, although increasing numbers of cancer survivors live longer, this does not equate to living well. Survivors face a multitude of unique, debilitating health problems, even after treatment with curative intent. These range from an increased risk of recurrent cancers (Low 2014), persistent symptoms such as fatigue (Low 2014), ongoing poor health and well-being (Elliott 2011), and mental health comorbidity (Nakash 2014). The burden of these problems can lead to negative impacts on health-related quality of life (HRQoL) (Corner 2013). Throughout this review, the term we define as 'cancer survivor' is synonymous with someone 'living with and beyond cancer', in accordance with the Macmillan Cancer Support definition (Macmillan Cancer Support 2011).

Description of the intervention

The goal of any exercise intervention is to offer a sustained physiological challenge that, over time, will induce a spectrum of beneficial cardiovascular, respiratory, musculoskeletal, neurological, metabolic adaptations as well as bringing a host of psychosocial benefits. In the context of living with and beyond cancer, such adaptations underpin improvements in cancer-related fatigue, HRQoL and physical function (Mishra 2014; Stout 2017). The UK Chief Medical Officer recommends that in adults, weekly activity should add up to at least 150 minutes of moderate intensity aerobic activity, performed in bouts of 10 minutes or longer (Department of Health 2011), with similar international recommendations for cancer survivors (Rock 2012). For example, this could translate to 30 minutes of aerobic activity that raises heart rate and breathing rate, five times per week. Alternatively, 75 minutes of vigorous intensity aerobic activity spread across the week has been suggested to confer similar benefit (Schmitz 2010a).

We have deliberately chosen the term 'habitual' over 'regular' to reflect the intention to assess which interventions could both A) improve and B) sustain exercise behaviour. 'Regular exercise' can be applied to both short-term and long-term contexts, where as a 'habitual' exerciser indicates a sustained and regular pattern of behaviour. Whilst 'habitual' refers to the process of behavioural 'habit forming' and an automaticity of behaviour (Gardner 2011; Verplanken 2009), we recognise there are other theoretical principals underpinning physical activity behaviour (Kwasnica 2016).

How the intervention might work

Encouraging people to participate in regular exercise from a background of an inactive lifestyle is difficult, requiring attention to important psychosocial and behavioural influences (Kampshoff 2014; Ormel 2017). A major challenge is to provide a support structure for physical activity until it becomes a pattern of sustained healthy behaviour. Randomised controlled trials (RCTs) in cancer survivors have assessed a number of exercise interventions, with the aim of promoting short- and long-term habitual exercise. A wide range of approaches have been investigated; including supervised exercise and home-based exercise (Bourke 2014), and inclusive of group counselling sessions, (Rogers 2015). Tailored exercise interventions commonly comprise aerobic exercise training, strength training or a combination of both, with or without behaviour change support. Behaviour change theory within exercise interventions is often viewed as essential, with the UK Medical Research Council (MRC) recommending the use of theory in intervention development for complex interventions to help improve behaviour change (Craig 2008). However, the application of behaviour change theory or specific behaviour change techniques is often generally poor, unclear and not clearly examined for impact of effectiveness.

Why it is important to do this review

The majority of people living with and beyond cancer are not regularly active, with estimates ranging from less than 10% to 20% to 30% of cancer survivors meeting the physical activity guidelines (Garcia 2014). There are a number of important beneficial effects of exercise participation in cancer survivors reported from RCTs including improved HRQoL, reduced fatigue and improved physical function, (Bourke 2014; Dittus 2017; Meneses-Echavez 2015; Mishra 2012a; Mishra 2012b; Stout 2017). However, the original review (Bourke 2013) found that most of the current evidence comes from studies with short-term interventions and follow-up. Understanding which interventions are most efficacious in supporting the maintenance of long-term exercise behaviour is critical not just because of the HRQoL benefits (Bourke 2012a), but multiple observational reports link being regularly active to reduced chances of dying from cancer after diagnosis (Li 2016).

The original review showed that there is a poor understanding of how to encourage people living with and beyond cancer to meet current exercise recommendations (Bourke 2013). Poor study reporting standards was a pervasive issue e.g. failure to report adherence data. However, there were some useful data regarding the use of behaviour change techniques (BCTs). An updated review can firstly, offer insight as to whether interventions being tested in contemporary studies are mapping to the existing international recommendations i.e. the American Cancer Society (ACS) guidance (i.e. provided by Rock 2012). Secondly, this will allow us to evaluate if there have been any improvements in the quality of intervention reporting around specifics of set prescriptions (i.e. frequency, intensity, duration etc). Thirdly, and critically, we can use a larger data set from our updated searches to assess if both the quality of reporting of exercise adherence has improved and if there is more to learn about how to promote and sustain better adherence to exercise behaviour interventions in previously inactive cancer survivors.

In the UK, the Independent Cancer Taskforce strategy document sets out a number of initiatives to achieve world class outcomes in cancer; ensuring survivors have the best possible quality of life and improving rates of mortality. Promoting habitual exercise participation could help to accomplish these high priority agendas within the UK.

OBJECTIVES

Primary objective

To assess the effects of interventions designed to promote exercise behaviour in sedentary people living with and beyond cancer.

Secondary objectives

To address the following questions.

- Which interventions are most effective in improving aerobic fitness and skeletal muscle strength and endurance?
- What adverse effects are attributed to different exercise interventions?
- Which interventions are most effective in improving exercise behaviour amongst patients with different cancers?
- Which interventions are most likely to promote long-term (12 months or longer) exercise behaviour?
- What frequency of contact with exercise professionals and/or healthcare professionals is associated with increased exercise behaviour?
- What theoretical basis is most often associated with increased exercise behaviour?
- What behaviour change techniques are most often associated with increased exercise behaviour?

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs) that allocated participants or clusters of participants by a random method to an exercise-promoting intervention compared with usual care or 'waiting list' control. We included studies conducted both during and after primary treatment or during active monitoring. Only interventions that included a component targeted at increasing aerobic exercise and/or resistance exercise behaviour were included in this review. We did not include studies of heterogeneous cancer cohorts (i.e. participants with different primary cancer sites). We did not include studies in 'at risk' populations (i.e. studies involving individuals who have risk factors for cancer but who have not yet been diagnosed with the disease) that addressed primary prevention research questions.

Types of participants

We included only studies involving adults (18 years of age or older) who had a sedentary lifestyle or physically inactive at baseline (i.e. not undertaking 30 minutes or more of exercise of at least moderate intensity, three days per week, or 90 minutes in total of moderate intensity exercise per week). Participants must have been histologically or clinically diagnosed with cancer regardless of sex, tumour site, tumour type, tumour stage and type of anticancer treatment received. We excluded studies directed specifically at end-of-life-care patients and individuals who were currently hospital inpatients.

Types of interventions

For the purposes of this review, the phrases 'exercise' and 'physical activity' were used interchangeably. Definitions of exercise, related terms and nomenclature that describe the performance of exercise must adhere to principles of science and must satisfy the Système International d'Unités (SI), which was adopted universally in 1960. Hence, we referred to the appropriate, combined definition that applies to all situations: 'A potential disruption to homeostasis by muscle activity that is either exclusively or in combination, concentric, eccentric or isometric' (Winter 2009). Investigators must have reported the frequency, duration and intensity of aerobic exercise behaviour or frequency, intensity, type, sets and repetitions of resistance exercise behaviour that was prescribed in the intervention.

We acknowledge that the maximal aerobic capacity ($\dot{V}O_2$max)/peak is often the most informative metric for setting aerobic exercise intensity; however, given the nature of the population involved (elderly, potentially with multiple comorbidities), it is often difficult to conduct maximal testing protocols to prescribe intensity on the basis of this measures because of the requirements for medically qualified staff to be present during assessment. As such, for reasons of pragmatism, we accepted that exercise intensity is more frequently reported in cancer the cohorts in terms of age-predicted maximum heart rate(HR_{max}) or Borg Rating of Perceived Exertion (RPE) (Borg 1982). The interventions in this review were categorised as achieving a mild (less than 60% HR_{max}/10 RPE or less), moderate (60% to 84% HR_{max}/11 to 14 RPE) or vigorous (85% HR_{max} or more/15 RPE or more) exercise intensity.

Types of outcome measures

Primary outcomes

Aerobic exercise behaviour as measured by:

- exercise frequency (number of bouts per week);
- exercise duration (total minutes of exercise achieved);
- exercise intensity (e.g. % HR_{max}, RPE);
- estimated energy expenditure from free-living physical activity (e.g. from accelerometer readings (where available));
- adherence to the exercise intervention (% of exercise sessions completed/attended); total duration of intervention when ≥75% adherence is achieved (in weeks);
- total duration of sustained exercise behaviour meeting American Cancer Society guidelines for exercise in people living with and beyond cancer (Rock 2012; i.e. aim to exercise at least 150 minutes per week, with at least two days per week of strength training).

Resistance exercise behaviour as measured by:

- exercise frequency (number of bouts per week);
- exercise intensity (e.g. % of 1 repetition max or % of body mass);
- type of exercise (e.g. free weights, body weight exercise);
- repetitions;
- sets.

Secondary outcomes

- Change in aerobic fitness or exercise tolerance (maximal or submaximal when measured directly or by a standard field test).
- Change in skeletal muscle strength and endurance.
- Adverse effects.

- study recruitment rate.
- Intervention attrition rate.

Interventions were judged as successful in achieving exercise goals if investigators reported at least 75% adherence over a given follow-up period as done in the original review (Bourke 2013). Data on compliance with the intervention were quantified in terms of number of prescribed exercise sessions completed as a proportion of the total set. The intervention must have included at least six weeks of follow-up. Interventions were described according to whether they reported being based on a behaviour change theory e.g. control theory, social cognitive theory; (Bandura 2000; Bandura 2002; Carver 1982. This relates to the National Institute for Health and Clinical Excellence (NICE) guidance for behaviour change, which recommends that clinicians should be explicit about the theoretical constructs on which interventions are based (NICE 2007). Interventions were also coded using the 'Coventry, Aberdeen & London—Refined' (CALO-RE) taxonomy (Michie 2011). This is a validated taxonomy of behaviour change techniques (BCTs) that can be used to help people change their exercise behaviour. Coding interventions according to this taxonomy allows for a better understanding of which techniques are employed by current interventions and how they are related to short- and longer-term exercise behaviour change.

Search methods for identification of studies

Electronic searches

The searches were run for the original review from inception to August 2012. The subsequent searches from the following electronic databases were run from August 2012 up to 3 May 2018. We carried out the following searches:

- the Cochrane Central Register of Controlled Trials (CENTRAL; 2018, Issue 5) in The Cochrane Library;
- MEDLINE via OVID August 2012 to April week 4 2018;
- Embase via OVID August 2012 to 2018 week 18;
- AMED (Allied and Alternative Medicine Database; covers occupational therapy, physiotherapy and complementary medicine) August 2012 to May 2018;
- CINAHL (Cumulative Index to Nursing and Allied Health Literature) August 2012 to May 2018;
- PsycINFO (Database of the American Psychological Association) August 2012 to May 2018;
- SportDiscus (Sports Evidence Database) August 2012 to April 2017;
- PEDro (Physiotherapy Evidence Database) August 2012 to April 2017.

The search strategies are presented in the Appendices, with both the 2018 updated strategy and previous 2012 strategy reported. CENTRAL search strategy is presented in Appendix 1 and the MEDLINE search strategy in Appendix 2. For databases other than MEDLINE, we adapted the search strategy accordingly: Embase (Appendix 3), AMED (Appendix 4), CINAHL (Appendix 5) PsycINFO (Appendix 6) PEDro (Appendix 7) SportsDiscus (Appendix 8).

The search strategies were developed with the Cochrane Gynaecological Cancer Group Information Specialist and included MeSH and text word terms as appropriate.

Searching other resources

We used snowballing, by searching reference lists of retrieved articles and published reviews on the topic.

We expanded the database search by identifying additional relevant studies for this review, including unpublished studies and references in the grey literature. This was done by searching the OpenGrey database (www.opengrey.eu/), which includes technical or research reports, doctoral dissertations, conference papers and other types of grey literature. We also searched the following clinical trials web pages.

- World Health Organisation apps.who.int/trialsearch/Default.aspx
- National cancer institute www.cancer.gov/about-cancer/treatment/clinical-trials/search

Furthermore, we wrote to Cancer Research UK (CRUK), Macmillan Cancer Support, the World Cancer Research Fund (WCRF), Worldwide Cancer Research , the American Association for Cancer Research (AACR), the American Cancer Society (ACS) and the American Society of Clinical Oncology (ASCO) to enquire about relevant unpublished papers.

Data collection and analysis

Since publication of the previous version of this review, we have included the use of the GRADE assessment to assess the quality of the evidence and produced a Summary of findings for the main comparison.

Selection of studies

We imported results from each database into the reference management software package Endnote, from which we removed duplicates. After training on the first 100 references retrieved from two different databases to ensure a consistent approach, two review authors (RT and HQ) worked independently to screen all titles and abstracts to identify studies that met the inclusion criteria, or that could not be safely excluded without assessment of the full text (e.g. when no abstract was available). Disagreements were resolved by discussion with another review author (LB). Full texts were retrieved for these articles.

After training was provided to ensure a consistent approach to study assessment and data abstraction, two review authors worked independently to assess the retrieved full texts (RT and HQ). We linked together multiple publications and reports on the same study. Studies that appeared to be relevant but were excluded at this stage are listed in the 'Characteristics of excluded studies' table. We resolved disagreements by discussion with other group members. We attempted to contact study corresponding authors if we could not access a full text (e.g. if only an abstract was available), if we required more information to determine whether a study could be included (e.g. to determine baseline exercise behaviour of a cohort), or if we required supplementary information about an already eligible study (please also see Excluded studies).

Data extraction and management

Review authors (RT and LB) extracted the following data using the same data extraction form used in the original review and entered data into RevMan 5.3 (Review Manager 2014).

- Study details: author; year; title; journal; research question/ study aim; country where the research was carried out; funding source; recruitment source (e.g. consecutive sampling from outpatient appointments; advertising in the community; convenient sample from support groups); inclusion and exclusion criteria; study design (cluster RCT, non-cluster RCT, single centre or multi-centre); sample size; number of participants per arm; length of follow-up; description of usual care.
- Intervention details: categorisation of intervention (e.g. supervised, independent, educational); setting (e.g. dedicated exercise facility, community, home); exercise prescription components (e.g. aerobic exercise, resistance exercise, stretching); theoretical basis, behaviour change techniques (using CALO-RE taxonomy), frequency of contact with an exercise professional and or healthcare professional; instructions to controls.
- Participant characteristics: primary cancer diagnosis; any cancer treatment currently undertaken; metastatic disease status; age; sex; body mass index (BMI); ethnicity; reported comorbidities.
- Resulting exercise behaviour: method of measuring exercise (e.g. self-report questionnaire). Numbers of participants randomly assigned and assessed at specified follow-up points. Frequency, duration, intensity of aerobic exercise achieved; frequency, intensity, type, sets and repetitions of resistance exercise achieved; total duration of the intervention; total duration of sustained meaningful exercise behaviour as a result of the intervention and whether the Rock 2012 guidelines were met, adherence to the intervention; rate of attrition and adverse effects reported.
- Resulting change in other outcomes: changes in aerobic fitness and estimated energy expenditure from free-living physical activity.

Three members of the group worked independently (RT, RG and LS) to extract data from all eligible papers using the data collection form. Data were entered into the Cochrane's statistical software, Review Manager 2014, by one review author and checked by a second review author.

Assessment of risk of bias in included studies

Risk of bias and methodological quality were assessed in accordance with Cochrane's tool for assessing risk of bias (Higgins 2011). The tool includes the following seven domains:

- sequence generation (method of randomisation);
- allocation concealment (selection bias);
- blinding (masking) of participants and personnel (detections bias);
- blinding (masking) of outcome assessors (detection bias);
- incomplete outcome data;
- selective outcome reporting;
- other sources of bias.

However, we did not include blinding to group allocation, as it is not possible (e.g. in a supervised exercise setting) to blind participants to an intervention while promoting exercise behaviour. Two review authors (RT and RG) independently applied the 'Risk of bias' tool, and differences were resolved by discussion with a third review author (LB). We summarised results in both a 'Risk of bias' graph and a 'Risk of bias' summary. Results of meta-analyses were interpreted in light of the findings with respect to risk of bias. We contacted study authors to ask for additional information or for further clarification of study methods if any doubt surrounded potential sources of bias. Individual 'Risk of bias' items can be seen in Appendix 9.

Measures of treatment effect

For the purposes of this review, all exercise behaviour was synthesised as specified in the primary outcomes. For comparison of measures of change in fitness levels or estimated energy expenditure from free-living physical activity, please see the section on 'Continuous data' in Data synthesis.

Unit of analysis issues

We did not include any cross-over trials in this review because of the high risk of contamination. It can be very difficult to “wash out” exercise behaviour. Cancer survivors in particular can be a highly-motivated cohort, and significant contamination has been reported even in conventional RCT settings (Courneya 2003; Mock 2005). Hence this learning effect distorts results. Furthermore, asking individuals to revert to sedentary behaviour could be considered unethical (Das 2012). Therefore, any cross-over trials identified were rejected at the title and abstract screening stage.

Dealing with missing data

We assessed missing data and dropout rates for each of the included studies and reported the numbers of participants included in the final analysis as a proportion of all participants included in the study. We assessed the extent to which studies conformed to an intention-to-treat analysis.

Assessment of heterogeneity

Consistency of results was assessed visually and through examination of the I^2 statistic, a quantity that describes approximately the proportion of variation in point estimates that is due to heterogeneity rather than sampling error.An I^2 greater than or equal to 50% was considered significant heterogeneity. We addressed this by performing a sensitivity analysis that excluded any heterogeneous trials. We supplemented this with a test of homogeneity to determine the strength of evidence that the heterogeneity was genuine. When significant statistical heterogeneity was detected, differences in characteristics of the studies or other factors were explored as possible sources of explanation. Any differences were summarised in a narrative synthesis.

Assessment of reporting biases

Publication bias

We intended to examine funnel plots corresponding to meta-analysis of the primary outcomes to assess the potential for small study effects such as publication bias if a sufficient number of studies (i.e. more than 10) was identified. However, this was not the case; therefore this step was not included in the analysis.

Data synthesis

Continuous data

For continuous outcomes (e.g. cardiorespiratory fitness), we extracted the final value, the standard deviation (SD) of the outcome of interest and the number of participants assessed at endpoint for each treatment arm at the end of follow-up, to estimate standardised mean differences (SMD) between treatment arms.

Dichotomous outcomes

For dichotomous outcomes (e.g. adverse effects, deaths), if it was not possible to use a hazard ratio (HR), we extracted the number of participants in each treatment arm who experienced the outcome of interest and the number of participants assessed at endpoint, to estimate a risk ratio (RR).

Meta-analysis

When possible, and if appropriate, we performed a meta-analysis of review outcomes. If statistical heterogeneity was noted, a meta-analysis was performed using a random-effects model. We planned to use a fixed-effect model if no significant statistical heterogeneity was observed.

When possible, all data extracted were those relevant to an intention-to-treat analysis in which participants were analysed in groups to which they were assigned. We noted the time points at which outcomes were collected and reported.

Subgroup analysis and investigation of heterogeneity

If a sufficient number of studies were identified, we performed subgroup analyses for the following.

- Cancer site.
- Type of intervention (i.e. supervised, home-based, etc).
- Age of individuals (i.e. elderly versus non-elderly).
- Current treatment (currently undergoing treatment versus not currently undergoing treatment).
- Participants with metastatic disease (metastatic cohort versus non-metastatic cohort).
- Accordance with behaviour change theory.
- Interventions in obese individuals (mean body mass index (BMI) of intervention group > 30 kg/m^2 versus mean BMI of intervention group < 30 kg/m^2).

Sensitivity analysis

Methodological strength was judged using Cochrane's tool for assessing risk of bias to identify studies of high and low quality (Higgins 2011). Sensitivity analyses were performed with the studies of low quality excluded.

Summary of findings

To assess the overall quality of the evidence for each outcome of the meta-analysis, we employed the GRADE approach. The GRADE profile (https://gradepro.org) enabled us to import data directly from Review Manager 5.3 to create Summary of findings for the main comparison. These tables provide outcome-specific information concerning the overall certainty of the evidence from studies included in the meta-analysis. Risk of bias, inconsistency of the data, the preciseness of the data publication bias and the indirectness of the data were all considered in assessing the quality of the data.

We downgraded the evidence from 'high' certainty by one level for serious (or by two for very serious) concerns for each limitation.

- **High certainty:** we are very confident that the true effect lies close to that of the estimate of the effect.
- **Moderate certainty:** we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
- **Low certainty:** our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
- **Very low certainty:** we ha*ve v*ery little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

The following outcomes were included in the 'Summary of findings' table.

- Aerobic exercise tolerance (all cancers: eight to 12 weeks of follow-up)
- Aerobic exercise tolerance (all cancers: eight to 12 weeks of follow-up sensitivity analysis)
- Aerobic exercise tolerance (all cancers: six months of follow-up)
- Aerobic exercise tolerance (breast cancer: eight to 12 weeks of follow-up)
- Aerobic exercise tolerance (all cancers: combination of supervised and home-based exercise: eight to 12 weeks of follow-up)
- Aerobic exercise tolerance (all cancers: supervised exercise: eight to 12 weeks of follow-up)
- Aerobic exercise tolerance (all cancers: home-based exercise: eight to 12 weeks of follow-up)

RESULTS

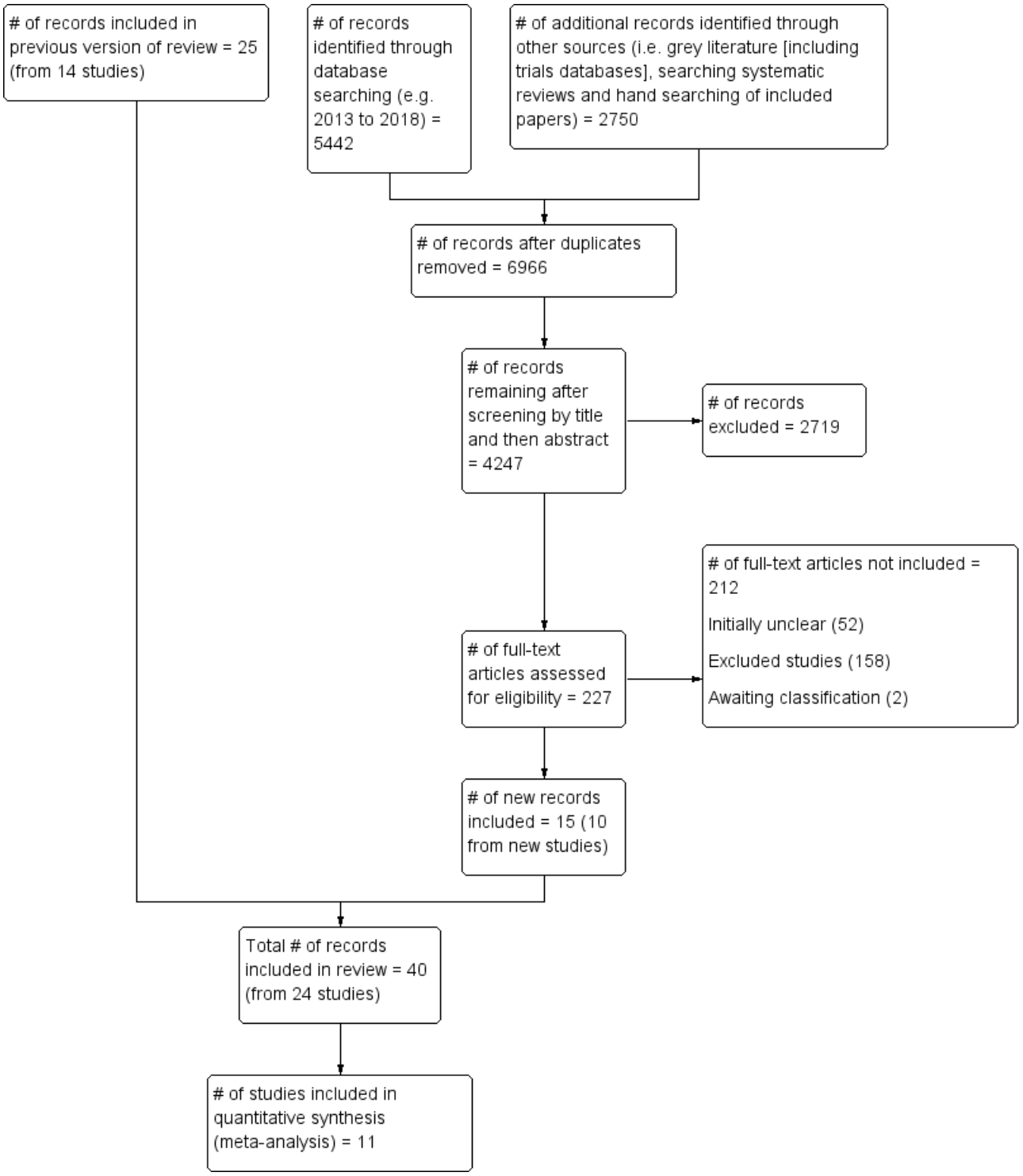
Description of studies

Please see Table 1, 'Summary of included studies'. See 'Characteristics of included studies'; 'Characteristics of excluded studies'; 'Characteristics of studies awaiting classification'; and 'Characteristics of ongoing studies'.

Results of the search

Figure 1 illustrates the process of the literature search and study selection for the review. The updated search identified 5442 unique records from databases searched. In addition, we identified 2750 records from grey literature and 'snowballing' techniques for this update. Given that the details of prescribed exercise are rarely reported in manuscript abstracts (e.g. frequency, intensity, duration of exercise prescription), this led to evaluation of a large number of manuscripts at full text stage (n = 227). From these full-text articles, 212 manuscripts were excluded, leaving 15 publications from 10 unique studies included in the review (total unique studies = 23). Reasons for excluding these 212 publications and a subset of the original review total (n = 377) are covered in the Excluded studies section below.

Figure 1. PRISMA flow diagram.



Included studies

This update identified 15 publications from 10 new studies, which when combined with the studies from the original review equates to 40 publications in total from 23 studies. (al-Majid 2015; Bourke 2014; Cadmus 2009; Campbell 2017; Cantarero-Villanueva 2012b; Cavalheri 2017; Daley 2007a; Drouin 2005; Hayes 2009; Irwin 2015; Kaltsatou 2011; Kim 2006; Kim 2017; McKenzie 2003; Mohamady 2017; Musanti 2012; Perna 2010; Pinto 2003; Pinto 2005; Pinto 2011; Rogers 2015; Scott 2013; Thomas 2013). One study (Bourke 2014) was a efficacy study, following on from a previous feasibility study (Bourke 2011a) from the original review.

For the 2018 update, we sent an additional 112 emails to request unpublished information for manuscripts that were unclear in reporting relative to our inclusion and exclusion criteria. We were able to include an additional seven published manuscripts and to exclude an additional eight published manuscripts on the basis of information received in correspondence from authors.

Only randomised controlled trials (RCTs) were included in the review. All included studies used a parallel-group design with baseline assessment and follow-up of 12 months maximum. All included studies were conducted using participant-level randomisation. The format of reporting precluded data extraction for meta-analytical combination in two studies (Drouin 2005; Pinto 2003). Sample size ranged from 14 to 222, with a total of 1372 participants included in this review (mean age range 51 to 72).

Participants

Twenty of the included trials were on breast cancer survivors (al-Majid 2015; Cadmus 2009; Campbell 2017; Cantarero-Villanueva 2012b; Daley 2007a; Drouin 2005; Hayes 2009; Irwin 2015; Kaltsatou 2011; Kim 2006; Kim 2017; McKenzie 2003; Mohamady 2017; Musanti 2012; Perna 2010; Pinto 2003; Pinto 2005; Rogers 2015; Scott 2013; Thomas 2013); only two studies involved colorectal cancer (Bourke 2011a; Pinto 2011), one prostate cancer (Bourke 2014,) and one lung cancer (Cavalheri 2017). Of these studies, 12 included participants who were currently undergoing active treatment inclusive of hormone-based therapy (al-Majid 2015; Bourke 2014; Cadmus 2009; Daley 2007a; Drouin 2005; Irwin 2015; Kim 2006; Mohamady 2017; Musanti 2012; Perna 2010; Pinto 2005; Scott 2013). We found only one study that reported data from participants with metastatic disease (Bourke 2014), and six studies that were conducted in obese cohorts (i.e. mean BMI > 30 kg/m^2; (Cadmus 2009; Drouin 2005; Mohamady 2017; Rogers 2015; Scott 2013; Thomas 2013). The majority of participants were white, and only five studies reported data from an ethnically diverse sample (al-Majid 2015; Irwin 2015; Perna 2010; Rogers 2015; Thomas 2013). Comorbidities at baseline were largely unclear or unreported.

Interventions

Type of exercise

Fourteen studies prescribed exclusively aerobic exercise (al-Majid 2015; Cadmus 2009; Campbell 2017; Cantarero-Villanueva 2012b; Daley 2007a; Drouin 2005; Kaltsatou 2011; Kim 2006; Mohamady 2017; Pinto 2003; Pinto 2005; Pinto 2011; Rogers 2015; Thomas 2013); the remaining RCTs used a mix of aerobic and resistance training (no exclusively resistance training studies met our inclusion criteria). Ten studies used a combination of supervised and home-based exercise (Bourke 2011a; Bourke 2014; Cadmus 2009; Campbell 2017; Hayes 2009; Irwin 2015; Kim 2006; Perna 2010; Pinto 2003; Rogers 2015), four studies opted to use an exclusively home-based design (Drouin 2005; Musanti 2012; Pinto 2005; Pinto 2011), and 10 studies were exclusively supervised studies (al-Majid 2015; Cantarero-Villanueva 2012b; Cavalheri 2017; Daley 2007a; Kaltsatou 2011; Kim 2017; McKenzie 2003; Mohamady 2017; Scott 2013; Thomas 2013).

Exercise sessions and the role of exercise professionals and healthcare professionals

Contact with exercise professionals or study researchers ranged from two to three weekly supervised sessions (Rogers 2015), to weekly phone calls after an initial one-to-one exercise consultation (Pinto 2005; Pinto 2011). Most commonly however, supervised sessions were offered two to three times per week. Of note, seven studies (Drouin 2005; Kaltsatou 2011; Kim 2006; McKenzie 2003; Pinto 2003; Pinto 2005; Pinto 2011), placed restrictions on the control group regarding exercise behaviour during the course of the study, usually taking the form of direct instruction to refrain from changing exercise behaviour. However, the 2018 update found no additional studies that placed restrictions on the control group, usual activities were encouraged. Contact with healthcare professionals was not frequent amongst the studies, with three studies having healthcare professionals carry out medical assessments for eligibility (Cantarero-Villanueva 2012b; Kim 2017; Mohamady 2017), two studies having oncologists refer the participants onto the study, but it was not stated explicitly if they delivered any aspects of the intervention (al-Majid 2015; Campbell 2017).

Level of exercise and adherence

Thirteen studies incorporated prescriptions that would meet the Rock 2012 recommendations for aerobic exercise (i.e.150 minutes per week); (Cadmus 2009; Campbell 2017; Cantarero-Villanueva 2012b; Pinto 2011; Rogers 2015) or resistance exercise (i.e. resistance training strength training exercises at least two days per week); (Bourke 2011a; Bourke 2014; Cavalheri 2017; Irwin 2015; Kim 2017; Musanti 2012; Perna 2010; Scott 2013). However, only eight of these studies reported 75% adherence to these guidelines, (Bourke 2011a; Bourke 2014; Campbell 2017; Cantarero-Villanueva 2012b; Irwin 2015; Kim 2017; Rogers 2015; Scott 2013).

Theoretical basis

Of the interventions provided, only six were explicitly based on a theoretical model (Daley 2007a; Musanti 2012; Perna 2010; Pinto 2005; Pinto 2011; Rogers 2015); the trans-theoretical model was most common, followed by social cognitive theory and exercise, and self-esteem theory. Only one intervention from the 2018 update was found to be based on a theoretical model (Rogers 2015).

Behaviour change techniques (BCT) and adherence

Full details of intervention BCT coding according to the CALO-RE taxonomy for the previous review (Bourke 2013) and the 2018 update can be seen in Table 2 and Table 3 (respectively). In the previous review, there was a lack of identified studies that met the Rock 2012 guidelines. For this updated version of the review, our searches found more instances of studies (eight in total) that meet the 150 minutes per week or two strength sessions per week Rock 2012 target. Also, there were other studies with lower exercise targets but good adherence (i.e. over 75%). Hence, we presented BCTs in a hierarchy format: Tier 1 and Tier 2. Tier 1 BCTs are presented from interventions that set prescriptions which meet the Rock 2012 target and achieved 75% or more adherence. Tier 2 BCTs are presented from interventions that reported good adherence (i.e. 75% or more) but set prescriptions that are below the 150 minutes per week Rock 2012 target. BCTs reported in the eight Tier 1 trials are presented in Table 4. It is notable that four of these studies incorporated both a supervised and an independent exercise component as part of their intervention and four were exclusively supervised, with all placing no restrictions on the control group in terms of exercise behaviour. Six studies were included in Tier 2 BCTs and reported adherence of 75% or greater to a specified exercise aerobic prescription which was lower than the targets set in the Rock 2012 guidelines (al-Majid 2015; Bourke

2011a; Bourke 2014; Cadmus 2009; Kim 2017; Scott 2013). BCTs reported in Tier 2 studies are presented in Table 5.

Few interventions (Bourke 2014; Cadmus 2009; Daley 2007a; Kim 2006; Perna 2010; Rogers 2015) reported providing information on the consequences of behaviour (BCT #1). All interventions had programme set goals, which we have highlighted as being different for the purpose of this review to goal setting (behaviour) and goal setting (outcome). Only seven studies set exercise goals in conjunction with participants (BCT # 5) (Bourke 2014; Cadmus 2009; Daley 2007a; Perna 2010; Pinto 2005; Pinto 2011; Rogers 2015). These same seven studies also reported problem-solving with barriers identified (BCT #8) and solutions facilitated. Three interventions (Daley 2007a; Perna 2010; Rogers 2015) which participants had some input into setting of goals were these reviewed (BCT #10). When monitoring did occur (BCT #16) or monitoring of outcome behaviour occurred (BCT #17), feedback on performance (BCT #19) was provided in only five out of 10 (Cadmus 2009; Perna 2010; Pinto 2005; Pinto 2011; Rogers 2015), which is important to note. Fourteen studies (Bourke 2011a; Bourke 2014; Cadmus 2009; Daley 2007a; Drouin 2005; Hayes 2009; Kaltsatou 2011; Kim 2006; Musanti 2012; Perna 2010; Pinto 2003; Pinto 2011; Rogers 2015; Scott 2013) reported providing instruction on how to perform the behaviour (BCT #21), although it may be anticipated that this did occur but just was not reported. In addition, 15 studies prompted practise of the behaviour (BCT #26) (Bourke 2011a; Bourke 2014; Cadmus 2009; Daley 2007a; Drouin 2005; Hayes 2009; Kaltsatou 2011; Kim 2006; McKenzie 2003; Musanti 2012; Perna 2010; Pinto 2003; Pinto 2005; Pinto 2011; Rogers 2015), Only four studies used techniques to increase social support (BCT #29); (Bourke 2014; Cadmus 2009; Daley 2007a; Perna 2010). Other common BCTs included setting of graded tasks (i.e. increased exercise duration or intensity over time) and self-monitoring of behaviour (exercise) and outcomes of behaviour (e.g. heart rate), although it is not clear for all interventions whether this was done primarily for data collection or as a mechanism of behaviour change.. Only three studies reported relapse prevention (BCT #35) (Daley 2007a; Perna 2010; Rogers 2015).

Measurement of exercise behaviour

Ten studies were identified that attempted to objectively validate independent exercise behaviour with accelerometers or heart rate monitoring (al-Majid 2015; Bourke 2014; Cadmus 2009; Irwin 2015; Mohamady 2017; Pinto 2005; Pinto 2011; Rogers 2015; Scott 2013; Thomas 2013). Seven of these studies attempted to validate self-reported independent exercise behaviour by using accelerometers or heart rate monitors (al-Majid 2015; Bourke 2014; Irwin 2015; Pinto 2005; Pinto 2011; Rogers 2015; Thomas 2013), however in three studies (Pinto 2005; Pinto 2011; Rogers 2015), data either were not supportive of exercise behaviour recorded by participants or were not reported in their entirety.

Excluded studies

Reasons for excluding published studies included the following.

- Non-RCTs (e.g. review manuscripts, comment/editorial articles).
- Mixed cancer cohorts or cohorts that included non-cancer populations.
- Studies that failed to describe essential metrics of exercise prescription used in the intervention (e.g. frequency, intensity, duration).
- Studies involving active participants at baseline.
- Studies involving hospital inpatients.
- Interventions that provided follow-up of less than 6 weeks.
- Studies involving participants younger than 18 years of age.

All excluded studies (N = 180) for the 2018 update, are presented in the Characteristics of excluded studies. However for the original review only a subset of excluded studies could be included in the 'Characteristics of excluded studies' section. This is a result of the large volume of studies that had to be full text screened (N = 402) and the high proportion (around 90%) that were excluded. In accordance with editorial advice, we divided this large number (N = 365) into initially unclear studies that required further investigation (N = 76) and those that clearly were not eligible after full text had been retrieved (N = 289). This approach is analogous to the approach adopted in recent reviews (Galway 2012), and is detailed in the existing PRISMA diagram (Figure 1).

For the 2018 update, we sent an additional 101 emails to corresponding authors to request additional information (regarding included studies, excluded studies and studies that we could not access) to determine eligibility and to supplement published data for this review.

Risk of bias in included studies

Only seven studies were judged not to include a high risk of bias (al-Majid 2015; Bourke 2011a; Cadmus 2009; Cantarero-Villanueva 2012b; Drouin 2005; Irwin 2015; Scott 2013). Full results of the methodological quality assessment for allocation bias, blinding, incomplete data outcome and selective reporting (along with justifications) are covered in the 'Risk of bias' tables for each study and are illustrated in Figure 2; Figure 3. Twelve studies stated that an intention-to-treat analysis was used (Bourke 2011a; Bourke 2014; Cadmus 2009; Cantarero-Villanueva 2012b; Cavalheri 2017; Daley 2007a; Irwin 2015; Perna 2010; Pinto 2005; Rogers 2015; Scott 2013; Thomas 2013).

Figure 2. 'Risk of bias' summary: review authors' judgements about each risk of bias item for each included study.

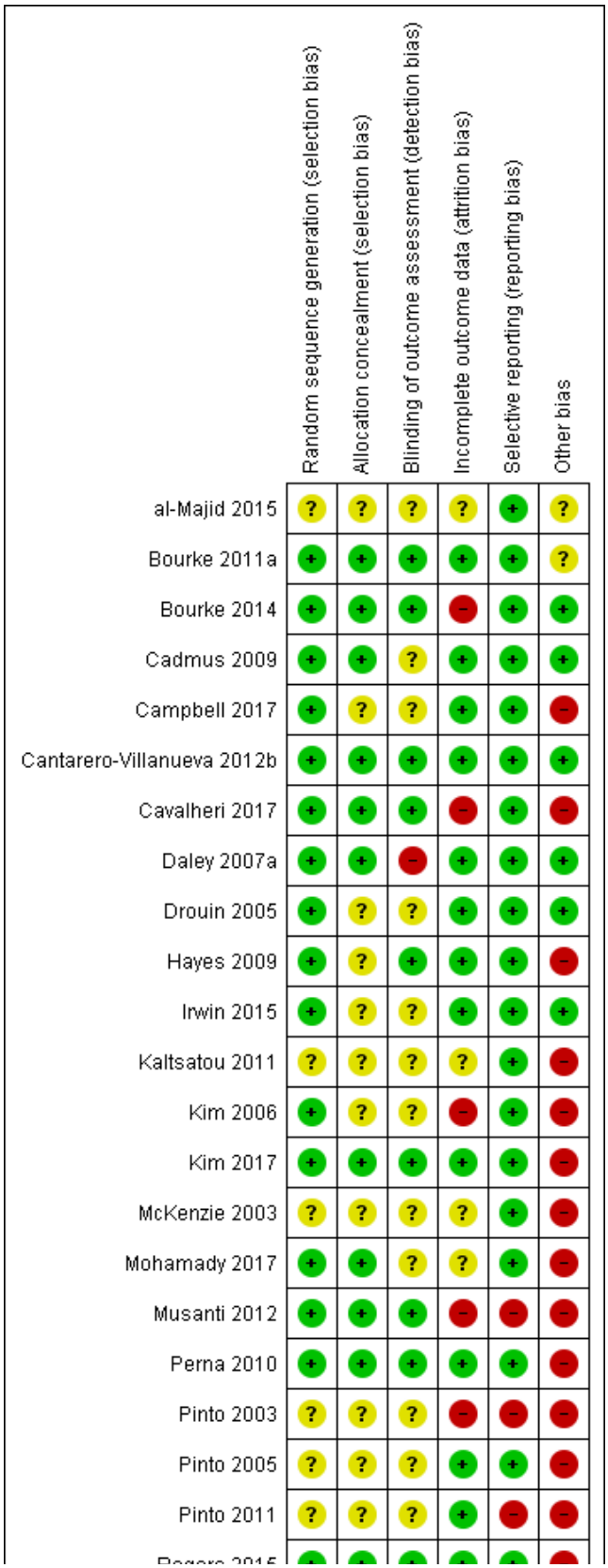


Figure 2. (Continued)

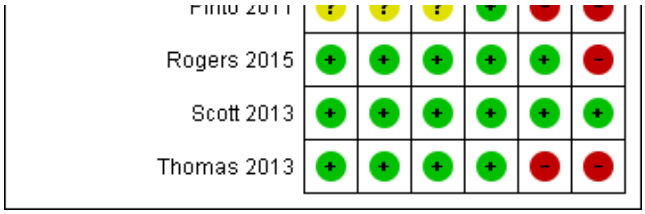
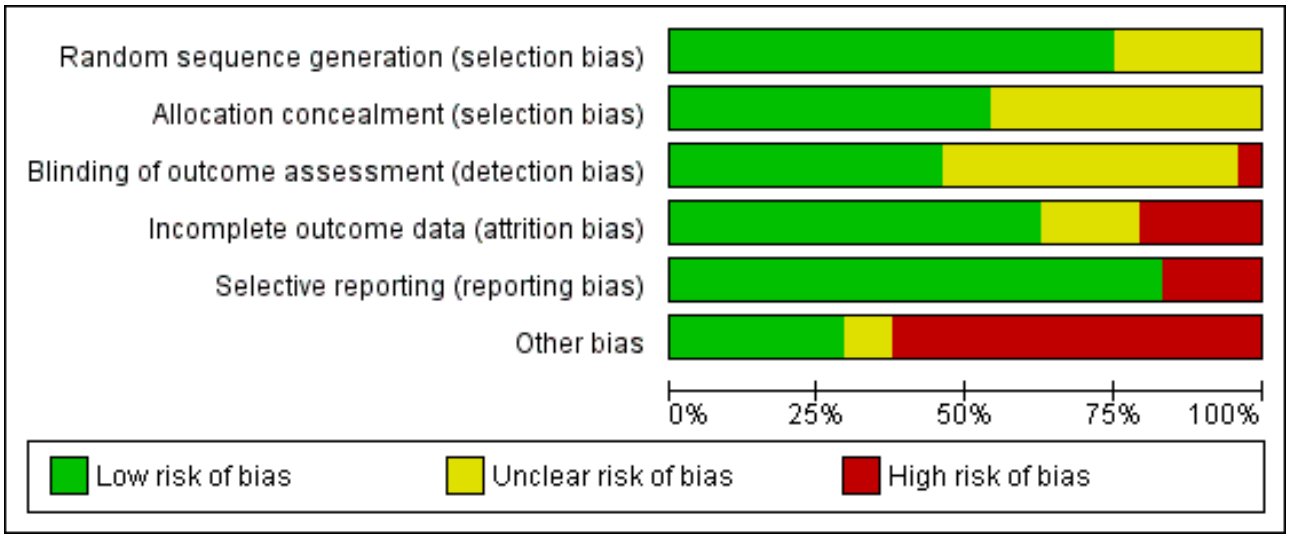


Figure 3. 'Risk of bias' graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Allocation

Eleven studies had an unclear risk in their description of concealment in randomisation allocation. However, no study was judged to have a high risk of bias in this respect.

Blinding

Eleven studies had undertaken the blinding of study assessors (Bourke 2011a; Bourke 2014; Cantarero-Villanueva 2012b; Cavalheri 2017; Hayes 2009; Kim 2017; Musanti 2012; Perna 2010; Rogers 2015; Scott 2013; Thomas 2013). The remaining studies did not include enough information for the review authors to make a definitive judgement on this criterion.

Incomplete outcome data

Five studies were judged to have been subject to incomplete data outcome bias: Kim 2006 reported data from only 41 of 74 participants randomly assigned; Musanti 2012 reported that 13 women (24%) did not complete their assigned 12-week programme; and Pinto 2003 did not report control group data for the exercise tolerance test. Bourke 2014 had incomplete outcome data at six months follow-up. Cavalheri 2017 reported missing patient data in both arms with no reasons given.

Selective reporting

Most studies reported all listed outcomes; however, four studies were judged to omit outcomes from their results reporting. Musanti 2012 did not report waist and upper, mid and lower arm circumference outcomes; Pinto 2003 reported none of the physiological assessments in the control group at 12 weeks of follow-up; Pinto 2011 did not report data derived from the use of accelerometers; and Thomas 2013 did not report on body fat or lean mass values and no data were given from food frequency questionnaire.

Other potential sources of bias

Other sources of bias found in the included studies that are worth highlighting include adherence data missing or not clear (Cavalheri 2017; Hayes 2009; Kaltsatou 2011; Kim 2017; McKenzie 2003; Mohamady 2017; Musanti 2012); high attrition at follow-up (Pinto 2003); low recruitment rate (Bourke 2011a; Campbell 2017; Thomas 2013); Significant differences in participants excluded from study analysis/dropouts (Kim 2006; Musanti 2012; Pinto 2003); numbers randomly assigned to study arms with study completion rate unclear (Perna 2010); significant differences in cohorts at baseline (Kim 2017; Musanti 2012; Pinto 2003; Pinto 2005); and inconsistencies between objective and subjective measures of exercise behaviour (Pinto 2005; Pinto 2011; Rogers 2015). Insufficient information was reported to permit a judgement about any single element of bias because of lack of data (al-Majid 2015; Bourke 2011a; Cadmus 2009; Campbell 2017; Drouin 2005; Hayes 2009; Irwin 2015; Kaltsatou 2011; Kim 2006; McKenzie 2003; Mohamady 2017; Pinto 2003; Pinto 2005; Pinto 2011).

Effects of interventions

See: **Summary of findings for the main comparison** Exercise interventions compared to usual care for promoting habitual exercise in people living with and beyond cancer to improve aerobic exercise tolerance

Primary outcome

To assess the effects of interventions designed to promote exercise behaviour in sedentary people living with and beyond cancer

Please see Table 1, 'Summary of included studies'. As it is not meaningful to interpret individually the component metrics of aerobic (frequency, intensity and duration) or resistance exercise (frequency, intensity, type of exercise, sets and repetitions) behaviour, these primary outcomes are presented in the narrative synthesis below of interventions achieving 75% or greater adherence.

In Rogers 2015, adherence to planned intervention components was 98% for supervised exercise sessions, 96% for update sessions, and 91% for discussion group sessions. Only five participants did not receive the allocated intervention (i.e. did not complete 75 % of all intervention components combined). With the intervention group reporting an average of 169 minutes of moderate intensity exercise per week at 12 weeks, and 137 minutes of moderate intensity exercise per week at six months. Although, there is a high risk of bias around how 'in-active' the recruited participants were at baseline, as baseline accelerometer recordings are incongruent with the inclusion criteria.

Four of the studies included in this review reported that 75% or more of the intervention group met the (Rock 2012) aerobic exercise guidelines at any given follow-up (Campbell 2017; Cantarero-Villanueva 2012b; Irwin 2015; Rogers 2015). Four studies reported that 75% or more of the intervention group met the (Rock 2012) resistance exercise guidelines. (Bourke 2011a; Bourke 2014; Kim 2017; Scott 2013). Behaviour change techniques (BCTs) reported in these eight studies are presented in Table 4. Of these studies, only one study explicitly stated it had theoretical basis (Rogers 2015).

Due to of unclear reporting it was not possible to make a judgement on whether some trials achieved adherence of 75% or greater . Reasons for an unclear judgement or unsuccessful adherence are detailed below.

- Daley 2007a: judgement unclear; adherence reported as a proportion of participants attending a proportion of set exercise sessions (i.e. 77% of the intervention group attending 70% of sessions).
- Drouin 2005: judgement unclear; adherence reported as mean number of days per week when exercise was undertaken, relative to a range within the prescription (i.e. 3.6 days per week, when the prescription was for three to five days per week).
- Kaltsatou 2011: judgement unclear; no adherence data reported.
- Kim 2006: judgement unclear; high adherence was reported (78%), but in tandem with substantial attrition (i.e. data missing for 45% of the cohort).
- Pinto 2003: judgement unclear; high adherence was reported (88%) but in tandem with substantial attrition (i.e. 25% of the intervention group dropped out over the intervention period).
- Pinto 2005: judgement unsuccessful; 75% adherence threshold was not met after week four.
- Pinto 2011: judgement unsuccessful; three-day Physical Activity Recall (PAR) questionnaire indicates that 64.7% of the intervention group and 40.9% of controls were adhering to the exercise guidelines at three months.
- Hayes 2009: judgement unclear; adherence reported as a proportion of participants attending a proportion of set exercise sessions (i.e. 88% allocated to the intervention group participated in 70% or more of scheduled supervised exercise sessions). Further, adherence from the unsupervised aspect is not reported.
- McKenzie 2003: judgement unclear; no adherence data reported.
- Musanti 2012: judgement unclear; high adherence reported but only 50% of activity logs returned.
- Perna 2010: judgment unclear; women assigned to the structured intervention completed an average of 83% of their scheduled hospital-based exercise sessions (four weeks in total). Home-based adherence is not clear.
- Mohamady 2017: judgement unclear; no adherence data reported.
- Thomas 2013: judgement unsuccessful; the goal of the intervention was for participants to achieve 150 minutes of moderate intensity exercise per week; 33% of the intervention group achieved 150 minutes per week, 56% of the intervention group achieved 120 minutes per week and 75% achieved 90 minutes per week.
- Irwin 2015: judgement unsuccessful; resistance exercise - an average of 70% of strength-training sessions completed.
- Cavalheri 2017: judgement unsuccessful; of the nine participants randomised to the exercise intervention, four (44%) adhered to exercise training by completing 15 or more training sessions (i.e.≥60%).

Ideally, a meta-analysis of objectively verified (e.g. using accelerometers or heart rate monitoring) minutes per week of moderate intensity aerobic exercise achieved in an intervention group, compared with controls, for whom the exercise prescription adherence is at least 75%, would be most informative. However, due to variation in measurement and reporting amongst included studies, this was not possible. Insufficient data were available for a synthesis of evidence to be conducted around free-living energy expenditure.

Secondary outcomes

Aerobic exercise tolerance

1.1 All cancers: eight to 12 weeks of follow-up

A meta-analysis of change in aerobic exercise tolerance was carried out on 10 studies that reported these outcomes and also reported means for final value scores. Standardised mean differences (SMDs) were used to produce effect estimates as variation in how studies assessed this outcome was evident. Standard deviations (SDs) were calculated from 95% confidence intervals (CIs) using the formula in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011) (i.e. SD = √N * (upper limit-lower limit)/(t distribution

2), and from standard errors (SEs) using SD = SE√N, when they were not reported. Length of follow-up ranged from eight (Cavalheri 2017; Daley 2007a; Kim 2006), to 12 weeks (al-Majid 2015; Bourke 2011a; Bourke 2014; Musanti 2012; Pinto 2005; Pinto 2011; Rogers 2015) . Aerobic exercise tolerance was significantly better in intervention versus control groups in 604 participants: (SMD 0.54, 95% CI 0.37 to 0.70; 10 studies, 604 participants: low-certainty evidence; Analysis 1.1). Results were analysed using a fixed-effect model. Certainty of the evidence assessed using GRADE and was graded as low. As there was some serious concerns over risk of bias and concerns over the number of small studies with positive results (please see Summary of findings for the main comparison).

1.2 All cancers: eight to 12 weeks of follow-up (sensitivity analysis)

We then removed studies with a high risk of bias relative to this outcome and repeated the analysis with the four remaining studies (al-Majid 2015; Bourke 2011a; Bourke 2014; Pinto 2005), and aerobic exercise tolerance was better in intervention versus control groups (SMD 0.85, 95% CI 0.56 to 1.14; 4 studies, 201 participants; low-certainty evidence; Analysis 1.2). The certainty of the evidence was graded as low using GRADE as there were concerns imprecision as there were variations in effect sizes and concerns over the low number of participants in the studies (please see Summary of findings for the main comparison).

1.3 All cancers: six months of follow-up

Seven studies included data from a follow-up of six months (Bourke 2014; Daley 2007a; Kaltsatou 2011; Pinto 2005; Pinto 2011; Rogers 2015; Scott 2013) showing that aerobic exercise tolerance was significantly better at six months in intervention versus control groups (SMD 0.56, 95% CI 0.39 to 0.72; 7 studies; 591 participants: low-certainty evidence; Analysis 1.3). It should be highlighted that six of these studies have a high risk of bias, which could affect this outcome at six months; specifically, Bourke 2014 had high attrition at six months follow-up; no adherence data in the Kaltsatou 2011 study; substantial contamination among controls in the Pinto 2011 study; Rogers 2015 objective and subjective measures of exercise results varied greatly and non-blinded assessors in the Daley 2007a study. Note that in all meta-analyses, data from Pinto 2005 have been multiplied by -1 to control for direction of effect (i.e. lower values in a timed test indicate a better outcome). Brief narrative descriptions of studies not suitable for meta-analyses include the following: Drouin 2005 VO_2 peak data are reported as medians and interquartile ranges; for Pinto 2003, no control group data are presented for the exercise tests; for Campbell 2017, no means or SDs present at baseline and follow-up. For grading of data please see Summary of findings for the main comparison.

1.4 Breast cancers: eight to 12 weeks of follow-up

We were able to carry out one subgroup analysis in breast cancer patients This was a meta-analysis of change in aerobic exercise tolerance carried out on six studies (al-Majid 2015; Daley 2007a; Kim 2006; Musanti 2012; Pinto 2005; Rogers 2015), showing that aerobic exercise tolerance was significant (SMD 0.57, 95% CI 0.22 to 0.93; 6 studies, 441 participants; very low-certainty evidence; Analysis 1.4). However, it should be noted that four of the studies were considered to have high risk of bias (Daley 2007a; Kim 2006; Musanti 2012; Rogers 2015). The certainty of the evidence was graded as very low as there was high risk of bias, concerns over the precision of the data as the confidence intervals were wide and there were serious concerns over the heterogeneity of the data (please see Summary of findings for the main comparison).

1.5 All cancers: combination of supervised and home-based exercise: eight to 12 weeks of follow-up

A meta-analysis of aerobic exercise tolerance was carried out in the following subgroups: supervised exercise interventions, home-based interventions, and a combination of both. In a combination of home-based and supervised exercise interventions (Bourke 2014; Bourke 2011a; Kim 2006; Rogers 2015), aerobic exercise tolerance was better in the intervention than the control : (SMD 0.53, 95% CI 0.01 to 1.04; 4 studies, 357 participants; very low-certainty evidence; Analysis 1.5). The certainty of the evidence was graded as very low as there were concerns over the precision of the data as the confidence intervals were wide and there were very serious concerns over inconsistency due to the heterogeneity of the data and variations in effect sizes (please see Summary of findings for the main comparison).

1.6 All cancers: home-based exercise: eight to 12 weeks of follow-up

In home-based interventions (Musanti 2012; Pinto 2005; Pinto 2011), aerobic exercise tolerance was better in the intervention than the control (SMD 0.70, 95% CI 0.37 to 1.03: 3 studies, 155 participants; very low-certainty evidence; Analysis 1.6). The certainty of the evidence was graded as very low due to high risk of bias, low number of participants within the studies and wide confidence intervals (please see Summary of findings for the main comparison).

1.7 All cancers: supervised exercise: eight to 12 weeks of follow-up

In supervised interventions (al-Majid 2015; Cavalheri 2017; Daley 2007a), aerobic exercise tolerance was better in the intervention group versus control (SMD 1.07, 95% CI 0.26 to 1.89; 3 studies, 92 participants; very low-certainty evidence; Analysis 1.7). Serious concerns with inconsistency and imprecision were presented due to wide variations in effect sizes and wide confidence intervals. Therefore the certainty of evidence was classed as very low (please see Summary of findings for the main comparison).

1.8 All cancers: undergoing active treatment: eight to 12 weeks of follow-up

A meta-analysis of active treatment and no current treatment for aerobic exercise tolerance was carried out. For participants undergoing active treatment in six studies, (al-Majid 2015; Bourke 2014; Daley 2007a; Kim 2006; Musanti 2012; Pinto 2005), demonstrated aerobic exercise tolerance was better in the intervention than the control (SMD 0.72, 95% CI 0.49 to 0.95; 6 studies, 313 participants; Analysis 1.8). However, five of these studies had a high risk of bias so interpretation of these results should be done with caution.

1.9 All cancers: no active treatment: eight to 12 weeks of follow-up

A meta-analysis of aerobic exercise tolerance in participants not undergoing active treatment was carried out in four studies (Bourke 2011a; Cavalheri 2017; Pinto 2011; Rogers 2015), showing that aerobic exercise tolerance was better in the intervention than the control (SMD 0.61, 95% CI 0.10 to 1.12; 4 studies, 291 participants: Analysis 1.9).

Sketal muscle strength

2.1 All cancers: eight to 12 weeks of follow-up

Four studies that used resistance exercise as a component of the intervention reported changes in lower- (Bourke 2011a; Rogers 2015) and upper limb (Musanti 2012; Kim 2017) strength. All four studies had reported strength changes at 12 weeks of follow-up. No significant improvement in strength was found (SMD 0.20, 95% CI -0.03 to 0.44; 4 studies, 278 participants: Analysis 2.1).

2.2 All cancers: eight to 12 weeks of follow-up

After two studies was removed for high risk of bias (Kim 2017; Musanti 2012), effect estimates remained non-significant (SMD 0.17, 95% CI -0.09 to 0.43; 2 studies, 231 participants; Analysis 2.2).

Planned subgroup analysis was not possible according to participant age, presence of metastatic disease, theoretical underpinning of interventions or participant body mass index (BMI).

Adverse effects

Thirteen studies reported adverse effects (Bourke 2011a; Bourke 2014; Cadmus 2009; Cantarero-Villanueva 2012b; Cavalheri 2017; Daley 2007a; Irwin 2015; Kim 2006; Musanti 2012; Pinto 2005; Pinto 2011; Rogers 2015; Thomas 2013); these ranged from minor (e.g. musculoskeletal problems; Musanti 2012; Rogers 2015), to major events (e.g. death; Kim 2006). However, only five studies (Cadmus 2009; Cantarero-Villanueva 2012b; Irwin 2015; Rogers 2015; Thomas 2013) were explicit as to which of these adverse effects were caused by inclusion of the participant in the intervention group (two instances of plantar fasciitis).

Study recruitment rate

Study recruitment rate ranged from 9.5% (Thomas 2013) to 94% (Thomas 2013, Cantarero-Villanueva 2012b, respectively). Eleven studies reported a priori sample size estimates (Bourke 2014; Cadmus 2009; Campbell 2017; Daley 2007a; Hayes 2009; Kaltsatou 2011; Musanti 2012; Perna 2010; Pinto 2003; Pinto 2011; Scott 2013), and seven (Bourke 2014; Cadmus 2009; Cantarero-Villanueva 2012b; Hayes 2009; Perna 2010; Rogers 2015; Scott 2013) met their recruitment target.

Intervention attrition rate

Fifteen studies produced CONSORT diagrams (al-Majid 2015; Bourke 2011a; Bourke 2014; Cadmus 2009; Campbell 2017; Cantarero-Villanueva 2012b; Cavalheri 2017; Daley 2007a; Irwin 2015; Kim 2017; Pinto 2005; Pinto 2011; Rogers 2015; Scott 2013; Thomas 2013). Intervention attrition rates from the included studies ranged from 0% to 25% (Campbell 2017, Pinto 2003) ,respectively, with seven studies not clearly reporting attrition in the intervention arm (Cavalheri 2017; Kaltsatou 2011; Kim 2006; McKenzie 2003; Mohamady 2017; Musanti 2012; Perna 2010).

DISCUSSION

Summary of main results

In this review update we have found more evidence that there are interventions that meet the Rock 2012 guidelines for aerobic (Campbell 2017; Cantarero-Villanueva 2012b; Irwin 2015; Rogers 2015) and resistance (Bourke 2011a; Bourke 2014; Kim 2017; Scott 2013) exercise with 75% adherence in previously inactive cancer cohorts. We have identified a hierarchy of the most common behaviour change techniques (BCTs) that feature in these studies (Table 4). The most frequent of these interventions were setting of graded tasks (#BCT 9), programme set goal and instruction of how to perform behaviour (#21). These studies were predominantly exclusively supervised studies or a combination of supervised and home-based studies. Supervision usually consisted of contact with the exercise professional or research team at least twice weekly. However, from our review of studies at full-text screening stage, it is still true that adherence to exercise interventions, which is crucial for understanding treatment dose, is frequently either poorly reported or not reported at all in randomised controlled trials (RCTs).

Despite the uncertainty surrounding adherence in many of the included studies, interventions caused improvement in aerobic exercise tolerance at eight to 12 weeks (Analysis 1.1) in intervention participants compared with controls. There is also evidence that this can be sustained at six months of follow-up, but owing to potential high risk of bias, this should be viewed with caution (Analysis 1.3). We were able to carry out one cancer subgroup analysis in breast cancer patients, showing that aerobic exercise tolerance was significantly improved up to 12 weeks (Analysis 1.4), however caution is again warranted when interpreting the result, due to frequent high risk of bias.

Adverse effects these ranged from minor e.g. musculoskeletal problems (Musanti 2012; Rogers 2015) to major events e.g. death (Kim 2006). However, only five studies were explicit as to which of these adverse effects were caused by inclusion of the participant in the intervention group (two instances of plantar fasciitis) (Cadmus 2009; Cantarero-Villanueva 2012b; Irwin 2015; Rogers 2015; Thomas 2013).

Overall completeness and applicability of evidence

We included 23 studies in this systematic review, all of which were RCTs. These studies randomly assigned 1372 participants to exercise or comparison groups. A large majority of these studies included women with breast cancer, two involved colorectal cancer survivors, one involved men with advanced prostate cancer, and one involved lung cancer survivors. As found in the original review (Bourke 2013), although these four primary cancers account for most of the population living with and beyond cancer, other common cancers such as lymphoma do not appear at all in this review and less common cancers also are not represented in the evidence base.

Furthermore, an overwhelming majority of participants were white, and only five studies included an ethnically diverse population. As such, other ethnicities are still substantially underrepresented, as found previously (Bourke 2013). Comorbidities were rarely reported at baseline and only six studies were carried out in obese cohorts. Although we set a limit in this review of 90 minutes per week of moderate-intensity exercise at baseline as the criterion for categorising participants as 'sedentary' or 'physically inactive', we did not specify any threshold for vigorous exercisers. It is possible that we could have included individuals who were performing as much as 90 minutes per week of vigorous intensity exercise. However, it is important to note that baseline reporting of behaviour in terms of how much 'vigorous' exercise these cohorts were undertaking was rare.

Nineteen of the included studies were conducted in Northern America or Western Europe, and two studies were completed in Australia, one in Egypt and one in North Korea. The majority all are considered high-income nations according to the World Health Organization (WHO) taxonomy. Very little evidence was derived from developing countries, and it is uncertain whether the resources, infrastructure or both required for some of the interventions included in this review would be applicable in these parts of the world.

Although no single tool for measuring physical activity is infallible (Warren 2010), when possible it is desirable to have self-reported exercise behaviour supported by objective measurements such as accelerometers or heart rate data. Ten studies were identified that attempted to objectively validate independent exercise behaviour with accelerometers or heart rate monitoring (al-Majid 2015; Bourke 2014; Cadmus 2009; Irwin 2015; Mohamady 2017; Pinto 2005; Pinto 2011; Rogers 2015; Scott 2013; Thomas 2013). Seven studies of these studies attempted to validate self-reported independent exercise behaviour by using accelerometers or heart rate monitors (al-Majid 2015; Bourke 2014; Irwin 2015; Pinto 2005; Pinto 2011; Rogers 2015; Thomas 2013), however in three studies, data either were not supportive of exercise behaviour recorded by participants or were not reported in their entirety (Pinto 2005; Pinto 2011; Rogers 2015). Still a number of studies evaluated non-supervised exercise behaviour by using self-report logs or seven-day physical activity questionnaires. Whilst these tools are relatively non-complex and affordable for implementation in study design, they are prone to well-established bias, including difficulties in ascertaining the frequency, duration and intensity of physical activity; social desirability bias; the cognitive demands of recall and overestimation of behaviour, particularly when such data are used to extrapolate MET/hours of exercise per week performed, or kcal/week of energy expenditure.

Analysis by behaviour change techniques as it relates to any given outcome (e.g. aerobic exercise tolerance) was not possible given that few studies stated a theoretical basis for their intervention, and only one study in this update being based on theory i.e. the trans theoretical model in Rogers 2015. It is worthy of note, however, that interventions frequently consisted of little more than telling people how to exercise and providing opportunities for this to occur, with little consideration of the psychological aspects of changing behaviour. A number of interventions were excluded at full-text screening stage, that had a theoretical basis but did not meet our inclusion criteria. Whilst, the use of theory is variable amongst behaviour change interventions generally, the lack of interventions based on a theoretical model in this review is a concern.

It is also acknowledged that although coding of BCTs was done primarily on the basis of study reports, it is possible that some BCTs may have been implemented but not reported. To overcome this possibility and enhance understanding of the techniques important for changing behaviour in cancer patients, adoption of the CALO-RE taxonomy or the broader BCT v1 taxonomy is recommended.

We acknowledge that in this review, we have undertaken a synthesis of RCTs that represent a combination of exercise efficacy and behaviour change studies (Courneya 2010), we recognise the distinction and this is reflected in the literature. During the screening process, there were a number of behaviour change studies based on theory that we excluded as they did not meet our inclusion criteria. However, it should be noted by the reader that all eight studies that we judged as successful (i.e. reported 75% or greater adherence over the intervention period to the Rock 2012 guidelines) incorporated intervention elements that were designed to promote independent exercise behaviour and did not place any restrictions on the control group in terms of the exercise they were permitted to undertake during the study.

Finally, we stated in the justification for this review that a better understanding of the types of interventions that could promote long-term, habitual physical activity (i.e. 12 months or longer) in people living with and beyond cancer was a valuable addition to our knowledge due to the original review not being able to address this issue. Unfortunately, because of limitations in the evidence that we identified, we have not been able to address this issue. As such, this is an area of uncertainty that represents an important research gap. Whilst there is more research available of how to promote exercise behaviour at around eight to 12 weeks up until six months, there is still a lack of long-term follow-up of anything beyond this amongst these studies.

Quality of the evidence

Most of the uncertainty in judging study bias came from lack of clarity around randomisation procedures, allocation concealment and blinding of study outcome assessors. Most of the studies in this review were judged to include at least one element of high risk of non-standard bias, as described in the 'Other potential sources of bias outcome. Of note, we chose to refrain from judging studies according to the performance bias criterion because we considered it not possible to realistically blind intervention participants to 'sham' conditions. Public health guidelines (e.g. the UK CMO report) for aerobic and resistance exercise (which are identical to the Rock 2012 recommendations) are freely available to the public, and given their ease of access via the Internet, the validity of a 'sham' condition is highly dubious. The Summary of findings for the main comparison and 'Risk of bias' tables and Figure 2 and Figure 3 provide a summary of the certainty of evidence. Reporting of adherence of exercise behaviour within the studies was infrequent, which impacted upon the certainty of evidence.

We found the certainty of evidence assessed using the GRADE methodology for the majority of the outcomes to be low to very low; this was mainly due to high risk of bias, inconsistency of the results and imprecise results. One of the main reasons for a very low-certainty of evidence grading was due to the high number of studies presenting a low number of participants in their study. Concerns over inconsistency were present due to variations in effect sizes and heterogeneity. Additionally, the serious concerns were present with the imprecision of the data due to wide confidence intervals and overall low numbers of participants in each study.

Additionally, attrition ranged from 0% to 25%, some studies with longer term follow-up (post six months) demonstrated poorer attrition rates, but reasons for this were seldom explained. Ensuring reasons for dropout is reported in future studies is important.

Potential biases in the review process

We were not able to translate all non-English language studies identified through our database, grey literature and snowballing searches, due to not having access to or resources for translation services. However, a huge effort was made to identify all

relevant RCTs in this field. To the review authors' knowledge, we have identified and evaluated more RCTs involving exercise interventions in sedentary people living with or beyond cancer than any other systematic review in this field. More than 190 papers were screened at full-text stage for eligibility for this update, in addition to the 400 papers screen at full text for the original review. For this 2018 update, we sent 112 emails in addition to the 116 emails to request data to inform the screening and data extraction process, so that the conclusions of the review would be as accurate and informative as possible. Dual data extraction was used throughout the review, except for study characteristics.

Agreements and disagreements with other studies or reviews

To the review authors' knowledge, this is still the most comprehensive systematic review of exercise behaviour interventions in sedentary cancer cohorts. A recent systematic review of predictors of adherence to exercise in people living with and beyond cancer found that the trans-theoretical model of behaviour change and the theory of planned behaviour were significantly associated with better exercise adherence (Husebø 2013). The current review does not explicitly support such conclusions: mainly due to reporting in the included studies.

Howlett 2018 conducted a systematic review and meta-analysis that aimed to evaluate physical activity interventions for healthy inactive adults. The BCT analysis found that interventions that included 'biofeedback', 'demonstration of the behaviour', 'behaviour practice/rehearsal' and 'setting of graded tasks' showed larger effect sizes for physical activity outcomes than studies that did not include these BCTs. Our review also found 'setting of graded tasks' to be common amongst the studies with higher adherence rates. Additionally, this review reported a number of studies that were judged as having high risk of bias or were judged as being unclear due to the lack of clear reporting. A suggestion was for future studies to use the TIDieR (Template for Intervention Description and Rreplication) framework (Hoffman 2014), particularly around the description of intervention content. Our review findings support this recommendation, as a number of exercise studies appear to display problems with reporting and are often judged with high risk of bias.

Ormel 2017 carried out a recent systematic review of predictors of adherence and identified the issues with low adherence to exercise interventions for people with cancer. Home-based interventions were found to possibly address the issue of time and travelling to a location, which was identified as a potential barrier. Our review found that interventions that incorporated an element of supervision have better adherence rates to the set exercise target than home-based interventions. However, as previously stated adherence was infrequently reported amongst the studies.

AUTHORS' CONCLUSIONS

Implications for practice

Since the last version of this review none of the new relevant studies have provided additional information to change the conclusions. Service provision to promote exercise in sedentary people living with and beyond cancer could incorporate components of both supervised and independent exercise requirements, with supervision being most important for adherence. The majority of the studies in this review were undertaken in breast cancer cohorts and included mainly white females: these limitations to generalisability that were also present in our 2013 review (Bourke 2013). A number of behaviour change techniques (BCTs) were identified in studies which achieved 75% adherence to the aerobic or resistance guidelines (Rock 2012). Most commonly reported BCTs were goal setting, instruction on how to perform behaviour, and setting graded tasks. In the original review, we argued that expecting the most sedentary survivors to achieve at least 150 minutes per week of aerobic exercise is likely to be unrealistic. This review update has found studies that can achieve these guidelines, but only for limited follow-up. Exercise interventions were found to significantly improve aerobic exercise tolerance compared to usual care at eight to 12 weeks and six months follow-up. However, there is low to very low-certainty evidence according to the GRADE methodology to suggest this is due to issues of high risk of bias, inconsistency and imprecision. So caution is warranted when interpreting these results for future practice. A very small number of serious adverse effects were reported amongst the studies, ensuring researchers, clinicians and guideline developers that these aerobic and resistance exercise studies are safe in cancer survivors. The role of healthcare professionals involved in cancer care is still unclear from the studies we synthesised.

Implications for research

The majority of cancer survivors are not regularly active. Future research needs to address the following issues.

- How to promote and sustain exercise behaviour in other cancer survivorship cohorts who are inactive.
- Studies need to improve the standards of reporting adverse effects and if they are related or unrelated to the intervention or study participation.
- Studies need to be explicit about baseline exercise behaviour and about how it was assessed.
- Studies should attempt to use objective measures of exercise, which may be supported with the use of subjective measures.
- Studies should clearly state reasons for drop out.
- Studies need to report as standard frequency, intensity and duration of aerobic exercise, as well as repetitions, sets and intensity of resistance exercise used in intervention prescriptions.
- There needs to be a standardisation of adherence reporting in clinical studies investigating the effects of exercise in cancer survivors. We still recommend that adherence is reported as a single proportion of the cohort who attended/performed exercise according to the set prescription. If adherence were to be clearly reported, there is a much better chance of understanding which factors improve adherence.
- Reporting of BCTS used in such interventions should be standardised. Adoption of the CALO-RE taxonomy or the broader BCT v1 taxonomy is recommended.
- Future interventions should use the TIDieR (Template for Intervention Description and Rreplication) checklist as a guide when designing and when reporting interventions.

By achieving these standards, researchers and clinicians can aim to have an acceptable level of rigour that will demonstrate dose response relationship between exercise and given clinically relevant outcomes. Such rigor can underpin clinical exercise

guidelines and so that practitioners are able to communicate achievable exercise recommendations for sedentary people living with and beyond cancer.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

al-Majid 2015

Methods	• Study design: RCT individual participant level randomisation. • Study location: Central Virginia and Southern California, USA • Funding source: Oncology Nursing Society Grant • Inclusion criteria: patients eligible to participate included women aged 21 years or older diagnosed with Stage I or II breast cancer who were scheduled to receive chemotherapy, spoke and read English, and were willing to be randomly assigned to either group. • Exclusion criteria: consistent with the exclusion criteria stipulated by the American College of Sports Medicine, patients who had recent or uncontrolled cardiac conditions were excluded. Other exclusion criteria included self-reported history of unstable or severe clinical depression, activity-limiting arthritis, having had joint surgery within the previous 3 months, and having been engaged in regular exercise (5 days per week) in the past 3 months. • CONSORT diagram included: yes • Number of participants in each arm: 7,7 (intervention vs control) • Study recruitment rate: 16/35 • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline =15-16 weeks.
Participants	• Primary cancer diagnosis: stage I or stage II breast cancer

al-Majid 2015 *(Continued)*

	• Current cancer treatment: scheduled chemotherapy • Metastatic disease: none • Age, years, mean (SD): exercise group 47.9 +/- 10.4 & control group 52.7 +/- 10.7 • Gender: female • BMI: unknown • Ethnicity: for both groups: Hispanic 29%, Non Hispanic 71% • Comorbidities reported: unclear
Interventions	• Group or individual intervention: individual • Setting: rehabilitation suite • Exercise prescription components: aerobic • Theoretical basis: none • CALO-RE taxonomy components: programme set goal • Frequency of contact with researcher or exercise professional: every exercise session was supervised, two to three times per week contact with exercise physiologist over nine to 12 weeks. 4 Assessments over the intervention and follow-up period. • Frequency of contact with healthcare professional: eligible participants were informed about the study by referring oncologists and were approached by study staff who invited them to participate. • Instructions to controls: instructed to document and report any exercise activities they engaged in while on the study.
Outcomes	• Change in fitness reported: aerobic exercise tolerance was measured using VO^2 Max test. • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: adherence to exercise protocol, and the amount (duration HR) of exercise was achieved by participants during sessions was recorded using heart rate watch monitors. • Aerobic exercise frequency: two to three times per week. • Aerobic exercise duration: twenty to forty minutes. • Aerobic exercise intensity: progression throughout the 12-week period; from 40% heart rate reserve to 80% heart rate reserve. • Description aerobic exercise mode: treadmills • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: 14/14 • Adherence: ranging between 95% and 97% to exercise protocol. • Attrition: 12.5% • Adverse effects: none reported. • Achieves Rock et al guidelines: no
Description of usual care	Participants in the usual-care group received usual care, which did not involve exercise, and were instructed to document and report any exercise activities they engaged in while on the study. Similarly, the exercise-group participants to report engagement in non-protocol exercise activities during the study.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement

al-Majid 2015 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement.
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement.
Selective reporting (reporting bias)	Low risk	All outcomes reported.
Other bias	Unclear risk	None

Bourke 2011a

Methods	• Study design: RCT participant level randomisation • Study location (WHO income taxonomy): Sheffield, UK (high) • Funding source: Sheffield Hallam University • Inclusion criteria: patients who had histologically-confirmed colon cancer (Dukes stages A to C) respected 6 to 24 months previously • Exclusion criteria: existing participation in regular physical activity (purposeful activity of at least moderate intensity of 30 minutes or longer, three times a week), a Karnofsky rating of less than 80, unstable angina, uncontrolled hypertension, recent myocardial infarction or a pacemaker • CONSORT diagram included: yes • Study recruitment rate: 18/180 • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 12 weeks
Participants	• Primary cancer diagnosis: histologically-confirmed colon cancer (Dukes stages A to C) • Current cancer treatment: none • Metastatic disease: none • Age, years: mean (SD) = control: 70.3 (8.7), intervention: 67.9 (5.7) • Sex: 12 males, 6 females • BMI: mean (SD): control: 26.0 (3.5), intervention: 26.9 (3.8) • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 9), control (n = 9) • Group or individual intervention: group • Setting: university rehabilitation suite • Exercise prescription components: aerobic and resistance • Theoretical basis: not stated • CALO-RE taxonomy components: #15, #16, #26, #27 • Frequency of contact with researchers or exercise professionals: 18 supervised exercise sessions • Instructions to controls: continue behaviour as normal
Outcomes	• Change in fitness reported: aerobic—exercise tolerance using the Borg treadmill protocol. Resistance—maximal voluntary torque of the knee extensors using isokinetic dynamometry

Bourke 2011a *(Continued)*

	• Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: attendance at supervised session with HR monitors, exercise diaries and (Godin 1986) LSI at assessment points • Aerobic exercise frequency: three or more times per week • Aerobic exercise duration: 30 minutes per session or longer • Aerobic exercise intensity: intensity of 55% to 85% of age-predicted maximum heart rate and/or ratings of perceived exertion, 11 to 15/fairly light to hard, on the Borg Rating Perceived Exertion (RPE) scale • Description aerobic exercise mode: cycle/rowing ergometers, treadmill work. Plus brisk walking, cycling or gym exercise, etc, during independent exercise sessions • Resistance exercise frequency: three or more times per week • Resistance exercise sets: between 2 and 4 sets of resistance exercises • Resistance exercise repetitions: 8 to 12 repetitions • Resistance exercise intensity: 60% of 1 repetition max • Description of resistance exercise: large skeletal muscle groups (quadriceps, deltoids, pectorals, latissimus dorsi, hamstring muscles) were targeted using body weight resistance and free weights
Compliance	• Intervention uptake: 9/9 • Adherence: attendance was 146 of 162 of the supervised sessions attended (90% compliance). The median (range) rating of perceived exertion (Borg RPE scale) during the exercise sessions was 12 (7 to 16). On average, 94% of the independent exercise sessions (i.e. participants reporting at least 25 to 30 minutes of aerobic exercise) were completed • Attrition: one participant in the intervention arm was lost to follow-up. 89% completed final follow-up in the intervention arm • Adverse effects: one stroke in the intervention group occurred but was deemed unrelated to the study • Achieves Rock et al guidelines: six weeks of resistance training
Description of usual care	Both groups had access to standard care, which consisted of a holistic nurse-led colorectal cancer follow-up service
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were randomly assigned by an independent researcher via code numbers using nQuery statistical software
Allocation concealment (selection bias)	Low risk	Randomisation was undertaken by a senior academic who was not directly involved in the recruitment or assessment of participants
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All outcomes were assessed by an experienced exercise physiologist, who was blind to the group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Intention-to-treat analysis was used to compare participants in the groups to which they were randomly assigned, with data carried over from previous visits in cases of participant withdrawal
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Unclear risk	Low recruitment rate (18/180) could represent a biased sample

Bourke 2014

Methods	• Study design: RCT individual participant level randomisation • Study location: Sheffield, UK • Funding source: Sheffield Hallam University • Inclusion criteria: eligible men were sedentary (i.e. exercising < 90 min per week at a moderate intensity) and receiving continuous ADT for a minimum of 6 mo prior to recruitment, with planned long-term retention on ADT. • Exclusion criteria: Men with unstable angina, uncontrolled hypertension, recent myocardial infarction, pacemakers, and painful or unstable bony metastases were excluded. • CONSORT diagram included: yes • Study recruitment rate: 100/136 • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 6 months.
Participants	• Primary cancer diagnosis: prostate cancer • Current cancer treatment: androgen Deprivation Therapy • Metastatic disease: 20/100 men had metastatic disease • Age, years, mean (SD): intervention: 71 (6), control: 71 (6) • Gender: male • BMI: Intervention: 29.3 (4.4), control: 28.1 (4.1) • Ethnicity: unclear • Comorbidities reported: 4% previous MI, 3% previous stroke, 5% angina, 7% diabetes, 27% hypertension, 5% hypertension diagnosed since ADT commencement *from linked paper Gilbert 2016*.
Interventions	• Sample size: intervention (n = 25), control (n = 25) • Group or individual intervention: group • Setting: dedicated rehabilitation suite plus home-based. • Exercise prescription components: aerobic and resistance • Theoretical basis: none • CALO-RE taxonomy components: #1 #5 #8 #9 #15 #17 #20 #21 #26 #29 • Frequency of contact with researcher or exercise professional: men would be supervised by an exercise physiologist, this was undertaken twice a week from weeks 1–6, and once per week from weeks 7–12. Small-group healthy eating seminars, lasting approximately 20 minutes, were carried out every 2 week throughout the 12-week intervention. Outcomes would be assessed by a trained technician at 3 points over the intervention. • Frequency of contact with healthcare professional: men randomised to usual care were followed up in the urology clinic and seen by an oncology nurse specialist and urologist. • Instructions to controls: no restrictions were placed on exercise/dietary behaviours over the period of the study.
Outcomes	• Change in fitness reported: aerobic exercise tolerance was tested using the Borg treadmill protocol • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: adherence to exercise protocol, Godin Questionnaire and Borg scales. • Aerobic exercise frequency: supervised - twice a week from weeks 1-6, and once per week from weeks 7-12. Independent - once a week from weeks 1-6 and twice a week from weeks 7-12. • Aerobic exercise duration: 30 minutes per supervised and independent exercise. • Aerobic exercise intensity: the aerobic exercise prescription was 30 minutes at an intensity of 55% to 75% of age predicted maximum heart rate or 11–13 on the Borg Rating of Perceived Exertion scale. • Description aerobic exercise mode: use of stationary cycles, rowing ergometers and treadmills. Independent - brisk walking, cycling and gym exercise. • Resistance exercise frequency: supervised - twice a week from weeks 1-6, and once per week from weeks 7-12.

Bourke 2014 *(Continued)*

	• Resistance exercise sets: between 2-4 sets • Resistance exercise repetitions: 8-12 reps • Resistance exercise intensity: intensity of 60% of one repetition max with progression through increasing volume before weight was increased. • Description of resistance exercise: body weight resistance and free weights targeting large skeletal muscle groups.
Compliance	• Intervention uptake: 25. • Adherence: adherence was 94% for the supervised and 82% of the prescribed independent exercise sessions over the first 12 weeks. • Attrition: 85% cohort completing 12-week follow-up, 68% men attending 6-month follow-up. • Adverse effects: 2 unrelated deaths *from linked paper Gilbert 2016* • Achieves Rock et al guidelines: yes, six weeks of resistance training
Description of usual care	Men randomised to usual care were followed up in the urology clinic and seen by an oncology nurse specialist and urologist. The treating physicians were informed that the man was participating in a lifestyle intervention study and further information would be available on application. No restrictions were placed on exercise/dietary behaviours over the period of the study.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was undertaken (1:1) by a senior academic independent of the study, at the patient level using nQuery statistical software.
Allocation concealment (selection bias)	Low risk	Randomisation was undertaken (1:1) by a senior academic independent of the study, at the patient level using nQuery statistical software.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Randomisation was undertaken (1:1) by a senior academic independent of the study, at the patient level using nQuery statistical software.
Incomplete outcome data (attrition bias) All outcomes	High risk	Incomplete outcome data at 6 months follow-up.
Selective reporting (reporting bias)	Low risk	All outcomes reported.
Other bias	Low risk	None.

Cadmus 2009

Methods	• Study design: RCT participant level randomisation • Study location (WHO income taxonomy): USA, Connecticut (high) • Funding source: supported in part by a General Clinical Research Center grant from the National Center of Research Resources, National Institutes of Health (Grant # M01-RR00125) awarded to Yale University School of Medicine • Inclusion criteria: postmenopausal women, aged 40 to 75 years, AJCC Stages 0 to IIIa breast cancer, 1 to 10 years post diagnosis, > 12 months post completion of adjuvant treatment, physically able to exercise with physician consent to begin an exercise programme, sedentary activity pattern (< 60 minutes/week) with physician consent to begin an exercise programme

Cadmus 2009 *(Continued)*

	• Exclusion criteria: diagnosis of recurrent or other primary cancer event. Current smoker, diabetes mellitus, current or planned enrolment in a structured weight-loss programme • CONSORT diagram included: yes, in Irwin 2008 • Study recruitment rate: 75/88 • Length of follow-up: length of intervention = 6 months, length of follow-up from baseline = 6 months
Participants	• Primary cancer diagnosis: AJCC Stages 0 to IIIa breast cancer • Current cancer treatment: completed adjuvant treatment (with the exception of hormonal therapy) at least six months before enrolment. 57% versus 70% on hormone therapy in the intervention group versus controls; 30% on tamoxifen in both arms; 27 versus 40% versus control on aromatase inhibitors • Metastatic disease: none • Age, years: mean (SD): intervention: 56.5 (9.5), control: 55.1 (7.7) • Sex: women • BMI: mean (SD): intervention: 30.4 (6.0), control: 30.1 (7.4) • Ethnicity: 84% white in both groups • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 37), control (n = 38) • Group or individual intervention: supervised and home-based • Setting: a supervised training programme at a local health club. Participants exercised at the club during designated sessions • Exercise prescription components: aerobic training • Theoretical basis: not stated • CALO-RE taxonomy components: #1, #5, #8. #9, #15, #16, #17, #19, #21, #26, #29, #35 • Frequency of contact with researchers or exercise professionals: unclear exactly how many exercise sessions were supervised • Instructions to controls: participants assigned to the usual care groups were told that they could exercise on their own if they chose, but that the study's physical activity programme would not be available to them. They received all exercise programme materials at six-month follow-up
Outcomes	• Change in fitness reported: not reported • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: heart rate monitors, physical activity questionnaire, a seven-day physical activity log and a seven-day pedometer log. Adherence to the intervention among exercise group participants was assessed by seven-day physical activity logs weekly • Aerobic exercise frequency: three sessions per week supervised, two sessions per week at home or at a health club: total five days a week • Aerobic exercise duration: participants were asked to perform three 15-minute sessions during week 1, building to five 30-minute moderate-intensity sessions by week 5 • Aerobic exercise intensity: 60% to 80% of maximal heart rate reserve • Description aerobic exercise mode: from Irwin 2008: The intervention consisted primarily of walking, an activity preferred by most women and breast cancer survivors, although participants could choose to meet the exercise goal through swimming, aerobics, other forms of activity or a combination of different activities. Activities that did not involve sustained aerobic effort, such as weight lifting and yoga, could be performed but did not count toward the exercise goal for each week • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: 37/37 Adherence:

Cadmus 2009 *(Continued)*

- Cadmus 2009: regarding the weekly goals of thrice-weekly supervised exercise sessions at the health club and twice-weekly unsupervised sessions on their own, women participated in 67% of the supervised exercise sessions, and 96% of women reported exercising on their own two other days of the week and exercised on average at 76% of their maximal heart rate (82% as a mean over both supervised and unsupervised)
- Irwin 2008: 33% reported 150 minutes/week of aerobic exercise at an average of 76% HR over the six-month intervention. Women randomly assigned to exercise chose weight-bearing activities most often, with 82% walking. Few women reported doing resistance training (3%). 75% of women were doing between 90 and 119 minutes of moderate-intensity exercise per week, over six months
- Latka 2009: the variables that predict adherence were BMI and trans theoretical model stage of change. Specifically, a lower BMI and a higher degree of readiness to change physical activity behaviour were associated with better adherence
- Attrition: one participant lost to follow-up in the intervention group, five lost to follow-up in the control group. 97% completed final follow-up in the intervention group
- Adverse effects: five of the 37 women randomly assigned to exercise experienced an adverse effect; two were related to the study (plantar fascitis), and three were unrelated (swollen Achilles, stress fracture in foot and plantar fasciitis) to the study. No women developed lymphoedema during the study
- Achieves Rock et al guidelines: 33% reported 150 minutes/week of moderate intensity aerobic exercise at an average of 76% HR for six months

Description of usual care	Unclear
Notes	Only YES study included in the review because of the requirement that participants must be sedentary at baseline

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A computer programme randomly assigned each YES study participant with equal probability to the exercise group or the usual care group
Allocation concealment (selection bias)	Low risk	The randomisation code for each participant was obtained by the principal investigator (who was not involved in recruitment or data collection) only after baseline measures for that individual had been completed and staff conducting clinic visits did not have access to the randomisation programme
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	Analyses were conducted according to the intention-to-treat principle. Baseline QOL values were carried forward for the five IMPACT study participants (three exercisers and two controls) and 10 YES study participants (five exercisers and five controls) for whom six-month data were unavailable
Selective reporting (reporting bias)	Low risk	None, all outcomes reported
Other bias	Low risk	None

Campbell 2017

Methods	• Study design: RCT individual participant level randomisation • Study location: Vancouver, BC, Canada • Funding source: Canadian Breast Cancer Foundation BC/Yukon.

Campbell 2017 *(Continued)*

	• Inclusion criteria: all participants were ≥3 months and up to 3 years post adjuvant treatment, physically able to undertake an exercise programme, postmenopausal (natural or chemotherapy induced) at time of enrolment, and receiving antihormonal treatment (i.e. aromatase inhibitor). • Exclusion criteria: > 90 minutes/week of self-reported moderate-vigorous physical activity (last 6 months); mini–mental status examination < 23; comorbid conditions that could alter cognitive testing results, such as a psychiatric conditions, history of substance use disorder, or other neurological disorder (i.e., head injury, epilepsy, and neurodegenerative disease); and deemed unsafe for magnetic resonance imaging (MRI). • CONSORT diagram included: yes • Study recruitment rate:19/86 • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 24 weeks.
Participants	• Primary cancer diagnosis: stages I to IIIA breast cancer • Current cancer treatment: following chemotherapy • Metastatic disease: unclear • Age, years, mean (SD): intervention = 53.2 (7.0), control = 51.4 (5.1) • Gender: female • BMI: intervention = 26.1 (5.5), control = 26.3 (5.7) • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 10), control (n = 9) • Group or individual intervention: unclear • Setting: research gym plus home-based • Exercise prescription components: aerobic • Theoretical basis: none • CALO-RE taxonomy components: programme set goal, #9 • Frequency of contact with researcher or exercise professional: two study visits at baseline and at 24 weeks with trained study staff. 2 x 24 sessions per week were supervised - unclear by whom. • Frequency of contact with healthcare professional: 15 were referred by their oncologists • Instructions to controls: participants randomised to CON were asked to maintain usual lifestyle and offered a 12-week exercise programme upon study completion.
Outcomes	• Change in fitness reported: aerobic exercise tolerance using VO2 peak. • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: heart rate reserve, American College of Sports Medicine metabolic equation for treadmill walking • Aerobic exercise frequency: supervised- twice per week and unsupervised - twice per week. • Aerobic exercise duration: 30 to 45 minutes duration per session, 150 minutes per week of moderate-vigorous aerobic exercise for 24 weeks. • Aerobic exercise intensity: the prescription began at 60% of HRR for 20 minutes, with a weekly increase in duration toward 45 minutes by week 6, followed by a weekly increase in intensity toward 80% HRR by week 12. • Description aerobic exercise mode: independent walking or exercises of participants choice at home. Supervised sessions - treadmill walking. • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: 19/19 • Adherence: participants attended 88% of supervised gym sessions (mean 1.8 sessions/ week and 87.5 minutes/week), and participants met 82% of the prescribed exercise targets (mean intensity 74.5%

Campbell 2017 *(Continued)*

	HRR). Home session completion was 87% (mean 2.4 sessions/week and 101.5 minutes/week), and participants met 87% of the prescribed exercise targets (mean intensity 73.5% HRR). • Attrition: 100% • Adverse effects: none reported • Achieves Rock et al guidelines: yes, 150 minutes of exercise per week.
Description of usual care	Participants randomised to the control were asked to maintain usual lifestyle and offered a 12-week exercise programme upon study completion.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Following completion of baseline measures, eligible participants were randomised using permutated blocks of 4 to 6 in a 1:1 ratio to the aerobic exercise intervention group or delayed exercise control.
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement.
Incomplete outcome data (attrition bias) All outcomes	Low risk	All data completed
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	High risk	Low study recruitment rate

Cantarero-Villanueva 2012b

Methods	• Study design: RCT individual participant level randomisation • Study location: Granada, Spain • Funding source: this study was funded by a research project grant (FISPI10/02749) from the Health Institute Carlos III and PNI+D+I 2008–2011, Madrid, Spanish Government, and from a grant of Andalusian Health Service, Junta de Andalucia. • Inclusion criteria: participants were eligible if they: 1) had a diagnosis of breast cancer (stages I-IIIA); 2) had received a simple mastectomy or quadrantectomy with posterior breast reconstruction; 3) between 25 and 65 years; 4) finished their co-adjuvant treatment, except hormone therapy, at least 3 months before beginning the study; 5) not having an active cancer; and, 6) having neck and shoulder pain that began after the breast cancer surgery assessed with a visual analogue scale (VAS) (0–100). Neck pain was defined as pain from the occipital to C7 vertebra, not including the shoulder region, whereas shoulder axillary pain was defined as pain experienced in the shoulder and/or the axillary region, not including the cervical spine. • Exclusion criteria: participants were excluded if they: 1) were receiving chemotherapy or radiotherapy at the time of the study; 2) suffer from an orthopaedic disease that limit to follow the water programme; 3) had uncontrolled hypertension (diastolic pressure >95 mm Hg); 4) had presence of lymphoedema; 5) had recurrent cancer; or 6) had previous diagnosis of fibromyalgia. • CONSORT diagram included: yes

Cantarero-Villanueva 2012b *(Continued)*

- Study recruitment rate: 66/70
- Length of follow-up: length of intervention = 8 weeks, length of follow-up from baseline = 8 weeks.

Participants	• Primary cancer diagnosis: bBreast cancer • Current cancer treatment: none • Metastatic disease: unclear • Age, years, mean (SD): intervention = 48 (8), control = 47 (9) • Gender: female • BMI: unclear • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 33), control (n = 33) • Group or individual intervention: group • Setting: a deep-water pool frequently used for swimming (water temperature: 28–31°C; depth: 1.40 m in the lowest part and 1.80 m in the deepest part). • Exercise prescription components: aerobic • Theoretical basis: none • CALO-RE taxonomy components: programme set goal, #9 • Frequency of contact with researcher or exercise professional: initial telephone contact for recruitment with study researchers. Following that they attending the exercise sessions three per week for eight weeks, supervised by two physical therapists. • Frequency of contact with healthcare professional: after inclusion criteria was met, they had a medical visit. Oncologist recommended a healthy lifestyle to patients as part of usual care. • Instructions to controls: participants followed usual care recommendations by an oncologist in relation to a healthy lifestyle. Breast cancer survivors received a document printable dossier from the oncologist where they found recommendations related to nutrition, lifestyle behaviours, and exercise. A follow-up of the physical activity during the control period was used to control bias detected in previous studies with exercise in cancer survivors [35,36]. For that purpose, we used the Spanish version of the Minnesota Leisure Time Physical Activity Questionnaire [37]. Control group were offered the intervention after the 8 weeks.
Outcomes	• Change in fitness reported: unclear • Free-living energy expenditure: assessed by the leisure time physical activity questionnaire.
Process measures	• Method of measuring exercise behaviour: Minnesota Leisure Time Physical Actiivty Questionnaire, adherence to exercise programme and the Borg scale • Aerobic exercise frequency: three sessions per week for eight weeks. • Aerobic exercise duration: 60 minutes per session. • Aerobic exercise intensity: the intensity of the training was established following the recommendations of the American College of Sports Medicine and American Heart Association. Participants used the “Borg Rating of Perceived Exertion Scale” for rating their fatigue during the exercise. Progression in the aerobic training was performed throughout the 8 weeks by gradually increasing the intensity and the duration. • Description aerobic exercise mode: swimming with use of pool noodles and swimming belts. • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: 33 • Adherence: a checklist of all sessions was completed by the participants to determine adherence to the water exercise programme. One participant in the WATER programme dropped out due to a recurrence of breast cancer during the programme. All participants within the WATER group completed

Cantarero-Villanueva 2012b *(Continued)*

	more than 85% of the 24 water exercise sessions, showing a high adherence rate to the programme. Three women reported a transient increase of oedema, and four women noted an increase in fatigue immediately after the beginning of the first session, which improved in the next few days. These women did not dropout of the study. • Attrition: 3% drop out • Adverse effects: one participant in the WATER programme dropped out due to a recurrence of breast cancer during the programme. All participants within the WATER group completed more than 85% of the 24 water exercise sessions, showing a high adherence rate to the programme. Three women reported a transient increase of oedema, and four women noted an increase in fatigue immediately after the beginning of the first session, which improved in the next few days. These women did not dropout of the study. No other adverse effects were reported. • Achieves Rock et al guidelines: yes, aims to achieve 180 minutes of aerobic exercise per week.
Description of usual care	Participants followed usual care recommendations by an oncologist in relation to a healthy lifestyle. Breast cancer survivors received a document printable dossier from the oncologist where they found recommendations related to nutrition, lifestyle behaviours, and exercise. A follow-up of the physical activity during the control period was used to control bias detected in previous studies with exercise in cancer survivors [35,36]. For that purpose, we used the Spanish version of the Minnesota Leisure Time Physical Activity Questionnaire [37]. Control group were offered the intervention after the 8 weeks.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A randomised, controlled clinical study was conducted. Eligible participants who agreed to participate were randomly assigned into two groups: WATER group who received the water exercise programme or CONTROL group who received the usual care treatment for breast cancer.
Allocation concealment (selection bias)	Low risk	We allocated patients to WATER or CONTROL groups into two randomisation cycles using a computer-generated numbers. The sequence was entered into numbered opaque envelopes by an external member, and they were opened after completion of the baseline assessment.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome measures were assessed 1 week before and after the intervention by an individual blind to group assignment.
Incomplete outcome data (attrition bias) All outcomes	Low risk	All outcome data completed
Selective reporting (reporting bias)	Low risk	All outcomes reported.
Other bias	Low risk	None

Cavalheri 2017

Methods	• Study design: RCT individual participant level randomisation • Study location: Perth, Australia • Funding source: the study received funding from Sir Charles Gairdner Hospital Research Advisory Committee (grant number: 2011/12/013).

Cavalheri 2017 *(Continued)*

	• Inclusion criteria: measurements were collected in people 6-10 weeks after lobectomy for non-small cell lung cancer (stages I-IIIA) or, for those who required post-operative chemotherapy, 4-8 weeks after their last chemotherapy cycle. Participants were recruited from outpatient clinics and referrals to the pulmonary rehabilitation programs at two hospitals and a private thoracic surgery clinic. • Exclusion criteria: Exclusion criteria comprised: presence of any comorbid condition that could compromise safety during assessments; severe neuro musculoskeletal limitations; participation in a program of supervised exercise training in the last 3 months; and inability to understand spoken or written English. • CONSORT diagram included: yes • Study recruitment rate: 17/50 • Length of follow-up: length of intervention = 8 weeks, length of follow-up from baseline = 8 weeks.
Participants	• Primary cancer diagnosis: non-small cell lung cancer • Current cancer treatment: measurements were collected in people 6-10 weeks after lobectomy for NSCLC (stages I-IIIA) or, for those who required post-operative chemotherapy, 4-8 weeks after their last chemotherapy cycle. • Metastatic disease: unclear • Age, years, mean (SD): intervention = 66 (10), control = 68 (9) • Gender: female • BMI: intervention = 25 (5), control = 27(6) • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 9), control (n = 8) • Group or individual intervention: individual • Setting: two hospital gyms • Exercise prescription components: aerobic and resistance exercise • Theoretical basis: none • CALO-RE taxonomy components:programme set goal, #9 • Frequency of contact with researcher or exercise professional: three weekly sessions for eight weeks ran by senior physical therapists. Three assessment points by an independent researcher at baseline, post baseline and 8 weeks. • Frequency of contact with healthcare professional: patients were recruited from outpatient clinics but it is unclear by whom. • Instructions to controls: participants in the control group were instructed to continue to perform their usual activities during the period of the study. They received weekly phone calls from a research assistant, which consisted of general conversation as well as standardised questions about their health and well-being. These phone calls allowed the investigators to maintain contact with those in the control group and optimise their retention in the study and also served to minimise bias resulting from differences in attention provided by the investigators to the participants during the intervention period.
Outcomes	• Change in fitness reported: aerobic exercise tolerance was measured using VO2 peak and the six-minute walk test. • Free-living energy expenditure: yes, this was assessed using a step watch activity monitor.
Process measures	• Method of measuring exercise behaviour: activity monitors and adherence to exercise protocol. • Aerobic exercise frequency: three times a week for eight weeks. • Aerobic exercise duration: 60 minutes per session. • Aerobic exercise intensity: for treadmill walking, the initial average speed was set at 70% of the average 6MWT speed. Average walking speed was increased if the participant was able to walk for 20 minutes continuously providing symptoms and O2 were within acceptable limits (≥ 88%). Cycling consisted of 10 minutes of endurance training (initial work rate was set at 60% of the max achieved during the CPET) and two periods of 2 minutes of power training (initial work rate was set at 80% of the max achieved during the CPET performed at the baseline assessment). • Description aerobic exercise mode: walking or cycling • Resistance exercise frequency: three times a week for eight weeks.

Cavalheri 2017 *(Continued)*

	• Resistance exercise sets: two sets for lower limbs and three sets for upper limb training • Resistance exercise repetitions: 10 repetitions • Resistance exercise intensity: lower limbs -In the last session, the number of step ups performed was 69 ± 46% greater than in the first session (P = 0.004). Upper limbs In the last session, the product of weights lifted, number of sets and number of repetitions during the biceps brachii muscle training was 53 ± 52% greater than in the first session (P = 0.02). There was no difference in the product of weights lifted, number of sets and number of repetitions during the deltoid muscle training (P = 0.08) • Description of resistance exercise: Step ups with parallel bars, hand weights for elbow flexion and shoulder abduction.
Compliance	• Intervention uptake: 9 • Adherence: Adherence to exercise training was defined as a completion rate of ≥ 60% of training sessions (i.e., ≥15 training sessions) and reported by the senior physical therapists to the investigators. Of the nine participants randomised to the EG, four (44%) adhered to exercise training by completing 15 or more training sessions (i.e.,≥60%). • Attrition: unclear • Adverse effects: one participant completed four sessions and another completed six sessions. Both stopped training as they felt unwell. They completed some of the post-intervention assessments and were later diagnosed with a primary cancer other than lung cancer. • Achieves Rock et al guidelines: yes; six weeks of resistance exercise training.
Description of usual care	Participants in the control group were instructed to continue to perform their usual activities during the period of the study. They received weekly phone calls from a research assistant, which consisted of general conversation as well as standardised questions about their health and well-being. These phone calls allowed the investigators to maintain contact with those in the control group and optimise their retention in the study and also served to minimise bias resulting from differences in attention provided by the investigators to the participants during the intervention period.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	The randomisation sequence was generated and man-aged by an independent researcher using a computer.
Allocation concealment (selection bias)	Low risk	concealed using sequentially-numbered opaque envelopes. The sequence was stratified according to the hospital from which the participant was recruited and for the use (or not) of adjuvant chemotherapy.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	The primary investigator, who was responsible for the baseline and post-intervention period assessments, was not aware of whether a participant had been allocated control or intervention.
Incomplete outcome data (attrition bias) All outcomes	High risk	Missing patient data in both arms with reasons not given
Selective reporting (reporting bias)	Low risk	All outcomes reported.
Other bias	High risk	Poor adherence rates (44%)

Daley 2007a

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Sheffield, UK (high) • Funding source: supported by Grant No. CE8304 from Cancer Research UK • Inclusion criteria: women who were not regularly active (up to 2 × 20-minute sessions a week at moderate intensity (researcher had to gauge with client whether it was moderate intensity—fairly light to somewhat hard) RPE 11 to 13 were used); exercise 'pre-contemplators', 'contemplators' or 'prepares' as defined by the trans theoretical model, who had been treated for localised breast cancer 12 to 36 months previously, were eligible • Exclusion criteria: women with metastases and inoperable or active locoregional disease were ineligible (clinician determined) • CONSORT diagram included: yes • Study recruitment rate: 108/273 • Length of follow-up: length of intervention = 8 weeks, length of follow-up from baseline = 24 weeks
Participants	• Primary cancer diagnosis: breast cancer survivors without metastases (inoperable or active locoregional disease) were ineligible • Current cancer treatment: 73.5%, 69.4% and 76.3% using hormone therapy in the intervention, placebo and usual care groups, respectively • Metastatic disease: none • Age, years, mean (SD): 51.6 (8.8); 50.6 (8.7); 51.1 (8.6) (intervention; sham; control, respectively) • Gender: women • BMI: mean (SD): 28.5 (4.4); 27.6 (4.1); 29.6 (5.1) (intervention; sham; control, respectively) • Ethnicity: two of 108 non-white • Comorbidities reported: 45/108 had lymphoedema
Interventions	• Sample size: intervention (n = 34), sham (n = 36) control (n = 38) • Group or individual intervention: one-to-one supervised sessions • Setting: university rehabilitation suite • Exercise prescription components: aerobic • Theoretical basis: trans theoretical model • CALO-RE taxonomy components: #1, #5, #8, #9, #10, #13, #16, #17, #18, #20, #21, #23, #26, #29, #35 • Frequency of contact with researchers or exercise professionals: every exercise session was supervised • Instructions to controls: the usual-care group continued with their lives as usual. the exercise-placebo group attended 24 one-to-one 50-minute sessions during 8 weeks; however, instead of aerobic exercise, they performed light-intensity body conditioning/stretching (e.g. flexibility, passive stretching) exercises, during which HR was maintained below 40% heart rate reserve (HR typically was kept below 100 beats per minute). No exercise counselling or behavioural change advice was provided; instead, conversations were entered on topics of everyday life (i.e. weather, news items, and families). HR and RPE were assessed every 5 minutes
Outcomes	• Change in fitness reported: aerobic exercise tolerance was measured using the submaximal, 8-minute, single-stage walking test performed on a treadmill • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: adherence was calculated from session attendance, and the amount (duration, RPE, HR) of exercise achieved by participants during sessions was calculated by abstraction from physical activity logs maintained by the researcher • Aerobic exercise frequency: three sessions per week • Aerobic exercise duration: 27 minutes of exercise on average per session • Aerobic exercise intensity: 65% to 85% of age-adjusted HR maximum and RPE of 12 to 13 • Description aerobic exercise mode: treadmills, rowing ergometers and cycling ergometers • Resistance exercise frequency: N/A • Resistance exercise sets: N/A

Daley 2007a *(Continued)*

	• Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: 34/34 • Adherence: adherence to the interventions was excellent; 77% of exercise therapy and 88.9% of exercise-placebo groups, respectively, attended 70% (at least 17 of 24 sessions) or more of sessions. Mean HR for the exercise therapy group ranged from 117.4 (SD, 12.9) to 121.5 (SD, 13.4) throughout the weeks. Mean HR for exercise-placebo ranged from 92.5 (SD, 13.2) to 95.9 (SD, 9.5). Average durations of aerobic exercise achieved by exercise therapy ranged from 25.7 (SD, 6.3) to 27.4 (SD, 6.2) minutes. HR data indicated that both groups were exercising in accordance with the protocol • Attrition: at 8 weeks, 1 ,0 and 5 women were lost to follow-up in the intervention, sham and control groups, respectively. At 24 weeks, 3, 2 and 7 women were lost to follow-up in the intervention, sham and control groups, respectively • Adverse effects: three withdrawals in the intervention group: unclear as to why this occurred. Some withdrawals due to medical complications in placebo and control arms, but unclear if study related • Achieves Rock et al guidelines: no
Description of usual care	All participants continue to receive usual care from their health team
Notes	Mean and SD data for aerobic exercise tolerance at 8 and 24 weeks provided by authors in response to email request

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A telephone randomisation service was provided by an independent studies unit. Randomisation to the three treatment arms was done on a 1:1:1 ratio and was performed using stratified random permuted blocks (with block size of six). Stratification factors were chemotherapy (yes/no) and tamoxifen (yes/no)
Allocation concealment (selection bias)	Low risk	Randomisation service was provided by an independent studies unit telephone service
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcome assessors were not blinded to participants' group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Little's D test indicated that missing data were missing completely at random (2 88.2; df 1290; P = 0.99). Data were analysed on an intention-to-treat basis
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None

Drouin 2005

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): USA, Michigan (high) • Funding source: this study was funded by grants from the Elsa U. Pardee Foundation in Midland, Michigan, and the Max and Victoria Dreyfus Foundation in White Plains, New York

Drouin 2005 *(Continued)*

	• Inclusion criteria: sedentary females (less than 30 minutes of moderate intensity exercise three times per week), between 20 and 65 years of age, with histologically-established Stage 0 (ductal carcinoma in situ) to III breast cancer, with medical clearance and signed informed consent • Exclusion criteria: uncontrolled cardiac or hypertensive disease, orthopaedic conditions that would limit exercise participation, refusal to accept randomisation or participation in aerobic exercise within three months before the start of the study. Medical clearance for this study was determined by the participant's oncologist, the results of a routine Multiple Uptake Gated Scan (MUGA) of heart function and a symptom limited graded exercise test • CONSORT diagram included: no • Study recruitment rate: 23/39 • Length of follow-up: length of intervention = 8 weeks, length of follow-up from baseline = 8 weeks
Participants	• Primary cancer diagnosis: stage 0 (ductal carcinoma in situ) to III breast cancer • Current cancer treatment: each participant was undergoing external beam radiation five days per week for seven weeks. The affected breast and regional lymph nodes received a 4500 to 5000 cGy dose in 200 cGy fractions with a boost of 1000 to 1600 cGy delivered to the primary tumour bed. Treatment dosages were similar between groups • Metastatic disease: no • Age, years: mean (SD): intervention: 49.4 (7.0), controls: 51.9 (10.0) • Sex: women • BMI: unclear • Ethnicity: 13 African American, 8 Caucasian • Comorbidities reported: not clear
Interventions	• Sample size: intervention (n = 13), control (n = 8) • Group or individual intervention: unsupervised—members of the aerobic exercise group were instructed to perform self-monitored walking in their neighbourhood or on a treadmill in their home • Setting: home-based • Exercise prescription components: aerobic • Theoretical basis: not stated • CALO-RE taxonomy components: #16, #17, #21, #26 • Frequency of contact with researchers or exercise professionals: weekly phone calls with researcher • Instructions to controls:participants in the placebo stretching group were instructed to perform a general stretching protocol three to five days per week during this same period. However, the control group was told not to begin any new exercise activity other than a general flexibility programme that they were given
Outcomes	• Change in fitness reported: VO_2 peak assessed before and after intervention • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: all participants were provided a training diary to record their training adherence in days per week and minutes per day; members of the intervention group also recorded their training heart rate range. The principal investigator communicated with all participants weekly in person or by telephone. Participants in the intervention group wore heart rate monitors to record training time and time spent in the training heart rate range to improve reporting of data on exercise compliance, training intensity and training duration • Aerobic exercise frequency: three to five times per week • Aerobic exercise duration: 20 to 45 minutes • Aerobic exercise intensity: exercise intensity was 50% to 70% of the maximal heart rate achieved by the participant during a symptom limited graded exercise test • Description aerobic exercise mode: self-monitored walking in the neighbourhood or on a treadmill in the home • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A

Drouin 2005 *(Continued)*

	• Resistance exercise intensity: N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: 13/13 • Adherence: participants in the intervention group averaged 3.6 days per week of aerobic exercise over an 8-week period, and placebo stretching subjects averaged 3.9 days per week of participation during this same time period. No details are available on what 'participation' for the placebo stretching group constituted • Attrition: two women were lost to follow-up in the placebo stretching arm. Data from one participant in the placebo stretching group were eliminated from the final analysis because of marked irregularities in pretest and post-test physical measures from moderate to severe fluid retention during the initial test session • Adverse effects: none reported • Achieves Rock et al guidelines: unclear
Description of usual care	Each participant was treated with external beam radiation five days per week for seven weeks. The affected breast and regional lymph nodes received a 4500 to 5000 cGy dose in 200c Gy fractions with a boost of 1000 to 1600 cGy delivered to the primary tumour bed. Treatment dosages were similar between groups
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A random number table was used
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 of 23 participants lost to follow-up
Selective reporting (reporting bias)	Low risk	None
Other bias	Low risk	None

Hayes 2009

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Austrailia (high) • Funding source: National Breast Cancer Foundation for funding Dr. Hayes' fellowship • Inclusion criteria: women younger than 76 years, who had completed treatment for unilateral breast cancer at least six months before, subsequently had unilateral upper limb lymphoedema diagnosed by a healthcare professional and were prepared to travel to the exercise clinic for 12 weeks (if randomly allocated to the intervention group (IG)) were eligible. All participants were doing < 90 minutes/week of moderate intensity exercise (intensity was assessed by RPE)

Hayes 2009 *(Continued)*

	• Exclusion criteria: no other exclusion criteria were applied • CONSORT diagram included: no • Study recruitment rate: 32/138 • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 24 weeks
Participants	• Primary cancer diagnosis: unilateral breast cancer • Current cancer treatment: none • Metastatic disease: no • Age, years: mean (SD): control: 60 (11), intervention 59 (7) • Sex: women • BMI: unclear • Ethnicity: unclear • Comorbidities reported: all had lymphoedema

Interventions	• Sample size: intervention (n = 16), control (n = 16)
	• Group or individual intervention: a mix of supervised and non-supervised. Supervised sessions were group based (up to 10 women)
	  ◦ Weeks 1 to 4: three times per week (two supervised)
	  ◦ Weeks 5 to 8: four times per week (two supervised)
	  ◦ Weeks 9 to 12: at least four times per week (one supervised)
	• Setting: unclear
	• Exercise prescription components
	  ◦ Weeks 1 to 2: aerobic only (floor-based aerobic exercise to music and walking)
	  ◦ Weeks 3 to 4: aerobic (floor-based aerobic exercise to music, water-based aerobic exercise and walking) and water-based resistance exercises
	  ◦ Weeks 5 to 8: aerobic (mix of all types) and water-based and free-weight resistance exercises
	  ◦ Weeks 9 to 12: aerobic (mix of all types) and machine-weight resistance exercise
	• Theoretical basis: not stated
	• CALO-RE taxonomy components: #9, #26
	• Frequency of contact with researchers or exercise professionals: 20 supervised exercise sessions over 12 weeks
	• Instructions to controls: the control group was instructed to continue habitual activities

Outcomes	• Change in fitness reported: none • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: together, exercise adherence rates and qualitative comments were used to provide insight into the acceptability of the programme • Aerobic exercise frequency: three to four or more times per week • Aerobic exercise duration: 20 to 45+ minutes • Aerobic exercise intensity: 3 to 7 on a modified Borg scale • Description aerobic exercise mode: floor-based aerobic exercise to music, water-based aerobic exercise and walking • Resistance exercise frequency: three to four or more times per week • Resistance exercise sets: unclear • Resistance exercise repetitions: 20 to 10 • Resistance exercise intensity: approximately 15 to 10 repetition max • Description of resistance exercise: unclear
Compliance	• Intervention uptake: 16/16 • Adherence: most women (88%) allocated to the intervention group participated in 70% or more of scheduled supervised exercise sessions. The intervention was scheduled over winter, and missed sessions were most often related to respiratory illness (n = 10). Other reasons included having a skin le-

Hayes 2009 *(Continued)*

	sion removed (n = 1), undergoing gynaecological surgery (n = 1) and having work commitments (n = 2). One participant missed 50% of supervised sessions. Unsupervised exercise adherence is unclear Qualitative quotes: • "Without having you to guide me, there is no way I would have ever done the things I've done as part of this program" • "You gave me the confidence to know what I and my arm can do" • "I would not have tried the things I've done if not for the study. I now feel capable of joining an aqua class" • "You've shown me what I can do rather then tell me what I shouldn't do" • Attrition: one participant in each group at 24 weeks • Adverse effects: none reported • Achieves Rock et al guidelines: unclear
Description of usual care	Physiotherapy, massage, compression, lymphatic drainage or laser therapy for lymphoedema
Notes	Resistance aspect of this intervention will be excluded from analysis because of unclear exercise metrics

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were randomly allocated using a computer-generated table of random numbers
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measures were assessed pre-intervention (time 1; T1), immediately post-intervention (time 2; T2) and at 12-week follow-up (time 3; T3) and were conducted by the same assessor, who was blinded to participant group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants (n = 32) participated in T1 and T2, whereas data were unavailable for two participants (one in the IG and one in the CG) at T3. To ensure that missing data did not contribute to the results found, data analysis was repeated with these two participants excluded, and no differences in results were observed (data not shown)
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	High risk	Adherence data on home-based aspect of the intervention not clear

Irwin 2015

Methods	• Study design: RCT individual participant level randomisation • Study location: Yale and Connecticut • Funding source: National Cancer Insitute • Inclusion criteria: inclusion criteria required participating in less than 90 minutes/week of physical activity in the past 6 months and no strength training in the past year. Additionally, participants had to be experiencing at least mild arthralgias (as defined by a score of 3 out of 10 on the worst pain item of the Brief Pain Inventory (BPI)) for at least 2 months before enrolment. • Exclusion criteria: see inclusion criteria.

Irwin 2015 *(Continued)*

	• CONSORT diagram included: yes • Study recruitment rate: 121/1016 • Length of follow-up: length of intervention = 12 months, length of follow-up from baseline = 12 months.
Participants	• Primary cancer diagnosis: breast cancer • Current cancer treatment: chemotherapy, radiotherapy and none. • Metastatic disease: unclear • Age, years, mean (SD): intervention = 62.0 (7.0), control = 60.5 (7.0). • Gender: female • BMI: intervention = 30.0 (6.8), control = 28.7 (5.5) • Ethnicity: intervention = 85% Non-Hispanic white, 2% Hispanic, 10% African American, 2% Asian/Pacific Islander. Control = 84% Non-Hispanic white, 5% Hispanic, 7% African American, 2% Asian/Pacific Islander, 2% American Indian. • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 61), control (n = 60) • Group or individual intervention: individual • Setting: local health club and home-based. • Exercise prescription components: aerobic and resistance. • Theoretical basis: none • CALO-RE taxonomy components: programme set goal, #9 • Frequency of contact with researcher or exercise professional: • Frequency of contact with healthcare professional: twice-weekly supervised resistance training programme, supervised by a certified cancer exercise trainer. Assessments were carried out at baseline, 6 months and 12 months • Instructions to controls: women in the usual care group were instructed to continue with their usual activities. Participants in both groups were provided with a breast cancer specific educational booklet developed for the HOPE study, which discussed topics such as lymphoedema and fatigue. This booklet was individually discussed during the exercise training for the exercise group and in a monthly phone call for the usual care group.
Outcomes	• Change in fitness reported: cardiorespiratory fitness was measured at baseline and at 12 months with a standard maximal oxygen consumption (VO2 max) treadmill test. • Free-living energy expenditure: measured using a physical activity questionnaire.
Process measures	• Method of measuring exercise behaviour: heart rate monitors, exercise log books and adherence to exercise programme • Aerobic exercise frequency: twice weekly • Aerobic exercise duration: 150 minutes per week. • Aerobic exercise intensity: 50% HRMax and increased to 60-80% HRMax • Description aerobic exercise mode: brisk walking, cycle ergometers and elliptical trainers • Resistance exercise frequency: twice weekly • Resistance exercise sets: 3 • Resistance exercise repetitions: 8-12 reps • Resistance exercise intensity: participants progressed up to three sets per exercise over the first month. After two sessions during which a participant lifted the same weight 12 times during each set, the weight was increased by the smallest possible increment. One rep max was measured at baseline and 12 months. • Description of resistance exercise: lower and upper body, leg press, leg extension, leg curl, bench press and seated row. *from linked paper, Thomas 2017*
Compliance	• Intervention uptake: 61 • Adherence: women randomly assigned to exercise also reported their exercise prospectively in daily activity logs and reported an average 119 minutes per week of aerobic exercise, with an average of

Irwin 2015 *(Continued)*

	70% of strength-training sessions completed. Women randomly assigned to exercise increased their physical activity by an average 159 minutes per week, compared with 49 minutes per week in the usual-care group. Additionally, 53% of women adhered to monthly telephone calls. • Attrition: 88.5% remained after 6 months, 69% at 12 months. • Adverse effects: five participants had to discontinue the use of Atromatise inhibitors • Achieves Rock et al guidelines: yes, six weeks of resistance exercise.
Description of usual care	Women in the usual care group were instructed to continue with their usual activities. Participants in both groups were provided with a breast cancer specific educational booklet developed for the HOPE study, which discussed topics such as lymphoedema and fatigue. This booklet was individually discussed during the exercise training for the exercise group and in a monthly phone call for the usual care group.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were grouped according to the intention-to-treat principle. Permuted block randomisation (at 1:1 ratio) with random block size was performed, stratified by joint pain before AI therapy and current bisphosphonate use (related to our secondary aim of bone mass).
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	Balanced across both groups and intention to treat applied to the analysis/
Selective reporting (reporting bias)	Low risk	All outcomes reported.
Other bias	Low risk	None.

Kaltsatou 2011

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Greece (high) • Funding source: unclear • Inclusion criteria: participating only in the dancing exercising programme; none of the participants had prior physical practise or experience in traditional Greek dances or were participating in regular moderate intensity exercise. All participants had been diagnosed and surgically treated for breast cancer. They had completed cancer therapies, including surgery, radiotherapy and chemotherapy and had stopped all medical treatments at least three months before the beginning of the study (mean time post-treatment: 2.2 years) • Exclusion criteria: included poorly controlled hypertension and any health condition that would deter the participant from performing the exercises • CONSORT diagram included: no • Study recruitment rate: unclear

Kaltsatou 2011 *(Continued)*

	• Length of follow-up: length of intervention = 24 weeks, length of follow-up from baseline = 24 weeks
Participants	• Primary cancer diagnosis: all participants had been diagnosed and surgically treated for breast cancer • Current cancer treatment: participants had completed cancer therapies, including surgery, radiotherapy and chemotherapy and had stopped all medical treatments at least three months before the beginning of the study (mean time post-treatment: 2.2 years) • Metastatic disease: unclear • Age, years: mean (SD): intervention: 56.6 (4.2), control: 57.1 (4.1) • Sex: women • BMI: unclear • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 14), control (n = 13) • Group or individual intervention: group • Setting: supervised • Exercise prescription components: aerobic training with Greek traditional dances, upper body training and cool-down • Theoretical basis: not stated • CALO-RE taxonomy components: #9, #21, #22, #26 • Frequency of contact with researchers or exercise professionals: three supervised exercise sessions per week • Instructions to controls: asked to refrain from any form of recreational activity during the study period
Outcomes	• Change in fitness reported: aerobic exercise tolerance assessed by 6-minute walk test • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: unclear • Aerobic exercise frequency: three times per week • Aerobic exercise duration: the aerobic training phase lasted 25 minutes and included learning and practising Greek traditional dances • Aerobic exercise intensity: all dances, practised throughout the intervention, were of moderate intensity (between 65% and 80% of maximum heart rate). Heart rate was estimated by palpation by participants for four 15-second periods. Participants also rated their perceived exertion on a Borg scale. They were encouraged to reach perceived exertion 13 to 14 on the Borg 6 to 20 category scale. Intensity of exercise was prescribed on an individual basis, and the workload was progressively increased • Description aerobic exercise mode: Greek traditional dances • Resistance exercise frequency: three times per week • Resistance exercise sets: unclear • Resistance exercise repetitions: unclear • Resistance exercise intensity: unclear • Description of resistance exercise: upper body exercise training and cool-down lasted 25 minutes and emphasised stretching and resistance training with the use of various resistance machines
Compliance	• Intervention uptake: unclear • Adherence: unclear • Attrition: unclear • Adverse effects: none reported • Achieves Rock et al guidelines: unclear
Description of usual care	Unclear
Notes	Resistance aspect of this intervention will be excluded from analysis because of unclear exercise metrics

Kaltsatou 2011 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	High risk	Method of measuring exercise behaviour and adherence not reported

Kim 2006

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): USA (high) • Funding source: supported by an R01 grant from the National Institutes of Health, National Institute of Nursing Research and a Postdoctoral Fellowship Award from the Korea Science and Engineering Foundation KOSEF). • Inclusion criteria: women newly diagnosed with breast cancer; no history of cancer; all stages of breast cancer; age 40 years and above; and receiving cancer treatment • Exclusion criteria: women with known bony metastasis; high risk of fracture; known psychiatric illness; uncontrolled cardiopulmonary or other serious medical condition; and regular exercise at least two to three times a week of moderate intensity (less than 90 minutes total) within the past two months • CONSORT diagram included: no • Study recruitment rate: unclear • Length of follow-up: length of intervention = 8 weeks, length of follow-up from baseline = 24 weeks
Participants	• Primary cancer diagnosis: women with newly diagnosed breast cancer were stratified by the stage of breast cancer (Stages I to IIB vs locally advanced) • Current cancer treatment: undergoing treatment—chemotherapy was the most common type of adjuvant therapy (48.8%), followed by radiotherapy (34.1%) and a combination of chemotherapy and radiotherapy (17.1%) • Metastatic disease: none • Age, years: mean (SD): intervention: 51.3 (6.7), controls: 48.3 (8.8) • Sex: women • BMI: unclear; 33 women who had significantly higher BMI (34.3 ± 10.2) excluded from analysis • Ethnicity: 78% white reported • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 22), control (n = 19) • Group or individual intervention: unclear

Kim 2006 *(Continued)*

	• Setting: cardiac rehabilitation unit with cardiac monitoring until participants were released to be safe (for n = 2) and an exercise facility within the School of Nursing. Although most participants continued their exercise intervention in this exercise facility, a few opted to exercise at home on their own treadmill or to do fast walking • Exercise prescription components: aerobic • Theoretical basis: not stated • CALO-RE taxonomy components: #1, #21, #26, #36 • Frequency of contact with researchers or exercise professionals: supervised exercise sessions three times per week for the 'majority' • Instructions to controls: Usual care participants were instructed to refrain from starting a regular or structured exercise programme while participating in the study
Outcomes	• Change in fitness reported: changes in VO_2 peak at baseline at 8 weeks (although it is not clear how VO_2 was measured) • Free-living energy expenditure: estimate of energy expenditure reported
Process measures	• Method of measuring exercise behaviour: frequency, intensity and duration of exercise during the 8-week intervention period were monitored using Polar HR monitors, which were provided to all participants. All participants in both groups received a seven-day physical activity log to track their levels of exercise/physical activity over 16 weeks after the eight-week intervention. The seven-day physical activity log included five categories of the exercise/physical activity level, ranging from vigorous to sleeping/reclining, with explicit examples given for each level, which made monitoring feasible for participants. During 16 weeks of the postintervention follow-up period, the exercise physiologist research member called participants regularly to collect exercise/physical activity data from the log biweekly for participants in the intervention group and monthly for participants in the control group. Participants in the control group received less-frequent calls to minimise unintentional motivation or a reminder for exercise, but data were recorded at 2-week intervals for both groups • Aerobic exercise frequency: three days per week • Aerobic exercise duration: 30 minutes of aerobic exercise and 5 minutes for warm-up or cool-down • Aerobic exercise intensity: moderate intensity to produce an HR corresponding to 60% to 70% of the individual's HR reserve and/or VO_2 peak achieved on a graded exercise test at baseline • Description aerobic exercise mode: cycling, walking, jogging or running on a treadmill or track • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: not clear • Adherence: average weekly frequency of exercise was 2.4 ± 0.6 sessions, and average duration of exercise was 42.7 ± 8.0 minutes per session, including warm-up and cool-down periods. Average duration of exercise within prescribed target HRs was 27.8 ± 8.1 minutes per session. Overall adherence to exercise intervention was 78.3% ± 20.1%, but week-to-week variations over the 8-week intervention period ranged from 68.3% at week 7 to 95.0% at week 3 • Attrition: of 74 women recruited, 11 women (6 control, 5 intervention) withdrew from the study. Reasons for withdrawal included personal problems (n = 2), problems at home (n = 2), problems related to chemotherapy (n = 3), thrombophlebitis in the lower leg (n = 2), non—exercise-related injuries (n = 1) and death (n = 1). Twenty-two women (12 control and 10 intervention) missed either a pre-intervention or a postintervention graded exercise test (GXT), mainly because of scheduling conflicts, not keeping GXT appointments more than twice or unwillingness to perform the GXT. Forty-one women completed both pre-intervention and postintervention GXTs (i.e. 41/74) • Adverse effects: see above • Achieves Rock et al guidelines: no
Description of usual care	Usual cancer care included general information on the benefits of exercise but did not include specific instructions or further guidance for exercise. Seventy-eight per cent of women had Stage I and Stage

Kim 2006 *(Continued)*

	II breast cancer, and chemotherapy was the most common type of adjuvant therapy (48.8%), followed by radiotherapy (34.1%) and a combination of chemotherapy and radiotherapy (17.1%). Regimens of adjuvant therapy most often consisted of Adriamycin 60 mg/m^2 and cytoxan 600 mg/m^2 every 2 to 3 weeks for 3 doses with or without Taxol 145 mg/m^2 every 2 to 3 weeks for 3 to 4 doses. Radiotherapy was typically composed of delivering a total of 45 to 65 Gy over 6 to 7 weeks with booster doses of 20 Gy
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	High risk	Data on only 41 of 74 randomly assigned participants reported
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	High risk	Women randomly assigned but excluded had higher BMI and more advanced stages of cancer

Kim 2017

Methods	• Study design: RCT individual participant level randomisation • Study location: Central Korea • Funding source: no funding • Inclusion criteria: participants were eligible to participate in this study if they met the following criteria, with medical clearance from their oncologist: (1) diagnosed with stage I ± III breast cancer, (2) 6 months after treatments with radio- and/or chemotherapy subsequent to surgery, (3) absence of metastatic diseases and other cancers, (4) < 60 minutes per week of physical activity including resistance exercise in the past 6 months, (5) absence of cardiovascular and respiratory diseases, and (6) no contraindicated medications and co morbidities that prohibit participation in a moderate exercise programme. • Exclusion criteria: history of chronic disease including diabetes, uncontrolled hypertension or thyroid disease, Weight reduction >= 10% within past 6 months, Metastatic disease, Participate in more than 60 minutes of exercise per week in the past 6 months, Cardiovascular, respiratory or musculoskeletal disease or joint problems that preclude moderate physical activity • CONSORT diagram included: yes • Study recruitment rate: unclear • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 12 weeks.
Participants	• Primary cancer diagnosis: breast cancer • Current cancer treatment: none

Kim 2017 *(Continued)*

	• Metastatic disease: none • Age, years, mean (SD): intervention = 56.0 (6.5), control = 49.3 (4.8) • Gender: female • BMI: intervention = 23.9 (2.7), control = 25.0 (4.7) • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 15), control (n = 15) • Group or individual intervention: unclear • Setting: unclear • Exercise prescription components: aerobic and resistance • Theoretical basis: none • CALO-RE taxonomy components: programme set goal, #9 • Frequency of contact with researcher or exercise professional: baseline and follow-up assessments by research staff. 180 minutes per week of supervision from (3 sessions) exercise trainer • Frequency of contact with healthcare professional: medical clearance from oncologist before taking part in trial. • Instructions to controls: instructed to maintain their routine physical activities and not to participate any new exercise programmes during 12 weeks. After the final assessments, they had the option of participation.
Outcomes	• Change in fitness reported: unclear • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: adherence to exercise protocol and health-related fitness tests. • Aerobic exercise frequency: three supervised sessions per week • Aerobic exercise duration: 20 minutes per session. • Aerobic exercise intensity: RPE range 11-13, that was gradually increased at 4-week intervals until reaching a rate of 13-15. • Description aerobic exercise mode: step aerobics on 17 cm platforms for 20 minutes • Resistance exercise frequency: three supervised sessions per week. • Resistance exercise sets: 20 minutes per session. • Resistance exercise repetitions: the strength training was designed to begin with one set for the first two weeks, and the set number was increased every two weeks to finally achieve three sets of each exercise performing 12–16 repetitions to volitional fatigue per set. • Resistance exercise intensity: volitional fatigue per set. The exercise intensity and the resistance of elastic band were progressively increased to maintain this range of repetition. • Description of resistance exercise: the strength training using body weight and elastic bands consisting of shoulder press, black burn exercise, wall push-up, biceps curl-up, plank exercise, leg bridge, squat, and calf raise for 20 minutes.
Compliance	• Intervention uptake: 85.7% • Adherence: two participants did not fulfil the required exercise • Attrition: 7.23% • Adverse effects: unclear • Achieves Rock et al guidelines: yes, six weeks of resistance exercise training
Description of usual care	Instructured to maintain their routine physical activities and not to participate any new exercise programmes during 12 weeks. After the final assessments, they had the option of participation.
Notes	
Risk of bias	

Kim 2017 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Following baseline assessments, 30 participants were randomly assigned to either an exercise intervention group or a control group using a sealed, computer random number generator with an allocation ratio of 1 to 1
Allocation concealment (selection bias)	Low risk	Following baseline assessments, 30 participants were randomly assigned to either an exercise intervention group or a control group using a sealed, computer random number generator with an allocation ratio of 1 to 1
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Four research staff members who were unaware of group assignment performed all outcome assessments
Incomplete outcome data (attrition bias) All outcomes	Low risk	Dropouts similar in both groups and reasons given. Reasons given for lack of inclusion in final analysis.
Selective reporting (reporting bias)	Low risk	All outcomes reported.
Other bias	High risk	Age differences between groups in baseline demographics were present. Adherence data is vague.

McKenzie 2003

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Canada (high) • Funding source: supported by the Canadian Breast Cancer Research Initiative • Inclusion criteria: participants were eligible for the study if they had undergone breast cancer treatment for Stage I or II breast cancer that had been completed more than six months before enrolling in the study and had subsequently developed unilateral lymphoedema that was greater than 2 cm and less than 8 cm on at least one measurement point. Participants were not participating in > 90 minutes per week of moderate intensity exercise • Exclusion criteria: stage III lymphoedema, bilateral disease or cases for which medication was required that might affect upper extremity swelling • CONSORT diagram included: no • Number of participants in each arm: 7 intervention, 7 control • Study recruitment rate: unclear • Length of follow-up: length of intervention = 8 weeks, length of follow-up from baseline = 8 weeks
Participants	• Primary cancer diagnosis: stage I or II breast cancer • Current cancer treatment: all completed treatment six months before starting the study • Metastatic disease: no • Age, years: mean (SD): intervention: 56.4 (10.4), control: 56.9 (8.2) • Sex: women • BMI: mean (SD): intervention: 29.1 (6.6), control: 25.6 (3.3) • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 7), control (n = 7) • Group or individual intervention: unclear • Setting: supervised

McKenzie 2003 *(Continued)*

	• Exercise prescription components: aerobic and resistance • Theoretical basis: not stated • CALO-RE taxonomy components: #9, #26 • Frequency of contact with researchers or exercise professionals: supervised exercise sessions three times per week • Instructions to controls: Control participants were given no specific exercise instruction until after they completed the study but were specifically asked to refrain from initiating any new activity
Outcomes	• Change in fitness reported: no • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: work in kilo joules was calculated for each session for every participant, and this was used to calculate cumulative work done over the course of the programme • Aerobic exercise frequency: three days per week (initiated after week 2) • Aerobic exercise duration: 5 to 20 minutes • Aerobic exercise intensity: arm cycling at a resistance of 8.3 W to 25 W. Intensity was also assessed with Polar HR monitors. Target HR was 60% to 80% of maximum predicted by age • Description aerobic exercise mode: arm cycling • Resistance exercise frequency: three days per week • Resistance exercise sets: two sets of 10 repetitions for each exercise were done for the first week, three sets of 10 were done thereafter • Resistance exercise repetitions: see above • Resistance exercise intensity: unclear • Description of resistance exercise: seated row, bench press, latissimus dorsi pull-down, one arm bent-over rowing, triceps extension, and biceps curl
Compliance	• Intervention uptake: unclear • Adherence: unclear • Attrition: no attrition reported • Adverse effects: none reported • Achieves Rock et al guidelines: no
Description of usual care	Unclear
Notes	Resistance aspect of this intervention will be excluded from analysis because of unclear exercise metrics

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement

McKenzie 2003 *(Continued)*

Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	High risk	Adherence to prescribed exercise not reported

Mohamady 2017

Methods	• Study design: RCT individual participant level randomisation • Study location: Cairo University • Funding source: unclear • Inclusion criteria: patients were selected to be enrolled into this study after they had fulfilled the inclusion criteria of the study; female patients with breast cancer undergoing chemotherapy, they were medically stable and not receiving Erythropoietin therapy, their BMI ranged from 30 to 35, and they had an inactive lifestyle for at least the previous 6 months. • Exclusion criteria: BMI more than 35, age older than 70 or younger than 60 years. Patients who received erythropoietin treatments, suffered uncorrected visual problems, had scars under their feet, and had a history of serious cerebrovascular or cardiovascular diseases, or severe musculoskeletal problems restricting physical activity. • CONSORT diagram included: no • Study recruitment rate: unclear • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 12 weeks.
Participants	• Primary cancer diagnosis: breast cancer • Current cancer treatment: chemotherapy • Metastatic disease: unclear • Age, years, mean (SD): intervention = 54.6 (4.23), control = 58.25 (2.65) • Gender: female • BMI: intervention = 34.7 (3.44), control = 35.2 (3.36) • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 15), control (n = 15) • Group or individual intervention: unclear • Setting: lab • Exercise prescription components: aerobic • Theoretical basis: none • CALO-RE taxonomy components: programme set goal, #9 • Frequency of contact with researcher or exercise professional: initial assessment before baseline with oncologist. Assessments at baseline and 12 weeks. 3 times per week for 25 to 40 minutes at exercise sessions. • Frequency of contact with healthcare professional: initial assessment before baseline assessment with oncologist. • Instructions to controls: the control group, who performed the usual daily living activities in addition to administration of their medication and nutritional support.
Outcomes	• Change in fitness reported: none reported • Free-living energy expenditure: none reported
Process measures	• Method of measuring exercise behaviour: heart rate monitor • Aerobic exercise frequency: three sessions per week for 12 weeks • Aerobic exercise duration: 3 25-40 minute sessions per week

Mohamady 2017 *(Continued)*

	• Aerobic exercise intensity: 50% to 70% Maximal HR. Aerobic exercise intensity was determined using the Karvonen formula in which Target Heart Rate= [(max HR _ resting HR) _ % intensity] + resting HR, where maximum heart rate = 220-age. • Description aerobic exercise mode: treadmill • Resistance exercise frequency: N/A • Resistance exercise sets:N/A • Resistance exercise repetitions:N/A • Resistance exercise intensity:N/A • Description of resistance exercise:N/A
Compliance	• Intervention uptake: unclear • Adherence: unclear • Attrition: unclear • Adverse effects: unclear • Achieves Rock et al guidelines: unclear
Description of usual care	The control group, who performed the usual daily living activities in addition to administration of their medication and nutritional support.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was done via random number generator and opening opaque envelopes prepared by an independent individual.
Allocation concealment (selection bias)	Low risk	Randomisation was done via random number generator and opening opaque envelopes prepared by an independent individual.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement.
Selective reporting (reporting bias)	Low risk	Reported on all outcomes.
Other bias	High risk	No adherence data.

Musanti 2012

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): New Jersey, USA (high) • Funding source: supported by an award from the Greater NYC Affiliate of the Susan G. Komen Breast Cancer Foundation, Inc., New York, NY • Inclusion criteria: eligible survivors were English-speaking women diagnosed with Stage I to IIIB breast cancer who had completed adjuvant chemotherapy at least three months or radiation therapy at least 6 weeks before entry, and who were no more than 24 months beyond their last treatment. Hormonal therapy could be ongoing

Musanti 2012 *(Continued)*

	• Exclusion criteria: women were excluded if medical history or physical examination revealed evidence of anaemia (haemoglobin < 10 mg/dL), uncontrolled hypertension, congestive heart failure, pulmonary disease, diabetes and thyroid or musculoskeletal disease. Additional exclusion criteria included current enrolment in a weight loss or exercise programme or a positive response to any question on the Physical Activity Readiness Questionnaire, thus indicating the need for medical clearance before starting an exercise programme • CONSORT diagram included: no • Study recruitment rate: 55/231 • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 12 weeks
Participants	• Primary cancer diagnosis: completed adjuvant chemotherapy at least three months or radiation therapy at least six weeks before entry and were no more than 24 months beyond their last treatment • Current cancer treatment: hormonal therapy could be ongoing: 56% on hormone therapy • Metastatic disease: none • Age: overall mean (SD) = 50.5 (7.5) • Sex: women • BMI: unclear • Ethnicity: unclear • Comorbidities reported: unclear
Interventions	• Sample size: flexibility group (n = 13), aerobic group (n = 12), resistance group (n = 17), aerobic and resistance group (n = 13). • Group or supervised intervention: individual • Setting: home-based • Exercise prescription components: aerobic and resistance exercise • Theoretical basis: exercise and self-esteem model • CALO-RE taxonomy components: #9, #16, #17, #21, #22, #26 • Frequency of contact with researchers or exercise professionals: weekly contact via phone or e-mail. Content included exercise programme adherence, the need for progression of the exercise prescription and adverse effect reporting • Instructions to controls: all participants were prescribed flexibility exercise. In-person verbal instruction plus demonstration was used to teach participants how to do their assigned exercises. In addition, each participant received a written guidebook that included general information about exercise participation, such as clothing and safety tips, as well as their individualised exercise prescription, exercise instructions and an exercise log sheet
Outcomes	• Change in fitness reported: prediction of VO_2 max from submaximal treadmill testing using the Bruce protocol; change in upper body weight lifted and endurance reported • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: Adherence to the exercise prescription was calculated as a proportion of completed sessions over the total possible number of sessions in the assigned exercise programme. Mean percentage scores were as follows: flexibility = 85, aerobic = 81, resistance = 91 and aerobic plus resistance = 86. Although participants were encouraged to complete their exercise log, only 50% of participants successfully did so • Aerobic exercise frequency: three times per week. Women who participated in the aerobic and resistance group followed instructions similar to those given to the aerobic and resistance only groups; however, the frequency of aerobic exercise progressed to four to five days per week, and resistance was maintained at two times per week • Aerobic exercise duration: 15 to 30 minutes • Aerobic exercise intensity: 40% to 65% of the calculated heart rate max • Description aerobic exercise mode: walking • Resistance exercise frequency: times per week. A+R group performed resistance exercise twice per week • Resistance exercise sets: one

Musanti 2012 *(Continued)*

	• Resistance exercise repetitions: women started with one set of 10 to 12 repetitions. Progression through more resistive bands occurred so that RPE rose to around seven to eight at the completion of 12 repetitions • Resistance exercise intensity: women in the resistance group were prescribed a Thera-Band that produced an RPE of 3 to 5 on a scale of 0 to 10. Progression through more resistive bands occurred so that RPE rose to around seven to eight at the completion of 12 repetitions • Description of resistance exercise: Women started with one set of 10 to 12 repetitions of the following exercises: shoulder flexion, shoulder press, latissimus pull-down, seated row, chest press, elbow press (triceps), elbow curl (biceps), hip flexion, hip extension, abdominal crunches, leg press and squat
Compliance	• Intervention uptake: 13/13,12/12,17/17,13/13 for flexibility, aerobic, resistance and combined groups, respectively • Adherence: adherence to the exercise prescription was calculated as a proportion of completed sessions over the total possible number of sessions in the assigned exercise programme. Mean percentage scores were as follows: flexibility = 85, aerobic = 81, resistance = 91 and aerobic plus resistance = 86. Although participants were encouraged to complete their exercise log, only 50% successfully did so • Attrition: 42/55. Forty-two women completed the study; however, five of these women returned the survey data form but refused final fitness testing because of time constraints related to work and family obligations. Thirteen women (24%) did not complete their assigned 12-week programme. All dropped out by week 6, except one woman, who developed appendicitis after the 12-week exercise programme but before she could complete the postintervention testing. No post study assessments were obtained from these women. The most frequently cited reason given for discontinuing the exercise programme was perceived difficulty fitting the exercise into their lives because of work and/or family responsibilities (seven women). One woman had her breast reconstruction surgery rescheduled so that completion became impossible, one did not give a reason, and one could not complete the initial fitness testing because of an elevated HR. Two women cited the need for additional supervised exercise sessions because they could not maintain motivation on their own • Adverse effects: adverse effects were reported in two women during the study. In both cases, the women developed tendonitis: one in the shoulder and the other in the foot. Both had a history of tendonitis, and both received standard treatment (i.e. rest, anti-inflammatory medication, and gentle movement). Both women resumed exercise at a lesser intensity, progressed their exercise over time and completed the study without further incident • Achieves Rock et al guidelines: 12 weeks of resistance exercise at two or three times per week. Aerobic prescription: unclear
Description of usual care	Unclear
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation table
Allocation concealment (selection bias)	Low risk	Computer-generated randomisation table maintained by office staff in the clinical research office
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Physical fitness testing was performed at a hospital-based fitness centre. The same research assistant, blinded to participant group allocation, performed these measurements at pre-intervention and postintervention measurement time points
Incomplete outcome data (attrition bias) All outcomes	High risk	Thirteen women (24%) did not complete their assigned 12-week programme

Musanti 2012 *(Continued)*

Selective reporting (reporting bias)	High risk	Waist, upper and mid and lower arm circumference measures not reported
Other bias	High risk	• A significant number of the dropouts belonged to the resistance exercise group (n = 8/13). These women did not verbalise any discontent with this specific modality of exercise; their reasons for dropping out were as previously described. Of note, these women had significantly stronger muscular endurance measurements than were reported in the non-dropout group • Second, significant differences were noted in baseline levels of fatigue (P = 0.003), with the dropout group perceiving a greater level of fatigue. Baseline leisure time activity was also markedly different. Women in the completion group reported a significantly greater weekly volume of low to moderate physical activity. In the dropout group, however, scores ranged from 0 to 12, indicating very little general activity • Only 50% of activity logs were returned

Perna 2010

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Maryland, USA (high) • Funding source: funded by the National Cancer Institute (CA R01-78801) • Inclusion criteria: (a) English speaking, (b) between 21 and 75 years of age, (c) sedentary lifestyle (i.e. exercise fewer than three times per week for greater than 30 minutes/session, at a moderate intensity, in last six months), (d) average or below average fitness as determined by a graded exercise test (GXT) and (e) recent diagnosis of breast cancer (Stage 0, I, II or IIIa) • Exclusion criteria: (a) non—cancer-related contraindications to aerobic walking exercise (e.g. symptomatic coronary artery disease, psychotic spectrum mental illness, orthopaedic problems), (b) pre-existing metabolic disease (e.g. diabetes, uncontrolled hypertension) and (c) a contraindication to exercise discovered on the exercise stress test • CONSORT diagram included: no • Study recruitment rate: 51/57 • Length of follow-up: length of intervention = 3 months, length of follow-up from baseline = 3 months
Participants	• Primary cancer diagnosis: breast cancer (Stage 0, I, II or IIIa) • Current cancer treatment: most (52.9%) women had Stage I breast cancer and underwent lumpectomy surgery (74.1%). Many (44.1%) women received both radiation and chemotherapy, 26.5% received radiation only, 8.8% received chemotherapy only and 20.6% received no adjuvant therapy • Metastatic disease: none • Age, years: overall mean (SD) = 50.8 (11.8) • Sex: female • BMI: overall mean (SD): 28.8 (6.1) • Ethnicity: a large percentage of women were black (44.1%), and total ethnic minority group membership was high (45.1%) • Comorbidities reported: 23.5% of women had CESD depression scores above the clinical cut-off
Interventions	• Sample size: intervention (n = 51 in total), numbers randomly assigned to each arm are unclear • Group or supervised intervention: unclear • Setting: supervised hospital-based and subsequently home-based intervention • Exercise prescription components: aerobic and resistance • Theoretical basis: trans theoretical model • CALO-RE taxonomy components: #1, #5, #8, #9, #10, #12, #15, #16, #19, #20, #21, #22, #23, #24, #25, #26, #29, #35

Perna 2010 *(Continued)*

	• Frequency of contact with researchers or exercise professionals: supervised exercise sessions three times a week for 4 weeks during hospital phase. Thereafter, intervention participants received weekly contact by telephone or electronic mail according to participant preference • Instructions to controls: women in the information control group received a 45-minute session covering their fitness, strength and flexibility assessment results and an informational brochure. The session specifically excluded discussion of strategies addressing exercise barriers, and participants who asked about exercise were told to "do the best you can". To facilitate participant retention, the control group was contacted once per month, and one week before follow-up assessment, they were given a pedometer for data collection purposes (Note: Pedometer data were not part of the article)
Outcomes	• Change in fitness reported: no • Free-living energy expenditure: unclear

Process measures	• Method of measuring exercise behaviour: participants were provided with monthly calendars to record their exercise activity and were contacted weekly by telephone or electronic mail according to their preference. Godin Leisure Time Exercise Questionnaire and the LTEQ self-report instrument surveys were also used
	• Aerobic exercise frequency
	  ◦ Hospital-based phase (first 4 weeks): three times per week
	  ◦ Home-based phase: at least three days per week
	• Aerobic exercise duration
	  ◦ Hospital-based phase (first 4 weeks): 15 to 45 minutes
	  ◦ Home-based phase: 30 minutes or longer
	• Aerobic exercise intensity
	  ◦ Hospital-based phase: 50% to 85% max HR
	  ◦ Home-based phase: moderate intensity, RPE 11 to 16
	• Description aerobic exercise mode: home or treadmill walking
	• Resistance exercise frequency
	  ◦ Hospital-based phase: three per week
	  ◦ Home-based phase: participants were asked to continue resistance training three times a week
	• Resistance exercise sets
	  ◦ Hospital-based phase: 1 to 2 sets
	  ◦ Home-based phase: maintaining the same numbers of sets and repetitions
	• Resistance exercise repetitions
	  ◦ Hospital-based phase: 12 to 15
	  ◦ Home-based phase: maintaining the same numbers of sets and repetitions
	• Resistance exercise intensity
	  ◦ Hospital-based phase: 12 repetitions at the lightest weight, and, as tolerated, repetitions were increased to 15 after the first week. After a participant could perform 15 repetitions of an exercise, another set was added. Upper body exercises were performed with a padded weight belt with interchangeable 1.0 lb bars used to adjust the total weight up to a maximum of 20 lb. Participant body weight was used for lower body exercises
	  ◦ Home-based phase: maintain
	• Description of resistance exercise: The resistance programme consisted of upper body (biceps curl, triceps extension, chest fly, military press, upright row and shoulder shrug) and lower body (leg squat and lunge) exercises

Compliance	• Intervention uptake: unclear • Adherence: women assigned to the structured intervention completed an average of 83% of their scheduled hospital-based exercise sessions (mean = 9.9, SD = 3.3 sessions), and 76.9% completed all 12 sessions. LTEQ scores increased from baseline by 157% (from M = 9.7, SD = 8.1 to M = 25.0, SD = 13.1) in the intervention group and by 32.7% among the control group (from M = 10.7, SD = 12.8 to M = 14.2, SD = 11.8). Home-based adherence is not clear • Attrition: unclear. No details on numbers randomly assigned to each arm. An overall study completion figure of 80.4% is cited (i.e. participants completing follow-up assessments) • Adverse effects: unclear

Perna 2010 *(Continued)*

	• Achieves Rock et al guidelines: unclear
Description of usual care	unclear
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were stratified by cancer stage and were randomly assigned to groups
Allocation concealment (selection bias)	Low risk	Participant assignment to groups at enrolment was concealed from the project director
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Physicians monitoring graded exercise tests were blinded to participant group assignment. Similarly, a physical therapist or an exercise physiologist, blinded to participant assignment, performed strength assessments
Incomplete outcome data (attrition bias) All outcomes	Low risk	Intent-to-treat analysis done and multiple imputation used
Selective reporting (reporting bias)	Low risk	None
Other bias	High risk	Numbers randomly assigned to intervention and control groups are unclear, as are numbers completing in each arm

Pinto 2003

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Rhode Island, USA (High) • Funding source: this study was supported by Grant RO3 MH55570 from the National Institute of Mental Health to Dr Pinto • Inclusion criteria: sedentary women (exercised fewer than three times per week for 20 minutes per session) who had been diagnosed with breast cancer (Stage 0, I or II) over the past 3 years. Post-surgery patients who had completed chemotherapy or radiation treatment were invited to participate in a 12-week exercise programme or a wait-list control group (CG) • Exclusion criteria: medical or current psychiatric illness that would make compliance with the study protocol difficult or dangerous (e.g. coronary artery disease, hypertension, diabetes), orthopaedic problems or neuropathies that would limit exercise training. Medications that would alter training responses (e.g. beta blockers) or affect distress outcomes (e.g. antidepressants) were also reasons for exclusion • CONSORT diagram included: no • Study recruitment rate: 24/53* • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 12 weeks
Participants	• Primary cancer diagnosis: stage 0 to II breast cancer, postsurgery participants who had completed chemotherapy or radiation treatment • Current cancer treatment: none • Metastatic disease: none • Age, years: overall mean (SD): 52.5 (6.8) • Gender: women

Pinto 2003 *(Continued)*

	• BMI: overall mean (SD): 26.8 (4.1) • Ethnicity: all white • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 12), waiting list control (n = 12) • Group or supervised intervention: unclear • Setting: supervised and home-based exercise • Exercise prescription components: aerobic and resistance exercise (resistance exercise was introduced only for last 4 weeks of the 12-week programme) • Theoretical basis: none • CALO-RE taxonomy components: programme set goal, #9, #15, #16, #21, #26 • Frequency of contact with researchers or exercise professionals: an exercise physiologist monitored participants' blood pressure and heart rate once a week before, during and after exercise. Individual exercise prescriptions were updated before each session. Unclear whether physiologist was present at each exercise session • Instructions to controls: asked not to change their current level of physical activity
Outcomes	• Change in fitness reported: aerobic exercise tolerance test performed but no control group comparison data reported • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: attendance at supervised exercise sessions. Individual exercise prescriptions were updated before each session • Aerobic exercise frequency: three times per week • Aerobic exercise duration: over the 12 weeks, the exercise session developed into 10 minutes of warm-up (cardiovascular and flexibility), 10 minutes of cool-down (cardiovascular and flexibility) and 30 minutes of cardiovascular activity within an individual's target heart rate zone • Aerobic exercise intensity: 60% to 70% of peak heart rate by the end of the 12-week intervention • Description aerobic exercise mode: Cardiovascular activities included treadmill walking, arm and leg ergometers, arm cycling, stationary cycling and rowing. To tailor the programme for women who had undergone breast surgery and to improve upper body endurance, investigators encouraged arm cycling and rowing during the sessions. Participants used at least three modes of physical activity per session that would ensure at least one cardiovascular arm activity • Resistance exercise frequency: N/A less than 6 weeks • Resistance exercise sets: N/A less than 6 weeks • Resistance exercise repetitions: N/A less than 6 weeks. • Resistance exercise intensity: N/A less than 6 weeks • Description of resistance exercise: N/A less than 6 weeks
Compliance	• Intervention uptake: unclear — Quote: "Three women discontinued participation within the first four weeks of the 12-week programme" • Adherence: Of the 12 participants in the exercise group, three women discontinued participation within the first four weeks of the 12-week programme (reasons included child care responsibilities and inconvenience of travelling to the hospital). These individuals provided questionnaire data at post assessments but did not complete post-treatment exercise tolerance tests. The remaining participants attended a mean of 88% of the 36-session exercise programme and completed the exercise tolerance test and questionnaire assessments at post-treatment. Adherence rate to the home-based component of the exercise prescription was unclear • Attrition: nine participants were lost to follow-up (three in the exercise group, six in the control group) • Adverse effects: not reported; however, it is unclear why the six controls dropped out • Achieves Rock et al guidelines: unclear
Description of usual care	Unclear

Pinto 2003 *(Continued)*

Notes	*We estimated study recruitment rate on the basis of numbers randomly assigned of those approached and eligible

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	High risk	Exercise tolerance test performed but no control group comparison data reported. 38% lost to follow-up
Selective reporting (reporting bias)	High risk	None of the physiological assessments were performed for the control group at 12 weeks
Other bias	High risk	A statistically significant difference was noted between groups for body esteem at baseline (weight concerns and physical condition sub scales)

Pinto 2005

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Rhode Island, USA (high) • Funding source: supported by National Cancer Institute Grant No. CA 75452 (BMP) • Inclusion criteria: eligibility criteria included age 18 years; currently sedentary (exercised one time per week for 20 minutes at vigorous intensity or two times per week for 30 minutes at moderate intensity for the past six months)*; diagnosed with Stage 0 to II breast cancer over the past 5 years; completed surgery, chemotherapy and/or radiation; ambulatory (able to walk a mile without assistive devices); and willing to be randomly assigned • Exclusion criteria: participants were excluded if they had a prior history of cancer (exception: non-melanoma skin cancer), or if they had a medical or current psychiatric illness that could make compliance with the study protocol difficult or dangerous (e.g. cardiovascular disease, diabetes, orthopaedic problems that limit exercise training) • CONSORT diagram included: yes • Study recruitment rate: 86/123 • Length of follow-up: 12 weeks of 'treatment' with nine months of follow-up from baseline
Participants	• Primary cancer diagnosis: breast cancer Stage 0 to II • Current cancer treatment: 49% of intervention group and 74% of control group receiving hormone treatment • Metastatic disease: none • Age, years: mean (SD): intervention: 53.4 (9.1), control: 52.9 (10.4) • Sex: women • BMI: mean (SD): intervention: 27.5 (5.0), control: 28.6 (5.5) • Ethnicity: 95% white

Pinto 2005 *(Continued)*

	• Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 43), control (n = 43) • Group or supervised intervention: individual • Setting: home-based • Exercise prescription components: aerobic • Theoretical basis: trans theoretical model • CALO-RE taxonomy components: #5, #8, #12, #16, #17, #19 • Frequency of contact with researchers or exercise professionals: after randomisation, each intervention participant received in-person instructions on how to exercise at a moderate-intensity level, how to monitor heart rate, and how to warm up before exercise and cool down after exercise. Also, intervention participants received weekly phone calls for 12 weeks, then calls every month for three months • Instructions to controls: control participants were asked to refrain from changing their current level of activity during the 12 weeks. They received a weekly phone call from research staff for 12 weeks to match the frequency of contact with the intervention group. These women received the same cancer survivorship tip sheets as the PA group
Outcomes	• Change in fitness reported: aerobic exercise tolerance assessed by a timed one-mile walk test • Free-living energy expenditure: total weekly energy expenditure (kcal/kg/week) calculated from the seven-day physical activity recall questionnaire
Process measures	• Method of measuring exercise behaviour: seven-day physical activity recall questionnaire and accelerometer data providing kcal/hour • Aerobic exercise frequency: two to five days per week • Aerobic exercise duration: 10 to 30 minutes • Aerobic exercise intensity: The programme promoted moderate intensity activities at 55% to 65% of maximum heart rate • Description of aerobic exercise mode: brisk walking, biking, swimming or use of home exercise equipment • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A

Compliance	• Intervention uptake: 43/43
	• Adherence:
	  ◦ Pinto 2005: 15 of 43 in the intervention group and 0 of 41 in the control group accumulated at least 30 minutes of moderate intensity physical activity (e.g., walking briskly, heavy house work) on most, ideally all, days of the week as reported by seven-day recall questionnaires. No changes were reported in accelerometer data in the intervention group (change score = -0.33 kcal/hour).
	  ◦ Pinto 2009: from heart rate data: At week 1, participants reported an average of 43.12 minutes of exercise (SD 44.32) and at week 12, a mean of 128.53 minutes/week of exercise (SD 76.82), at between 55% and 65% of predicted max heart rate. However, less than 75% of the intervention group were meeting the prescribed goal after week 4.
	• Attrition: Four dropped out in the intervention arm and did not provide data at the post-treatment assessment. Reasons for dropout included no time (n = 1); could not be contacted to determine reasons (n = 2); and participation terminated (n = 1) (the study team terminated one woman's participation because of symptoms of chest pain during exercise and her refusal to have these symptoms evaluated by her physician)
	• Adverse effects: not clear whether chest pain was related to exercise in dropout whose participation was terminated
	• Achieves Rock et al guidelines: no

Description of usual care	Unclear

Pinto 2005 *(Continued)*

Notes	*Data from baseline questionnaires indicated that two participants in the intervention group were active at baseline (i.e. a discrepancy was noted between telephone screening and assessment). However, the author has advised that outliers were removed during data analysis of study outcomes. Author advised that accelerometer data should have been reported as kcal/hour)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	Intention-to-treat approach used and low attrition reported (5%)
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	High risk	Significantly more control group participants were receiving hormone treatment: 49% versus 74% in the intervention and control groups, respectively (P = 0.015). Objective accelerometer data do not support the self-reported physical activity behaviour

Pinto 2011

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Rhode Island, USA (high) • Funding source: this study was funded by the National Cancer Institute (CA 101770 to Dr Pinto) • Inclusion criteria: (i) men and women aged ≥ 18 years; (ii) completed primary and adjuvant treatments for colon or rectal cancer (Stages I to III); (iii) ≤ 5 years since treatment completion; (iv) able to read and speak English; (v) provided consent for medical chart review; (vi) able to walk unassisted; (vii) sedentary, which was defined as exercising < 60 minutes/week at moderate intensity PA or < 20 minutes/week of vigorous intensity PA over the past six months; and (viii) had access to a telephone • Exclusion criteria: patients with a prior history of cancer were excluded. Another exclusion criterion was a medical or current psychiatric illness (e.g. orthopaedic problems) that could make compliance with the study protocol difficult or unsafe. Patients with cardiovascular disease and/or diabetes were included if their treating physicians approved of their study participation • CONSORT diagram included: yes • Study recruitment rate: 46/66 • Length of follow-up: 12 weeks of counselling with 12 months of follow-up from baseline
Participants	• Primary cancer diagnosis: 57% colon cancer, 43% rectal cancer • Current cancer treatment: none • Metastatic disease: none • Age, years: mean (SD): control: 55.6 (8.24), intervention: 59.5 (11.2) • Gender: 56% female

Pinto 2011 *(Continued)*

	• BMI: mean (SD): control: 29.4 (6.1), intervention: 27.9 (6.0) • Ethnicity: 1 of 46 non white • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 20), control (n = 26) • Group or supervised intervention: individual • Setting: home-based and facilitated with phone calls • Exercise prescription components: aerobic • Theoretical basis: trans theoretical model, social cognitive theory • CALO-RE taxonomy components: #5, #8, #9, #12, #16, #17, #19, #21, #23, #24, #26 • Frequency of contact with researchers or exercise professionals: after an initial one-to-one consultation, each participant received a weekly call over 12 weeks from research staff to monitor physical activity participation, identify relevant health problems, solve any barriers to physical activity and reinforce participants for their efforts • Instructions to controls: were asked not to change their usual level of activity
Outcomes	• Change in fitness reported: timed one-mile walk with estimation of VO_2 peak • Free-living energy expenditure: calories per week estimated from CHAMPS questionnaire
Process measures	• Method of measuring exercise behaviour: questionnaires—seven-day physical activity recall; community healthy activities model programme for seniors (CHAMPS); stage of motivational readiness for physical activity. Accelerometer data also collected • Aerobic exercise frequency: two to five times per week • Aerobic exercise duration: 10 to 30 minutes • Aerobic exercise intensity: the programme promoted moderate intensity aerobic activities at 64% to 76% of estimated maximum heart rate • Description aerobic exercise mode: Brisk walking, biking, or use of home exercise equipment was recommended • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A

Compliance	• Intervention uptake: 20/20
	• Adherence:
	  ◦ Goal of 150 minutes/week of physical activity was met or exceeded by 64.7% of the intervention group versus 40.9% of the control group at three months, by 38.9% of the intervention group versus 27.3% of the control group at six months and by 31.6% of the intervention group versus 21.7% of the control group at 12 months
	  ◦ Physical activity of moderate intensity (recorded using the three-day PAR questionnaire) was compared with the corresponding accelerometer data over three days. Spearman rank correlations were weak at baseline (r = 0.12) because of a high proportion of sedentary participants. Correlation at the three-month follow-up showed the only significant between-group change reported in exercise minutes: r = 0.32
	• Attrition: 1/20 at three, six and 12 months in the intervention arm; 2/26 at three, 3/26 at six and 12 months in the control group
	• Adverse effects: one cancer recurrence in the control group at three months
	• Achieves Rock et al guidelines: self-report indicates that 64.7% of the intervention group and 40.9% of the control group were achieving the guidelines. However, accelerometer data are not provided to support this. Further, only a weak correlation was reported between self-report and accelerometer data at three months

Description of usual care	Unclear

Pinto 2011 *(Continued)*

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit a 'low' or 'high' risk judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% attrition reported
Selective reporting (reporting bias)	High risk	Accelerometer data not reported
Other bias	High risk	Accelerometer correlation with self-report questionnaires is weak at follow-up points when significant differences between groups in physical activity are reported (i.e. r = 0.32 at 3 months). Substantial contamination in the control group

Rogers 2015

Methods	• Study design: RCT individual participant level randomisation • Study location: Springfield, IL, USA *from linked to study Rogers 2012* • Funding source: this project was supported by the National Cancer Institute R01CA136859. Kerry S. Courneya is supported by the Canada Research Chairs Program. • Inclusion criteria: women (ages 18–70) with history of ductal carcinoma in situ (DCIS) or stage I–IIIA breast cancer who self-reported engaging in B30 minutes of vigorous or B60 minutes of moderate intensity physical activity per week on average over the past 6 months were enrolled. Participants had to be postprimary treatment, C8 weeks post surgery, English speaking, and medically cleared by their physician. *from linked to study Rogers 2012* • Exclusion criteria: women (ages 18–70) with history of ductal carcinoma in situ (DCIS) or stage I–IIIA breast cancer who self-reported engaging in less than 30 minutes of vigorous or less 0 minutes of moderate intensity physical activity per week on average over the past 6 months were enrolled. Participants had to be postprimary treatment, C8 weeks post surgery, English speaking, and medically cleared by their physician. *from linked to study Rogers 2012* • CONSORT diagram included: yes • Study recruitment rate: 222/288 • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 6 months.
Participants	• Primary cancer diagnosis: breast cancer • Current cancer treatment: post primary treatment and/or hormone treatment • Metastatic disease: unclear • Age, years, mean (SD): intervention = 54.9 (9.3), control = 53.9 (7.7) • Gender: female • BMI: intervention = 30.8 (6.9), control = 30.5 (6.8) *from linked paper Rogers 2016*

Rogers 2015 *(Continued)*

	• Ethnicity: 1.8% Hispanic and 98.2% non-Hispanic • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 110), control (n = 112) • Group or individual intervention: both • Setting: home-based and university • Exercise prescription components: aerobic • Theoretical basis: social cognitive theory • CALO-RE taxonomy components: #1 programme set goal, #8 #9 #10 #15 #17 #19 #20 #21 #22 #26 #35 • Frequency of contact with researcher or exercise professional: this intervention includes 12 supervised exercise sessions tapered over 6 weeks followed by three face-to-face update counselling sessions every 2 weeks with a trained exercise specialist. Six group sessions led by trained facilitators provided additional behavioural counselling (e.g. time management, stress management, behavioural modification strategies, etc.). Outcomes were measured at baseline, 3 months, 6 months and 12 months by blinded members of the team. • Frequency of contact with healthcare professional: unclear • Instructions to controls: usual care participants received printed American Cancer Society materials describing physical activity recommendations for cancer survivors (e.g. Living Smart: The American Cancer Society's guide to eating healthy and being active). No additional instructions regarding physical activity were given with the materials.
Outcomes	• Change in fitness reported: aerobic fitness was measured using a submaximal treadmill test and modified Naughton protocol • Free-living energy expenditure: assessed using self-report and accelerometers.
Process measures	• Method of measuring exercise behaviour: HR monitor, Accelerometers, use of Godin questionnaire and activity log. • Aerobic exercise frequency: 150 minutes per week. • Aerobic exercise duration: 20-30 minutes per session, three times per week. • Aerobic exercise intensity: the programme used the rating of perceived exertion, progressing from 1.5-5.5 over the programme. • Description aerobic exercise mode: walking on a treadmill in supervised sessions, after supervised sessions other aerobic exercises could be chosen by the participant as long as target intensity and duration was met • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity: N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: 222/288 • Adherence: adherence to the intervention was 98 % for supervised exercise sessions, 96 % for update sessions, and 91 % for discussion group sessions. Only five intervention participants did not receive the allocated intervention (i.e. did not complete C75 % of all intervention components combined). • Attrition: 3% at month 3, 4% at month 6. • Adverse effects: related expected adverse events in the intervention group included back or lower extremity musculoskeletal pain or injury (n = 14), heart rate monitor rash (n = 1), fall while walking (n = 1), breast reconstruction (n = 3), and chest pain during treadmill fitness test (n = 1) • Achieves Rock et al guidelines: yes, 150 minutes per week was the total aim of moderate intensity exercise per week, 96% to 98% achieved this.
Description of usual care	Usual care participants received printed American Cancer Society materials describing physical activity recommendations for cancer survivors (e.g. Living Smart: The American Cancer Society's guide to eating healthy and being active). No additional instructions regarding physical activity were given with the materials

Rogers 2015 *(Continued)*

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation to one of the two study group conditions was completed using computer-generated numbers in blocks of 4 within each recruiting site to facilitate an even distribution between study conditions during each recruitment wave.
Allocation concealment (selection bias)	Low risk	Random assignment was kept in sealed, opaque envelopes which were opened in the order in which participants completed baseline testing
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcomes were measured at baseline, 3 months, 6 months and 12 months by blinded members of the team.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Dropouts similar in both groups with reasons given.
Selective reporting (reporting bias)	Low risk	All outcomes were reported.
Other bias	High risk	Physical activity reported at baseline, differed between objective and subjective measures.

Scott 2013

Methods

- Study design: RCT individual participant level randomisation
- Study location: Sheffield, UK
- Funding source: American Institue for cancer research grant
- Inclusion criteria: this study recruited 90 overweight women with a BMI >25 kg/m^2
- Exclusion criteria: included concomitant hormone replacement therapy (HRT) or oral contraceptives; metastatic or active loco-regional disease; physical or psychiatric impairment limiting physical mobility; severe nausea, anorexia or other conditions precluding participation in exercise, the consumption of alternative/complementary diets or use of high-dose antioxidant supplements; and those already engaged in regular exercise.
- CONSORT diagram included: yes
- Study recruitment rate: 47, 43 (intervention vs control)
- Length of follow-up: length of intervention = 24 weeks, length of follow-up from baseline = 24 weeks.

Participants

- Primary cancer diagnosis: breast cancer
- Current cancer treatment: none or receiving adjuvant endocrine treatment
- Metastatic disease: unclear
- Age, years, mean (SD): intervention = 55.8 (10.0), control = 55.3 (8.8).
- Gender: female
- BMI: intervention = 29.7 (3.5), control = 31.1 (5.7)
- Ethnicity: white
- Comorbidities reported: unclear

Interventions

- Sample size: intervention (n = 47), control (n = 43)
- Group or individual intervention: individually tailored but in groups of 1-3.

Scott 2013 *(Continued)*

	• Setting: university exercise research facility • Exercise prescription components: aerobic and resistance • Theoretical basis: none • CALO-RE taxonomy components: programme set goal, #21 • Frequency of contact with researcher or exercise professional: assessments at baseline and 24 weeks by a trained technician blinded to the group allocation. Three weekly supervised sessions and an additional weekly small-group nutrition education seminar. • Frequency of contact with healthcare professional: unclear • Instructions to controls: in the control group contact with researchers was limited to assessment sessions. Participants in the control group were offered three exercise sessions at the university exercise research facility and general exercise and dietary advice after the final follow-up.
Outcomes	• Change in fitness reported: aerobic exercise tolerance was tested using a submaximal, 8-minute single stage walking test on a treadmill. • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: heart rate monitor and adherence to exercise protocol. • Aerobic exercise frequency: three sessions per week. • Aerobic exercise duration: thirty minutes per session. • Aerobic exercise intensity: 65% to 85% age predicted maximum heart rate • Description aerobic exercise mode: treadmill, cross-trainer, cycle-ergometer and/or rowing ergometer • Resistance exercise frequency: three sessions per week. Resistance exercise sets: 3 sets • Resistance exercise repetitions: 12 reps • Resistance exercise intensity: resistance training was individually tailored to the women's ability at the time (strength, range of motion). For upper body, we initially worked on range of motion then built up to 3 sets of 12 reps using light hand weights (1 kg, 2 kg or 3 kg) or resistance bands (according to patient preference) for a range of exercises focusing on the arms, chest and back. We also used the exercise balls for core stability work and some upper body work (e.g. press ups against the wall). Did not do much leg strengthening as they were using the exercise bike, treadmill, cross-trainer for the aerobic section of the session, but some women progressed to using the exercise balls for assisted squats against the wall. Women with lymphoedema did the same as the others but stuck to very light weights, e.g. 1 kg. The focus was light weights and lots of reps, as per the lymphoedema avoidance/management guidance at the time. • Description of resistance exercise: resistance bands, hand weights and stability balls.
Compliance	• Intervention uptake: 47/238 • Adherence: 80% of all sessions. • Attrition: 10% • Adverse effects: none reported. • Achieves Rock et al guidelines: yes, 6 weeks of resistance exercise.
Description of usual care	The control group received a healthy eating booklet (Eat well), which also included brief advice on keeping active.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Patients were randomised using minimisation (on the advice of statistician at the Leeds CTU [we used their distant randomisation service]) to balance the potential confounding variables of chemotherapy, hormone treatment or no hormone treatment. Using this approach, the first participant is allocated a treatment at random. For each subsequent participant a decision has to

Scott 2013 *(Continued)*

		be made about which treatment would lead to better balance between the groups in the variables of interest. The randomisation ratio was 1:1.
Allocation concealment (selection bias)	Low risk	Randomisation conducted by and independent researcher and not revealed until baseline assessment was complete
Blinding of outcome assessment (detection bias) All outcomes	Low risk	A trained technician was blinded to carry out outcome assessments.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss to follow-up disclosed.
Selective reporting (reporting bias)	Low risk	All outcomes reported.
Other bias	Low risk	None

Thomas 2013

Methods	• Study design: RCT individual participant level randomisation • Study location: Yale • Funding source: National Cancer Institue • Inclusion criteria: the inclusion criteria required participating in less than 90 minutes of physical activity per week prior to enrolment; participants were nonsmokers and were free of other serious health problems. Only those women who were sedentary or reported less than 90 minutes of moderate to vigorous physical activity per week and were not currently participating in a weight loss diet programme were eligible. • Exclusion criteria: exclusion criteria for the study included women younger than 40 years of age due to potential differences in disease aetiology and women over 75 years of age due to likelihood of significant co morbidities and safety concerns for elderly exercise participants. • CONSORT diagram included: yes *from linked study Irwin 2008* • Study recruitment rate: 75/788 *from linked study Irwin 2008*. • Length of follow-up: length of intervention = 6 months, length of follow-up from baseline = 6 months.
Participants	• Primary cancer diagnosis: breast cancer • Current cancer treatment: previous chemotherapy, radiotherapy, hormone therapy and none • Metastatic disease: unclear • Age, years, mean (SD): intervention = 56.5 (9.8), control = 55.1 (7.6). • Gender: female • BMI: intervention = 30.8 (5.9), control = 29.4 (7.4). • Ethnicity: intervention = 83% white, 17% African American, control = 90% white, 7% African-American, 3% Asian/Pacific islander. • Comorbidities reported: unclear
Interventions	• Sample size: intervention (n = 35), control (n = 30) • Group or individual intervention: individual • Setting: local health club • Exercise prescription components: aerobic • Theoretical basis: none • CALO-RE taxonomy components: #5 #9 #17 • Frequency of contact with researcher or exercise professional: 3 weekly supervised sessions with a certified exercise trainer.

Thomas 2013 *(Continued)*

	• Frequency of contact with healthcare professional: unclear • Instructions to controls: women in the usual care group were instructed to continue with their usual activities. If a participant wanted to exercise, she was told she could, but the exercise programme and training materials would not be offered to her until the end of the study. At the end of the study, women in the usual care condition were offered three supervised training sessions, a pedometer, exercise handouts, and the results of their clinical tests. Additionally, all study participants received quarterly newsletters that highlighted issues relevant to breast cancer survivorship.
Outcomes	• Change in fitness reported: unclear • Free-living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: physical activity questionnaire, 7-day physical activity log and heart rate monitors. • Aerobic exercise frequency: five weekly sessions, three supervised and two unsupervised. • Aerobic exercise duration: 30 minutes per session • Aerobic exercise intensity: 50% HRMax and increased to 60% to 80% HRMax • Description aerobic exercise mode: • Resistance exercise frequency: N/A • Resistance exercise sets: N/A • Resistance exercise repetitions: N/A • Resistance exercise intensity:N/A • Description of resistance exercise: N/A
Compliance	• Intervention uptake: 75/88 • Adherence: the goal of the intervention was for participants to achieve 150 minutes of moderate intensity exercise per week; 33% of the intervention group achieved 150 minutes per week, 56% of the intervention group achieved 120 minutes per week and 75% achieved 90 minutes per week. • Attrition: among the 75 women randomised, complete 6-month data were available for 67 women (89%); 34 women randomised to exercise and 33 women randomised to usual care. *from linked study Irwin 2008* • Adverse effects: five of the 37 women randomised to exercise experienced an adverse event; 2 events were related to the study (plantar fascitis), and 3 were unrelated (swollen achilles, stress fracture in foot, and plantar fascitis) to the study. No women developed lymphoedema during the study. *from linked study Irwin 2008* • Achieves Rock et al guidelines: no
Description of usual care	Women in the usual care group were instructed to continue with their usual activities. If a participant wanted to exercise, she was told she could, but the exercise programme and training materials would not be offered to her until the end of the study. At the end of the study, women in the usual care condition were offered three supervised training sessions, a pedometer, exercise handouts, and the results of their clinical tests. Additionally, all study participants received quarterly newsletters that highlighted issues relevant to breast cancer survivorship.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	After completion of all baseline measures, each participant was randomly assigned with equal probability to either the exercise or usual-care group.
Allocation concealment (selection bias)	Low risk	Randomisation was performed by using a random number generation, and group assignment was placed in a sealed envelope, which was opened by the study coordinator at the time of randomisation.

Thomas 2013 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Low risk	For each participant, the same data that were collected at the baseline visit were collected in a similar manner at 6 months postrandomisation by staff blinded to the participant's group, *from linked study Irwin 2008*
Incomplete outcome data (attrition bias) All outcomes	Low risk	Outcome data were present for 89% of the participants at 6 months.
Selective reporting (reporting bias)	High risk	No body fat or lean mass values given. No data given from food frequency questionnaire.
Other bias	High risk	Poor recruitment rate (9.5%)

ADP: androgen-deprivation therapy; BMI: body mass index; BPI: Brief Pain Inventor; yHR: heart rate; m: metre; MRI: magnetic resonance imaging; NSCLC: non-small cell lung cancer; PAR: Physical Activity Recall; QoL: quality of life; RPE: Rating of Perceived Exertion; SD: standard deviation; VAS: visual analogue scale;

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Adams 2016	Participants were not sedentary at baseline
Ahmed 2006	Sedentary status at baseline is unclear
Alibhai 2014	Participants were not sedentary at baseline
Ames 2011	Exercise prescription metrics are unclear
Anderson 2012	Sedentary status at baseline is unclear
Anderson 2013	Not a homogenous cancer cohort
Anderson 2015	Report - not a full-text paper
Anulika 2015	Unable to access full text
Arbane 2011	Author advised that baseline sedentary status was not assessed
Arbane 2014	Patients were hospitalised
Arikawa 2013	Not a cancer cohort
Banerjee 2013	Poster
Baruth 2015	Unclear if participants were meeting the baseline moderate exercise sedentary criteria
Battaglini 2007	Author advised that baseline sedentary status was not assessed
Battaglini 2008	Linked to Battaglini 2007
Bloom 2013	Poster
Bracha 2012	Unclear of duration and intensity of prescribed exercise

Study	Reason for exclusion
Brdareski 2012	No usual care comparison
Brown 2012	Linked to Schmitz 2009 and Schmitz 2010
Bruno 2018	Participants were not sedentary at baseline
Buchan 2016	No usual care comparison
Buffart 2013	Poster
Buffart 2014a	Not a homogenous cancer cohort
Buffart 2014b	Not a homogenous cancer cohort
Campbell 2005	Unclear if participants were meeting the baseline moderate exercise sedentary criteria
Cantaero-Villanueva 2013	Participants were not sedentary
Cantaero-Villanueva 2016	Unclear if participants were meeting the baseline moderate exercise sedentary criteria
Cantarero-Villanueva 2011	Intervention exercise prescription metrics unclear
Cantarero-Villanueva 2012a	Linked to Cantarero-Villanueva 2011
Carmack Taylor 2004	Linked to Carmack Taylor 2006
Carmack Taylor 2006	Exercise prescription metrics are unclear
Carmack Taylor 2007	Linked to Carmack Taylor 2006
Carson 2009	Author advised that baseline sedentary status was not assessed
Casla 2015	Participants were not sedentary at baseline
Cerulli 2014	Unknown exercise prescription
Chen 2015	Baseline exercise activity inclusion criteria is greater then 90 minutes
Chen 2016	Baseline exercise activity inclusion criteria is greater then 90 minutes
Cho 2006	Sedentary status at baseline is unclear
Christensen 2014	Participants not sedentary at baseline
Chuang 2017	Exercise prescription is not clear
Coleman 2003	Exercise prescription metrics are unclear
Cornette 2016	Exercise prescription is not clear
Cornie 2013a	Participants not sedentary at baseline
Cornie 2013b	Sedentary status at baseline is unclear
Cornie 2014	Protocol paper

Study	Reason for exclusion
Cornie 2015	Participants not sedentary at baseline
Courneya 2012	Participants not sedentary at baseline
Courneya 2013	Participants not sedentary at baseline
Courneya 2014a	Author advised us that the participants were not sedentary at baseline
Courneya 2014b	Author advised us that the participants were not sedentary at baseline
Courneya 2015	Participants not sedentary at baseline
Courneya 2016a	Participants not sedentary at baseline
Courneya 2016b	Linked to Courneya 2013 paper
Culos Reed 2010	Exercise prescription metrics are unclear
Danhauer 2009	Sedentary status at baseline is unclear
Daubenmier 2006	Linked to Ornish 2005
De Jesus 2013	Poster
Demark-Wahnefried 2015	No usual care comparison
DeNysschen 2011	Sedentary status at baseline is unclear
Dieli-Conwright 2014	Protocol paper
Dieperink 2017	Authors confirmed that participants were not sedentary at baseline
Diepold 2016	The participants were in palliative care
Do 2015	Cross-over trial
Dolan 2010	START trial includes non-sedentary participants
Dolan 2014	Poster
Dolan 2016	Participants not sedentary at baseline
Donmez 2017	Exercise prescription is not clear
Donnelly 2011	Author advised that cohort was not sedentary at baseline
Edvarsen 2015	Sedentary status at baseline is unclear
Emslie 2007	Linked to Mutrie 2007
Eriksen 2017	Participants were not sedentary at baseline
Fan-Ko 2017	Exercise prescription is not clear
Fernandez-Lao 2012	Intervention exercise prescription metrics unclear

Study	Reason for exclusion
Fields 2015	Poster
Fields 2017	Participants were not sedentary at baseline
Forbes 2017	Mixed cancer cohort
Frattaroli 2008	Linked to Ornish 2005
Friedenrich 2016	Participants were not cancer patients
Furzer 2016	Not a homogenous cancer cohort
Galiano-Castillo 2017	Unclear whether the participants were sedentary at baseline
Galvão 2010	Sedentary status at baseline is unclear
Galvão 2011	Linked to Galvão 2010
Galvão 2017	Participants were not sedentary at baseline
Gaskin 2016	Participants were not sedentary at baseline
Gehring 2014	Poster
Gehring 2015	Poster
Gehring 2018	Authors confirmed participants were not sedentary at baseline
Gerland 2012	Abstract
Giallauria 2014	Sedentary behaviour was not assessed
Gokal 2016	Participants were not sedentary at baseline
Granger 2013	Participants were hospitalised
Greenlee 2013	Cross-over trial
Gruenigen 2012a	Participants were not sedentary at baseline
Gruenigen 2012b	Linked to Gruenigen 2012a
Guinan 2013	Participants were not sedentary at baseline
Guinan 2017	Authors confirmed participants were not sedentary at baseline.
Gómez 2011	Cohort not sedentary at baseline
Haines 2010	Sedentary status at baseline is unclear
Hanssens 2012	Abstract
Hartman 2015	Protocol paper
Hatchett 2013	Intensity of exercise is unclear

Study	Reason for exclusion
Hayes 2011	Author advised that baseline sedentary status was not assessed
Hayes 2012	Paper not published yet
Hayes 2013	Author clarified that the participants were not sedentary at baseline
Hayes 2014	Trial still ongoing, paper not published yet
Headley 2004	Sedentary status at baseline is unclear
Heim 2007	Sedentary status at baseline is unclear
Herbert 2012	Participants were not sedentary at baseline.
Herrero 2006	Sedentary status at baseline is unclear
Ho 2016	No intensity reported
Hoffman 2013	Poster
Hoffman 2017	Unclear whether the participants were sedentary at baseline
Hojan 2016	Unable to gain copy of paper
Hojan 2017	Unsure whether participants were sedentary at baseline
Huang 2015	Participants were not sedentary at baseline
Hubbard 2016	Participants were not sedentary at baseline
Husebo 2014	Participants were not sedentary at baseline
Hwang 2012	Not all participants were randomised
James 2012	Poster
Jarden 2013	Study protocol
Jeffs 2013	intensity of the exercise is unclear
Jensen 2015a	Abstract
Jensen 2015b	Participants were hospitalised
Jensen 2016	Length of follow-up is less than 6 weeks
Jones 2014a	Participants were not sedentary at baseline
Jones 2014b	Participants were not sedentary at baseline
Kalter 2015	Moderator paper on previous excluded study
Kampshoff 2015	Not homogenous cancer cohort
Kampshoff 2016	Mixed cancer cohort

Study	Reason for exclusion
Kanera 2016	Mixed cancer cohort
Kanera 2017	Mixed cancer cohort
Kavanagh 2009	Sedentary status at baseline is unclear
Kilbreath 2006	Sedentary status at baseline is unclear
Kilbreath 2012	Sedentary status at baseline is unclear
Kim 2010	Sedentary status at baseline is unclear
Klepin 2015	Abstract
Klinkhammer-Schalke 2012	Sedentary status at baseline is unclear
Kwiatkowski 2013	Participants were not sedentary at baseline
Lahart 2016	Participants were not sedentary at baseline
Lai 2017	Follow-up is less than 6 weeks
Lee 2012a	Study protocol
Lee 2012b	Study protocol
Lee 2014	Participants were not sedentary at baseline
Leone 2016	No frequency/duration/intensity of exercise reported
Ligibel 2008	Author advised that exercise intensity was not clear
Ligibel 2009	Linked to Ligibel 2008
Ligibel 2016	Exercise intensity was unclear
Lin 2014	Not randomised controlled trial
Litterini 2013	Not homogenous cancer cohort
Livingston 2015	Participants were not sedentary at baseline
Lynch 2014	No frequency/duration/intensity data
Lyons 2016	Exercise is carried out for couples
MacVicar 1989	Sedentary status at baseline is unclear
Manassero 2007	Exercise prescription metrics are unclear
Martin 2013	Unclear if the participants were sedentary at baseline
Mayo 2014	Not homogenous cancer cohort
McClure 2010	Sedentary status at baseline is unclear

Study	Reason for exclusion
McGowan 2013	No frequency/duration/intensity data
McGuire 2011	Linked to Waltman 2010
McNeely 2004	Author advised that cohort was not sedentary
Milecki 2013	Participants were not sedentary at baseline
Mina 2013	No usual care comparison
Mock 1994	Sedentary status at baseline is unclear
Mock 1997	Sedentary status at baseline is unclear
Mock 2005	Sedentary status at baseline is unclear
Molassiotis 2015	Inspiratory muscle training
Moller 2015	Unable to source copy of full-text paper
Monga 2007	Sedentary status at baseline is unclear
Morielli 2018	Not a randomised controlled trial
Mustian 2008	Exercise prescription metrics are unclear
Mustian 2015	Poster
Mutrie 2007	Author advised that cohort was not sedentary at baseline
Naumann 2012	Not a randomised controlled trial
Newton 2014	Poster
Nieman 1995	Sedentary status at baseline is unclear
Nikander 2007	Sedentary status at baseline is unclear
Nikander 2012	Participants were not sedentary at baseline.
Nilsen 2015	Unclear whether participants were sedentary at baseline or not
Nobes 2012	Poster
Nuri 2012	Unclear on inclusion or exclusion criteria
Nuri 2016	Unclear whether participants were sedentary at baseline or not.
Nyrop 2017	Not sedentary at baseline
O'Neil 2015	Unclear on intensity of prescribed exercise
Ohira 2006	Linked to Schmitz 2005
Ornish 2005	Sedentary status at baseline is unclear

Study	Reason for exclusion
Ornish 2008a	Linked to Ornish 2005
Ornish 2008b	Linked to Ornish 2005
Park 2012	The interventions were prescribed continence exercises rather than aerobic/resistance exercise
Park 2016	Author confirmed participants were not sedentary at baseline
Payne 2008	Sedentary status at baseline is unclear
Philips 2012	Not a homogenous cancer cohort
Pickett 2002	Sedentary status at baseline is unclear
Pinto 2013a	No usual care comparison
Pinto 2013b	No usual care comparison
Pinto 2015	No usual care comparison
Porserud 2014	Intensity of prescribed exercise was unclear
Portela 2008	Author advised that baseline sedentary status was not assessed
Rabin 2016	The cancer cohort was not homogenous
Rahnama 2010	Author not able to confirm sedentary status
Rao 2012	Unclear whether participants were sedentary at baseline or not.
Reis 2013	Did not report or measure intensity
Rogers 2009	Author advised that cohort was not sedentary at baseline
Rogers 2012	Author advised that cohort was not sedentary at baseline
Rogers 2013a	No usual care comparison
Rogers 2013b	Participants were not sedentary at baseline
Rogers 2014	Participants were not sedentary at baseline
Rogers 2015b	Linked to Rogers 2014
Saarto 2012a	Participants were not sedentary at baseline
Saarto 2012b	Participants were not sedentary at baseline
Sajid 2013	No usual care comparison
Samuel 2013	Control was advised to keep physically active as possible
Sandel 2005	Sedentary status at baseline is unclear
Schmidt 2015	No usual care comparison

Study	Reason for exclusion
Schmidt 2017a	Linked to Schmidt 2015
Schmidt 2017b	Unclear whether participants were sedentary or not at baseline
Schmitz 2009	Author advised intensity not assessed
Schmitz 2010	Author advised intensity not assessed
Schmitz 2015a	Linked to Schmitz 2015b
Schmitz 2015b	Participants were not cancer survivors
Schuler 2017	Not homogenous cancer cohort
Schwartz 2015	Not homogenous cancer cohort
Scruggs 2018	Exercise prescription is not clear
Sebio Garcia 2017	Unclear if the participants were sedentary at baseline
Segal 2001	Author advised exercise behavior not formally assessed at baseline
Segal 2003	Author advised exercise behavior not formally assessed at baseline
Segal 2009	Author advised exercise behavior not formally assessed at baseline
Sener 2017	Intensity of exercise is not clear
Sheppard 2016	Intensity of exercise is not clear
Shobeiri 2016	Participants were not sedentary at baseline
Short 2012	Poster
Short 2017a	Participants were not sedentary at baseline
Short 2017b	Participants were not sedentary at baseline
Singh 2015	Cross-over trial
Skinner 2016	Participants were not sedentary at baseline
Sohl 2016	No usual care comparison
Spahn 2013	No usual care comparison
Stacey 2016	Mediator paper reporting on previous unsuitable randomised controlled trial
Stefanelli 2013	Unclear whether the participants were sedentary at baseline or not
Stolley 2017	Unclear whether participants were sedentary at baseline
Streckman 2014	Participants were hospitalised
Sturgeon 2017	Participants were not sedentary at baseline

Study	Reason for exclusion
Swisher 2015	Participants were not sedentary at baseline
Taafe 2017	Usual care participants were active
Taleghani 2012	Participants were not adults
Taso 2014	Intensity not reported
Terranova 2017	Unclear whether participants were sedentary at baseline
Tomasello 2017	Compared with a 'healthy' control
Tometich 2017	Participants were not sedentary at baseline
Travier 2015	Participants were not sedentary at baseline
Trinh 2014	Linked to Mutrie 2007
Uth 2014	Participants were not sedentary at baseline
Uth 2016	Participants were not sedentary at baseline
Van Vulpen 2016	Not a homogenous cancer cohort
van Waart 2015	Unclear whether participants were sedentary at baseline
von Gruenigen 2008	Author advised that cohort was not sedentary at baseline
von Gruenigen 2009	Linked to von Gruenigen 2008
von Gruenigen 2012	Author advised that cohort was not sedentary
Waltman 2010	Author advised that cohort was not sedentary
Wang 2012	Sedentary status at baseline is unclear
Wasley 2018	Mixed cancer cohort
Wiskemann 2017	Participants were not sedentary at baseline
Xu 2015	Participants were not sedentary at baseline
Yang 2011	Sedentary status at baseline is unclear
Yeo 2012	Author not able to clarify exercise metrics
Yuen 2007	Author advised that cohort was not sedentary at baseline
Yun 2013	Not homogenous cancer cohort
Zhang 2018	Unclear whether participants were sedentary at baseline
Zhao 2016	Not a randomised controlled trial
Zhou 2015	Conference paper

Study	Reason for exclusion
Zimmer 2014	Compared with a 'healthy control'
Zimmer 2016	Protocol paper
Zopf 2012	Poster

Characteristics of studies awaiting assessment *[ordered by study ID]*

Bai 2004

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Bai S-M, Ma C, Liu Y-M, Xue W-P, Luo M, Ou Z-H. Effects of cognitive behavior intervention and cinesiateics on the quality of life of patients with nasopharyngeal carcinoma after radiotherapy. Chinese Journal of Clinical Rehabilitation 2004;8(29):6312–3.

Chen 2010

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Chen J, Luo A, He Y. Influence of postoperative rehabilitation exercises on functional recovery of ill limb of breast cancer patients. Chinese Nursing Research 2010;24(4A):875–7.

Cho 2004

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Cho OH. Effects of a comprehensive rehabilitation programme for mastectomy patients. Taehan Kanho Hakhoe Chi 2004;34(5):809–19.

Choi 2012

Methods	
Participants	
Interventions	
Outcomes	
Notes	Still awaiting translation: Choi, J. Y. Kang, H. S. Effects of a home-based exercise program for patients with stomach cancer receiving oral chemotherapy after surgery. Journal of Korean Academy of Nursing, 2012; 42(1):95-104

Dong 2006

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Dong HY, Wang ZF, Cai L. Correlation between quality of life and rehabilitative guidance education in the postoperative patients with breast cancer. Chinese Journal of Clinical Rehabilitation 2006; 10(42), 28-30.

Guo 2004

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Guo Y-M. Effects of moderate strength and endurance exercise on emotion and quality of sleep in patients with malignant tumor. Chinese Journal of Clinical Rehabilitation 2004;8(35):7896–7.

Hu 2013

Methods	
Participants	
Interventions	

Hu 2013 *(Continued)*

Outcomes	
Notes	Still awaiting translation: Hu, H. F. Li, T. C. Liu, L. C. Wu, C. T. Wang, Y. J. Effects of a walking program on fatigue and exercise capacity in post-surgery breast cancer women, Hu li za zhi [Journal of nursing]. 2013 Oct;60(5):53-63

LeVu 1997

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Le Vu B, Dumortier A, Guillaume MV, Mouriesse H, Barreau-Pouhaer L. Efficacy of massage and mobilization of the upper limb after surgical treatment of breast cancer. Bulletin du Cancer 1997;80(10):957–61.

Oliveira 2010

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Oliveira MM, Souza GA, Miranda Mde S, Okubo MA, Amaral MT, Silva MP, Gurgel MS. Upper limb exercises during radiotherapy for breast cancer and quality of life. Revista Brasileira de Ginecologia e Obstetrícia 2010;32(3):133-8.

Park 2006

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Park HS, Cho GY, Park KY. The effects of a rehabilitation program on physical health, physiological indicator and quality of life in breast cancer mastectomy patients. Taehan Kanho Hakhoe Chi 2006;36(2):310-20.

Wang 2005

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Wang Y;Yao J-F;Yang J-Y. Effect of rehabilitation exercises on the recovery outcomes of lung function in postoperative patients with lung cancer. Zhongguo Linchuang Kangfu (Chinese Journal of Clinical Rehabilitation) 2005; 9(39):14-16.

Zhang 2005

Methods	
Participants	
Interventions	
Outcomes	
Notes	Study awaiting translation: Zhang T, Chang XM, He YG, Huang HX, Fan KS. Effects of rehabilitation therapy in relieving pain and improving quality of life in patients with advanced cancer. Zhongguo Linchuang Kangfu (Chinese Journal of Clinical Rehabilitation) 2005;40:59-61.

DATA AND ANALYSES

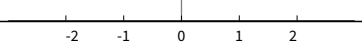
Comparison 1. Aerobic exercise tolerance

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up)	10	604	Std. Mean Difference (IV, Fixed, 95% CI)	0.54 [0.37, 0.70]
2 Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up sensitivity analysis)	4	201	Std. Mean Difference (IV, Fixed, 95% CI)	0.85 [0.56, 1.14]
3 Aerobic exercise tolerance (all cancers: 6 months of follow-up)	7	591	Std. Mean Difference (IV, Fixed, 95% CI)	0.56 [0.39, 0.72]
4 Aerobic exercise tolerance (breast cancer: 8-12 weeks of follow-up)	6	441	Std. Mean Difference (IV, Random, 95% CI)	0.57 [0.22, 0.93]
5 Aerobic exercise tolerance (all cancers: combination of supervised and home-based exercise: 8 to 12 weeks of follow-up)	4	357	Std. Mean Difference (IV, Random, 95% CI)	0.53 [0.01, 1.04]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6 Aerobic exercise tolerance (all cancers: home-based exercise: 8 to 12 weeks of follow-up)	3	155	Std. Mean Difference (IV, Fixed, 95% CI)	0.70 [0.37, 1.03]
7 Aerobic exercise tolerance (all cancers:supervised exercise: 8 to 12 weeks of follow-up)	3	92	Std. Mean Difference (IV, Random, 95% CI)	1.07 [0.26, 1.89]
8 Aerobic exercise tolerance (all cancers: undergoing active treatment: 8 to 12 weeks follow-up)	6	313	Std. Mean Difference (IV, Fixed, 95% CI)	0.72 [0.49, 0.95]
9 Aerobic exercise tolerance (all cancers: no active treatment: 8 to 12 weeks follow-up	4	291	Std. Mean Difference (IV, Random, 95% CI)	0.61 [0.10, 1.12]

Analysis 1.1. Comparison 1 Aerobic exercise tolerance, Outcome 1 Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up).

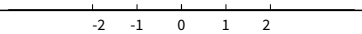
Study or subgroup	Exercise intervention N	Exercise intervention Mean(SD)	Usual care N	Usual care Mean(SD)	Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
al-Majid 2015	6	24.7 (2.5)	6	17.6 (2.8)		0.99%	2.47[0.82,4.12]
Bourke 2011a	9	528.2 (114.5)	9	376.7 (125.7)		2.57%	1.2[0.18,2.22]
Bourke 2014	43	475.6 (130.8)	42	375 (121.8)		13.82%	0.79[0.35,1.23]
Cavalheri 2017	6	0.9 (0.9)	8	-0.5 (1.9)		2.14%	0.86[-0.27,1.98]
Daley 2007a	33	35 (4.4)	33	31.5 (5.1)		10.84%	0.73[0.23,1.23]
Kim 2006	22	1810.1 (369.4)	19	1630.4 (351.5)		6.94%	0.49[-0.14,1.11]
Musanti 2012	11	24.7 (4.1)	12	23 (4.3)		3.95%	0.39[-0.44,1.22]
Pinto 2005	43	-16.3 (2.1)	43	-17.9 (2.2)		14.12%	0.74[0.3,1.17]
Pinto 2011	20	27.7 (5.3)	26	23.7 (4.7)		7.33%	0.79[0.18,1.4]
Rogers 2015	105	23.6 (4.8)	108	22.7 (5.3)		37.29%	0.18[-0.09,0.45]
Total ***	**298**		**306**			**100%**	**0.54[0.37,0.7]**
Heterogeneity: Tau^2=0; Chi^2=17.45, df=9(P=0.04); I^2=48.41%							
Test for overall effect: Z=6.42(P<0.0001)							



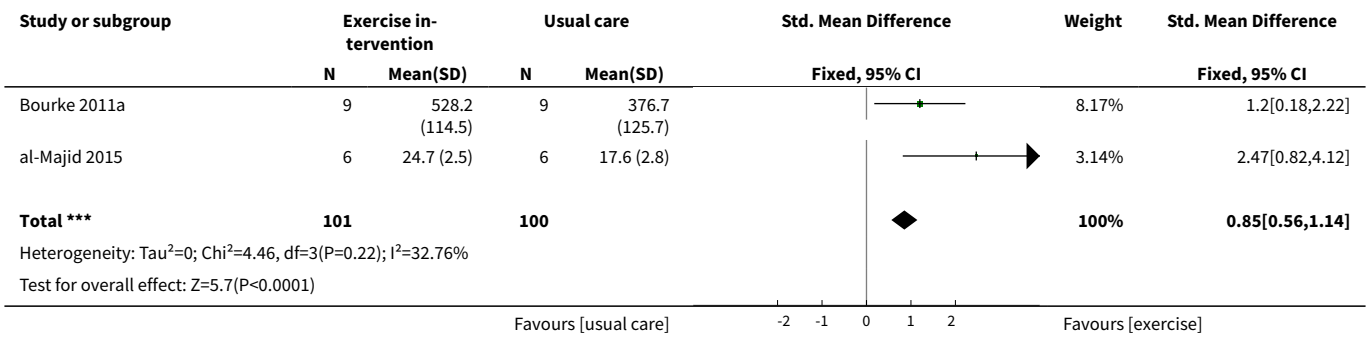
Favours [usual care] Favours [exercise]

Analysis 1.2. Comparison 1 Aerobic exercise tolerance, Outcome 2 Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up sensitivity analysis).

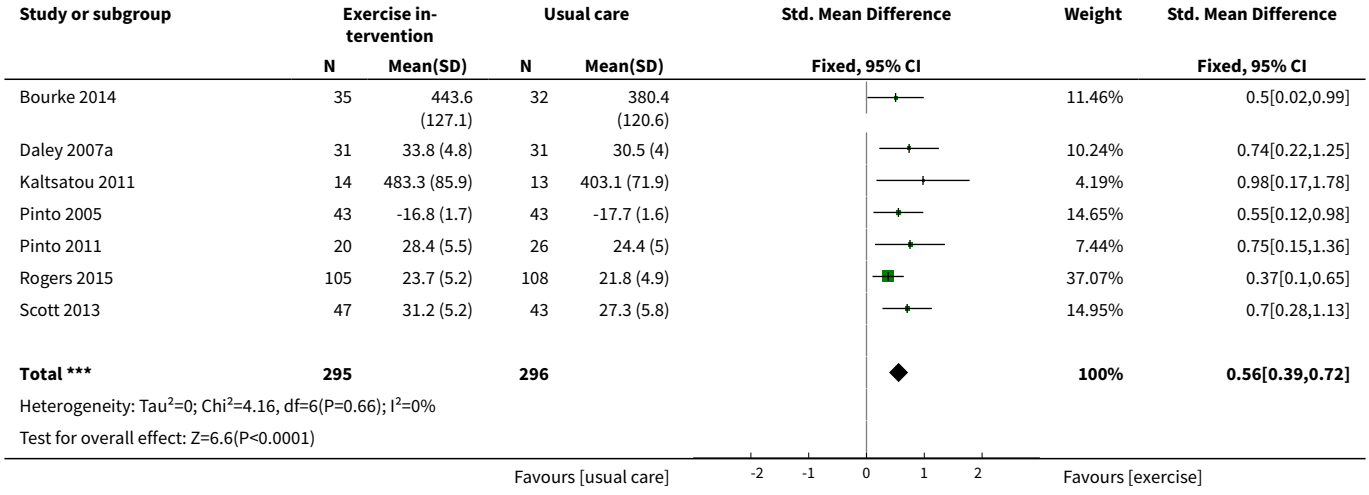
Study or subgroup	Exercise intervention N	Exercise intervention Mean(SD)	Usual care N	Usual care Mean(SD)	Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
Pinto 2005	43	-16.3 (2.1)	43	-17.9 (2.2)		44.82%	0.74[0.3,1.17]
Bourke 2014	43	475.6 (130.8)	42	375 (121.8)		43.87%	0.79[0.35,1.23]



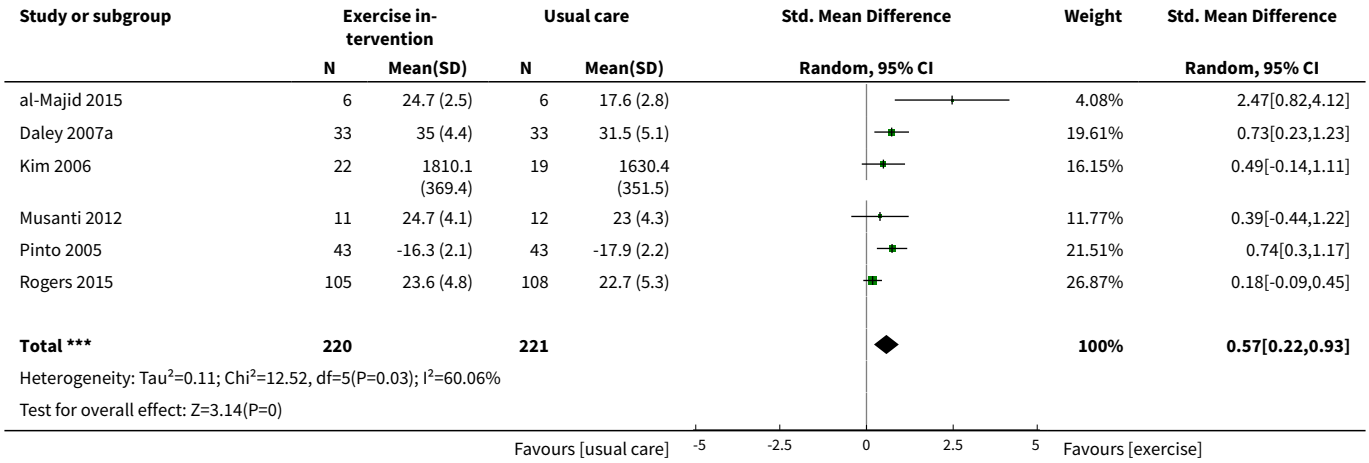
Favours [usual care] Favours [exercise]



Analysis 1.3. Comparison 1 Aerobic exercise tolerance, Outcome 3 Aerobic exercise tolerance (all cancers: 6 months of follow-up).

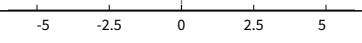


Analysis 1.4. Comparison 1 Aerobic exercise tolerance, Outcome 4 Aerobic exercise tolerance (breast cancer: 8-12 weeks of follow-up).



Analysis 1.5. Comparison 1 Aerobic exercise tolerance, Outcome 5 Aerobic exercise tolerance (all cancers: combination of supervised and home-based exercise: 8 to 12 weeks of follow-up).

Study or subgroup	Exercise intervention N	Exercise intervention Mean(SD)	Usual care N	Usual care Mean(SD)	Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
Bourke 2011a	9	528.2 (114.5)	9	376.7 (125.7)		14.83%	1.2[0.18,2.22]
Bourke 2014	43	475.6 (130.8)	42	375 (121.8)		28.57%	0.79[0.35,1.23]
Kim 2006	22	1810.1 (369.4)	19	1630.4 (351.5)		23.62%	0.49[-0.14,1.11]
Rogers 2015	105	23.6 (4.8)	108	22.7 (53)		32.98%	0.02[-0.24,0.29]
Total ***	**179**		**178**			**100%**	**0.53[0.01,1.04]**
Heterogeneity: Tau^2=0.19; Chi^2=12.06, df=3(P=0.01); I^2=75.13%							
Test for overall effect: Z=2.01(P=0.04)							



Favours [usual care] Favours [exercise]

Analysis 1.6. Comparison 1 Aerobic exercise tolerance, Outcome 6 Aerobic exercise tolerance (all cancers: home-based exercise: 8 to 12 weeks of follow-up).

Study or subgroup	Exercise intervention N	Exercise intervention Mean(SD)	Usual care N	Usual care Mean(SD)	Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
Musanti 2012	11	24.7 (4.1)	12	23 (4.3)		15.54%	0.39[-0.44,1.22]
Pinto 2005	43	-16.3 (2.1)	43	-17.9 (2.2)		55.58%	0.74[0.3,1.17]
Pinto 2011	20	27.7 (5.3)	26	23.7 (4.7)		28.88%	0.79[0.18,1.4]
Total ***	**74**		**81**			**100%**	**0.7[0.37,1.03]**
Heterogeneity: Tau^2=0; Chi^2=0.66, df=2(P=0.72); I^2=0%							
Test for overall effect: Z=4.2(P<0.0001)							

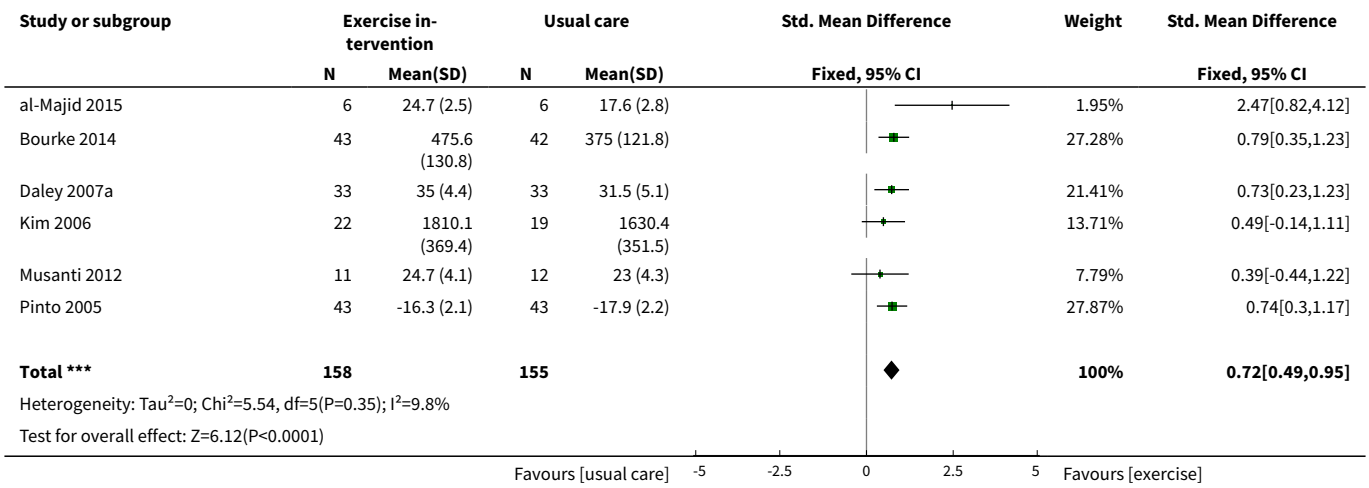
Favours [usual care] Favours [exercise]

Analysis 1.7. Comparison 1 Aerobic exercise tolerance, Outcome 7 Aerobic exercise tolerance (all cancers:supervised exercise: 8 to 12 weeks of follow-up).

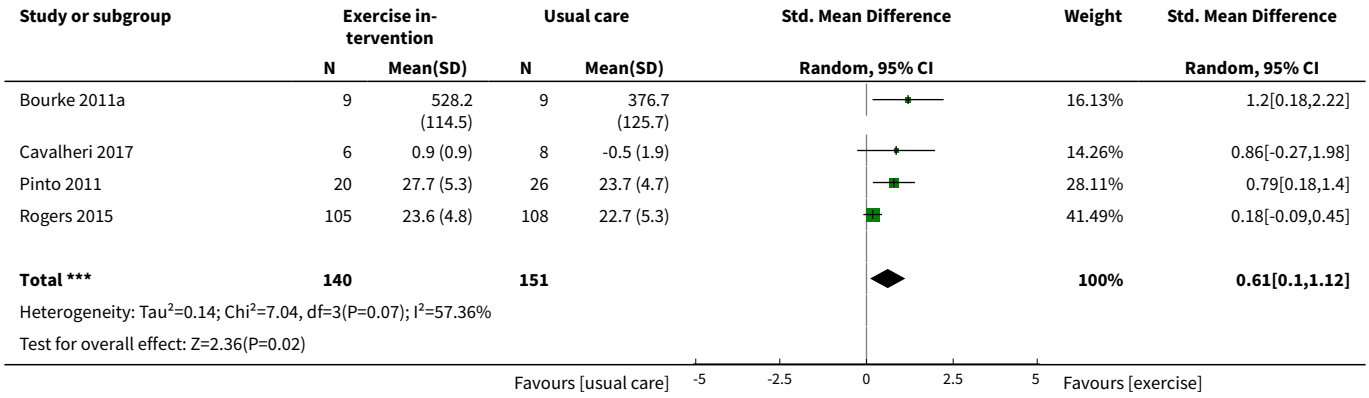
Study or subgroup	Exercise intervention N	Exercise intervention Mean(SD)	Usual care N	Usual care Mean(SD)	Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
al-Majid 2015	6	24.7 (2.5)	6	17.6 (2.8)		17.74%	2.47[0.82,4.12]
Cavalheri 2017	6	0.9 (0.9)	8	-0.5 (1.9)		29.29%	0.86[-0.27,1.98]
Daley 2007a	33	35 (4.4)	33	31.5 (5.1)		52.97%	0.73[0.23,1.23]
Total ***	**45**		**47**			**100%**	**1.07[0.26,1.89]**
Heterogeneity: Tau^2=0.26; Chi^2=3.91, df=2(P=0.14); I^2=48.9%							
Test for overall effect: Z=2.58(P=0.01)							

Favours [usual care] Favours [exercise]

Analysis 1.8. Comparison 1 Aerobic exercise tolerance, Outcome 8 Aerobic exercise tolerance (all cancers: undergoing active treatment: 8 to 12 weeks follow-up).



Analysis 1.9. Comparison 1 Aerobic exercise tolerance, Outcome 9 Aerobic exercise tolerance (all cancers: no active treatment: 8 to 12 weeks follow-up.

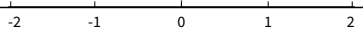


Comparison 2. Strength tests (all cancers)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Strength tests (all cancers, 12 weeks of follow-up)	4	278	Std. Mean Difference (IV, Fixed, 95% CI)	0.20 [-0.03, 0.44]
2 Strength tests (all cancers: 12 weeks of follow-up: sensitivity analysis)	2	231	Std. Mean Difference (IV, Fixed, 95% CI)	0.17 [-0.09, 0.43]

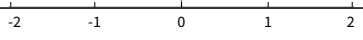
Analysis 2.1. Comparison 2 Strength tests (all cancers), Outcome 1 Strength tests (all cancers, 12 weeks of follow-up).

Study or subgroup	Exercise intervention N	Exercise intervention Mean(SD)	Usual care N	Usual care Mean(SD)	Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
Bourke 2011a	9	189.2 (27.7)	9	169 (45.6)		6.28%	0.51[-0.43,1.45]
Kim 2017	11	25.4 (3.1)	13	24.9 (4.4)		8.64%	0.12[-0.68,0.93]
Musanti 2012	11	48.3 (14.8)	12	36.8 (20)		7.88%	0.63[-0.21,1.47]
Rogers 2015	105	62.2 (24.7)	108	58.9 (20.6)		77.2%	0.14[-0.12,0.41]
Total ***	**136**		**142**			**100%**	**0.2[-0.03,0.44]**
Heterogeneity: Tau^2=0; Chi^2=1.6, df=3(P=0.66); I^2=0%							
Test for overall effect: Z=1.69(P=0.09)							



Analysis 2.2. Comparison 2 Strength tests (all cancers), Outcome 2 Strength tests (all cancers: 12 weeks of follow-up: sensitivity analysis).

Study or subgroup	Exercise intervention N	Exercise intervention Mean(SD)	Usual care N	Usual care Mean(SD)	Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
Bourke 2011a	9	189.2 (27.7)	9	169 (45.6)		7.52%	0.51[-0.43,1.45]
Rogers 2015	105	62.2 (24.7)	108	58.9 (20.6)		92.48%	0.14[-0.12,0.41]
Total ***	**114**		**117**			**100%**	**0.17[-0.09,0.43]**
Heterogeneity: Tau^2=0; Chi^2=0.53, df=1(P=0.47); I^2=0%							
Test for overall effect: Z=1.31(P=0.19)							



ADDITIONAL TABLES

Table 1. Summary of included studies

Study	Exercise components	n	Meets Rock et al guidelines?	Adherence summary	At least 75% adherence?	High risk of bias?	Change in AET reported?	Adverse effects
Cadmus 2009	Aerobic	37, 38 (intervention vs control)	33% reported 150 minutes/week of moderate intensity aerobic exercise at an average of 76% HR, for six months	75% of women were doing between 90 and 119 minutes of moderate intensity aerobic activity per week at six months	Yes; for up to 119 minutes per week	No	Not reported	Five of the 37 women randomly assigned to exercise experienced an adverse effect; two were related to the study (plantar fasciitis)
Daley 2007a	Aerobic	34, 36, 38 (intervention, sham, control, respectively)	No	77% of the exercise therapy; attended 70% (at least 17 of 24 sessions) or more of sessions	Unclear	Yes; outcome assessors were not blinded to participants' group allocation	Yes	Three withdrawals in the intervention group: unclear as to why this occurred. Some withdrawals because of medical complications in placebo and control arms but unclear whether study related
Drouin 2005	Aerobic	13 intervention, 8 placebo stretching controls	Unclear	Participants in the intervention group averaged 3.6 days per week of aerobic exercise over an 8-week period	Unclear	No	Yes	None reported
Kaltsatou 2011	Aerobic	14, 13 (intervention vs control)	Unclear	Not reported	Not reported	Yes; method of measuring exercise and adherence not reported	Not reported	None reported
Kim 2006	Aerobic	22,19 (intervention vs control).	No	Average weekly frequency of exercise was 2.4 ± 0.6 sessions, and average duration of exercise within prescribed target HR was 27.8 ± 8.1 minutes per	Yes	Yes; data missing for 45% of the cohort	Yes	Reasons for withdrawal included personal problems (n = 2), problems at home (n = 2), problems related to

Table 1. Summary of included studies *(Continued)*

				session. Overall adherence was 78.3% ± 20.1%				chemotherapy (n = 3), thrombophlebitis in the lower leg (n = 2), non—exercise-related injuries (n = 1), and death (n = 1). Unclear to which arm of the study these date relate
Pinto 2003	Aerobic	12, 12 (intervention vs control)	Unclear	Participants attended a mean of 88% of the 36-session supervised exercise programme	Yes	Yes; 38% lost to follow-up. Exercise tolerance test was performed but no control group comparison data were reported	Yes	None reported; however, it is unclear why the six controls dropped out
Pinto 2005	Aerobic	43, 43 (intervention vs control)	Unclear	At week 12, intervention participants reported a mean of 128.53 minutes/week of moderate intensity exercise. However, no changes were reported in the accelerometer data in the intervention group (change score = -0.33 kcal/hour)	Less than 75% of the intervention group was meeting the prescribed goal after week 4	Yes; significantly more control group participants were receiving hormone treatment. Accelerometer data do not support the self-reported physical activity behaviour	Yes	Not clear whether chest pain was related to exercise in dropout whose participation was terminated
Pinto 2011	Aerobic	20, 26 (intervention vs control)	Three-day PAR questionnaire indicates that 64.7% of the intervention group and 40.9% of the control group were achieving the	Correlation between self-reported moderate intensity exercise and accelerometer data at three-month follow-up, when the only significant between-group change is reported: r = 0.32	No	Yes; accelerometer data were not reported; also, cited correlation is weak (0.32). Further, substantial contamination was noted in the control group	Yes	One cancer recurrence in the control group at three months

Table 1. Summary of included studies *(Continued)*

			guidelines at three months					
Bourke 2011a	Aerobic and resistance	9, 9 (intervention vs control)	Six weeks of resistance exercise twice a week	90% attendance at the supervised sessions. 94% of independent exercise sessions were completed	Yes	No	Yes	One stroke in the intervention group, unrelated to the exercise programme
Hayes 2009	Aerobic and resistance	16, 16 (intervention vs control)	Unclear	Most women (88%) allocated to the intervention group participated in 70% or more of scheduled supervised exercise sessions	Unclear	Yes; adherence data on unsupervised aspect of the intervention are not clear	No	None reported
McKenzie 2003	Aerobic and resistance	7,7 (intervention vs control)	No	Unclear	Unclear	Yes; adherence to exercise not reported	Not reported	None reported
Musanti 2012	Aerobic and resistance	Flexibility group (n = 13), aerobic group (n = 12), resistance group (n = 17), aerobic and resistance group (n = 13)	12 weeks of resistance exercise two or three times per week	Mean percentages of adherence were as follows: flexibility = 85%, aerobic = 81%, resistance = 91% and aerobic plus resistance = 86%	Unclear	Yes; a significant number of dropouts belonged to the resistance exercise group (n = 8/13). Only 50% of activity logs were returned	Yes	Adverse effects were reported in two women during the study. In both cases, the women developed tendonitis: one in the shoulder and the other in the foot. Both had a history of tendonitis, and both received standard treatment
Perna 2010	Aerobic and resistance	51 participants in total. Numbers randomly assigned to each arm are unclear	Three months of resistance exercise three times per week	Women assigned to the structured intervention completed an average of 83% of their scheduled hospital-based exercise sessions (only 4 weeks in duration), and 76.9% completed all 12 sessions. Home-based component (8 weeks in duration)	Unclear	Yes; numbers randomly assigned to intervention and control groups are unclear, as are numbers completing in each arm	Not reported	Unclear

Table 1. Summary of included studies *(Continued)*

al-Majid 2015	Aerobic	7,7 (intervention vs control)	No	Adherence to per-protocol exercise sessions was very high, ranging between 95% and 97%.	Yes	No	Yes	None reported
Bourke 2014	Aerobic and resistance	25,25 (intervention vs control)	Yes; 6 weeks of resistance exercise	Adherence was 94% for the supervised and 82% of the prescribed independent exercise sessions over the first 12 week.	Yes	Yes incomplete outcome data at 6 months.	Yes	None reported
Campbell 2017	Aerobic	10 in exercise intervention, 9 in delayed exercise control	150 minutess per week of moderate-vigorous aerobic exercise for 24 weeks.	Participants attended 88% of supervised gym sessions (mean 1.8 sessions/ week and 87.5 minutes/week), and participants met 82% of the prescribed exercise targets (mean intensity 74.5% HRR). Home session completion was 87% (mean 2.4 sessions/week and 101.5 minutes/week), and participants met 87% of the prescribed exercise targets (mean intensity 73.5% HRR)	Yes	Yes; Low study recruitment rate.	Yes	None reported
Cantarero-Villanueva 2012b	Aerobic	33,33 (intervention vs control)	Three sixty minute sessions per week for 8 weeks.	All intervention group completed more than 85% of the 24 water exercise sessions, showing a high adherence rate to the program.	Yes	No	Not reported	One participant in the intervention dropped out due to a recurrence of breast cancer during the program. Three women reported a transient increase of oedema, and four women noted an increase in fatigue immediately after the beginning of the first session, which improved in the next few days. These women did not dropout of the study. No other adverse effects were reported.
Cavalheri 2017	Aerobic and resistance	9, 8 (intervention vs control)	Yes; six weeks of re-	Nine of the participants randomised to the EG, four (44%) adhered to exercise training by	No	Yes; missing patient data in both arms with	Yes	One participant completed four sessions and another complet-

Table 1. Summary of included studies *(Continued)*

			sistance exercise.	completing 15 or more training sessions (i.e.,≥60%).		no reasons given.		ed six sessions. Both stopped training as they felt unwell. They completed some of the post-intervention assessments and were later diagnosed with a primary cancer other than lung cancer.
Kim 2017	Aerobic and resistance	15, 15 (intervention vs control)	Three sixty minute sessions per week for 12 weeks.	Vague statement: Two participants did not fulfil the required exercise	Unclear	Yes; Age differences between groups in baseline demographics were present. Adherence data is vague.	Not reported	None reported
Mohamady 2017	Aerobic	15, 15 (intervention vs control)	No	Unclear	Unclear	Yes; No adherence data.	Unclear	Unclear
Rogers 2015	Aerobic	110, 112 (intervention vs control)	Yes	Adherence to the intervention was 98 % for supervised exercise sessions, 96 % for update sessions, and 91 % for discussion group sessions.	Yes	Yes; differences in objective and subjective measures of physical activity reported	Yes	Related expected adverse events in the intervention group included back or lower extremity musculoskeletal pain or injury (n = 14), heart rate monitor rash (n = 1), fall while walking (n = 1), breast reconstruction (n = 3), and chest pain during treadmill fitness test (n = 1)
Scott 2013	Aerobic and resistance	47, 43 (intervention vs control)	Yes, six weeks of resistance exercise.	Adherence for the intervention group was 80%	Yes	No	Yes	None reported.
Thomas 2013	Aerobic	35, 30 (intervention vs control)	Yes	The exercise goal was 150 minutes/week of moderate inten-	No	Yes; not all outcomes were reported and low	Not reported	None reported.

Table 1. Summary of included studies *(Continued)*

				sity aerobic exercise; 33% of women achieved this amount. 57% of women achieved 80% of the exercise goal or 120 minutes/week, and 75% of women achieved 90 minutes/week.		recruitment rate.			
Irwin 2015	Aerobic and resistance	61, 60 (intervention vs control)	Yes	Women randomly assigned to exercise also reported their exercise prospectively in daily activity logs and reported an average 119 minutes per week of aerobic exercise, with an average of 70% of strength-training sessions completed. Women randomly assigned to exercise increased their physical activity by an average 159 minutes per week, compared with 49 minutes per week in the usual-care group.	No	No	Yes	5 participants had to discontinue the use of Atromatise inhibitors.	

AET = aerobic exercise tolerance.

Table 2. Original review Behaviour change components

Behaviour change technique	Bourke 2011a	Cadmus 2009 YALE	Daley 2007a	Drouin 2005	Hayes 2009	Kaltsatou 2011	McKenzie 2003	Musanti 2012	Perna 2010	Kim 2006	Pinto 2003	Pinto 2005	Pinto 2011
Theory			TTM					EXSEM	TTM			TTM	TTM SCT
1. Provide Info on consequences of behaviour *in general*		X	X						X	X			
2. Provide Info on consequences of behaviour *to the individual*													

Table 2. Original review Behaviour change components *(Continued)*

3. Provide Info about others' approval													
4. Provide normative info about others' behaviour													
Programme set goal	X	X	X	X	X	X	X	X	X	X	X	X	X
5. Goal setting (behaviour)		X	X						X		X	X	X
6. Goal setting (outcome)													
7. Action planning													
8. Barrier identification/Problem solving		X	X						X			X	X
9. Setting of graded tasks		X	X		X	X	X	X	X		X		X
10. Prompt review of behavioural goals			X						X				
11. Prompt review of outcome goals													
12. Prompt rewards contingent on effort or progress towards goal									X			X	X
13. Provide rewards contingent on successful behaviour			X										
14. Shaping													
15. Prompt generalisation of a target behaviour	X	X							X		X		
16. Prompt self-monitoring of behaviour	X	X	X	X				X	X		X	X	X
17. Prompt self-monitoring of behavioural outcome		X	X	X				X				X	X

Table 2. Original review Behaviour change components *(Continued)*

18. Prompt focus on past success			X											
19. Feedback on performance provided		X								X			X	X
20. Information provided on *where and when* to perform behaviour			X							X				
21. Instruction provided on how to perform the behaviour		X	X	X		X		X	X	X	X	X		X
22. Modelling/Demonstration of behaviour						X		X	X					
23. Teaching to use prompts/cues			X						X					X
24. Environmental restructuring									X					X
25. Agreement on behavioural contract									X					
26. Prompt practise	X	X	X	X	X	X	X	X	X	X	X	X	X	X
27. Use of follow-up prompts	X													
28. Facilitating social comparison														
29. Planning social support/social change		X	X						X					
30. Prompt identification as role model/position advocate														
31. Prompt anticipated regret														
32. Fear arousal														
33. Prompt self-talk														
34. Prompt use of imagery														

Table 2. Original review Behaviour change components *(Continued)*

35. Relapse prevention/coping planning			X					X			
36. Stress management/emotional control training									X		
37. Motivational interviewing											
38. Time management											
39. General communication skills training											
40. Stimulation of anticipation of future rewards											

EXSEM = exercise self-esteem model; SCT = social cognitive theory; TTM = trans-theoretical model.

Table 3. 2018 Update Behaviour change components

Behaviour change technique	al-Majid 2015	Bourke 2014	Camp-bell 2017	Cantarero-Villanue-va 2012b	Caval-heri 2017	Irwin 2015	Kim 2017	Mo-hamady 2017	Rogers 2015	Scott 2013	Thomas 2013
Theory									SCT		
1. Provide Info on consequences of behaviour *in general*		x							x		
2. Provide Info on consequences of behaviour *to the individual*											
3. Provide Info about others' ap-proval											
4. Provide normative info about oth-ers' behaviour											
Programme set goal	x	x	x	x	x	x	x	x	x	x	x
5. Goal setting (behaviour)		x							x		

Table 3. 2018 Update Behaviour change components *(Continued)*

6. Goal setting (outcome)											
7. Action planning											
8. Barrier identification/Problem solving		x							x		
9. Setting of graded tasks	x	x	x (implicit)	x	x	x	x	x	x		x
10. Prompt review of behavioural goals									x		
11. Prompt review of outcome goals											
12. Prompt rewards contingent on effort or progress towards goal									x		
13. Provide rewards contingent on successful behaviour											
14. Shaping											
15. Prompt generalisation of a target behaviour		x (from linked paper Gilbert 2016*							x		
16. Prompt self-monitoring of behaviour											
17. Prompt self-monitoring of behavioural outcome		x							x		x
18. Prompt focus on past success											
19. Feedback on performance provided									x		
20. Information provided on *where and when* to perform behaviour		x							x		

Table 3. 2018 Update Behaviour change components *(Continued)*

21. Instruction provided on how to perform the behaviour	x			x	x
22. Modelling/Demonstration of behaviour				x	
23. Teaching to use prompts/cues					
24. Environmental restructuring					
25. Agreement on behavioural contract					
26. Prompt practise	x			x	
27. Use of follow-up prompts					
28. Facilitating social comparison					
29. Planning social support/social change	x				
30. Prompt identification as role model/position advocate					
31. Prompt anticipated regret					
32. Fear arousal					
33. Prompt self-talk					
34. Prompt use of imagery					
35. Relapse prevention/coping planning				x	
36. Stress management/emotional control training					
37. Motivational interviewing					
38. Time management					

Table 3. 2018 Update Behaviour change components *(Continued)*

39. General communication skills training									
40. Stimulation of anticipation of future rewards									

Table 4. Tier 1 BCTs - trials which had 75% adherence to the Rock resistance or aerobic guidelines

BCT	Bourke 2014	Campbell 2017	Cantarero-Villanueva 2012b	Bourke 2011a	Rogers 2015	Scott 2013	Kim 2017	Irwin 2015	
	Resistance	Aerobic	Aerobic	Resistance	Aerobic	Resistance	Resistance	Aerobic	**Frequency of BCTs**
Programme set goal	x	x	x	x	x	x	x	x	8
9. Setting of graded tasks	x	x	x	x	x	x	x		7
21. Instruction provided on how to perform behaviour	x				x	x			3
26. Prompt practise	x				x				2
5. Goal setting (outcome)	x				x				2
8. Barrier identification/problem solving	x				x				2
1. Provide information on consequences of behaviour *in general*	x				x				2
15. Prompt generalisation of a target behaviour	x				x				2
17. Prompt self-monitoring of behavioural outcome	x				x				2
20. Information provided on *where and when* to perform behaviour	x				x				2

Table 4. Tier 1 BCTs - trials which had 75% adherence to the Rock resistance or aerobic guidelines *(Continued)*

19. Feedback on performance provided				x			1
22. Modelling/demonstration of behaviour				x			1
12. Prompt rewards contingent on effort or progress towards goal				x			1
29. Planning social support/social	x						1
35. Relapse prevention/coping planning				x			1

BCTs: behaviour change techniques

Table 5. Tier 2 BCTs - trials which had 75% adherence to their specified aerobic exercise prescription

BCT	Bourke 2011a	al-Majid 2015	Bourke 2014	Cadmus 2009	Scott 2013	Kim 2017	
							Frequency of BCTs
Programme set goal	x	x	x	x	x	x	6
9. Setting of graded tasks	x	x	x		x	x	5
21. Instruction provided on how to perform behaviour			x	x	x		3
1. Provide information on consequences of behaviour *in general*			x	x			2
26. Prompt practise			x	x			2
8. Barrier identification/problem solving			x	x			2
15. Prompt generalisation of a target behaviour			x	x			2
5. Goal setting (outcome)			x				1
16. Prompt self-monitoring of behaviour				x			1

Table 5. Tier 2 BCTs - trials which had 75% adherence to their specified aerobic exercise prescription *(Continued)*

17. Prompt self-monitoring of behavioural outcome	x		1
20. Information provided on *where and when* to perform behaviour	x		1
29. Planning social support/social	x		1
27. Use of follow-up prompts		x	1

BCTs: behaviour change techniques

APPENDICES

Appendix 1. CENTRAL search strategy

CENTRAL 2018 update search

#1 MeSH descriptor Neoplasms explode all trees
#2 (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*)
#3 (#1 OR #2)
#4 MeSH descriptor Exercise explode all trees
#5 MeSH descriptor Exercise Movement Techniques explode all trees
#6 MeSH descriptor Exercise Therapy explode all trees
#7 MeSH descriptor Physical Fitness, this term only
#8 (physical* adj5 (fit* or activ*))
#9 (exercis* or aerobic* or resistance* or strength* or walk* or endurance* or lifestyle* or behav*)
#10 (#4 OR #5 OR #6 OR #7 OR #8 OR #9)
#11 #3 and #10
#12 MeSH descriptor: [Health Behavior] explode all trees
#13 MeSH descriptor: [Risk Reduction Behavior] this term only
#14 ((promot* or motivat* or advis* or encourag* or assist* or develop* or stimulat* or help* or support* or organis* or aid* or assist* or endors* or prompt* or driv* or inspire* or lead* or inspir* or further* or advocat* or recommend* or endorse* or foster* or champion*) near/5 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*))
#15 #12 or #13 or #14
#16 #11 and #15

CENTRAL 2012 search

#1 MeSH descriptor Neoplasms explode all trees
#2 (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*)
#3 (#1 OR #2)
#4 MeSH descriptor Exercise explode all trees
#5 MeSH descriptor Exercise Movement Techniques explode all trees
#6 MeSH descriptor Exercise Therapy explode all trees
#7 MeSH descriptor Physical Fitness, this term only
#8 (physical* adj5 (fit* or activ*))
#9 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*)
#10 (#4 OR #5 OR #6 OR #7 OR #8 OR #9)
#11 MeSH descriptor Patient Education as Topic, this term only
#12 (educat* or inform* or teach* or supervis* or communicat* or leaflet*)
#13 MeSH descriptor Survivors, this term only
#14 survivor*
#15 MeSH descriptor Behavior Therapy explode all trees
#16 (behaviour* or behavior* or cognit* or CBT)
#17 MeSH descriptor Motivation explode all trees
#18 MeSH descriptor Interview, Psychological, this term only
#19 (motivat* or interview*)
#20 (#11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19)
#21 (#3 AND #10 AND #20)

Appendix 2. MEDLINE search strategy

MEDLINE 2018 update search

1. exp Neoplasms/
2. (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*).ti,ab.
3. 1 or 2
4. exp Exercise/
5. exp Exercise Movement Techniques/
6. exp Exercise Therapy/
7. Physical Fitness/

8. (physical* adj5 (fit* or activ*)).ti,ab.
9. (exercis* or aerobic* or resistance* or strength* or walk* or endurance* or lifestyle* or behave*).mp.
10. 4 or 5 or 6 or 7 or 8 or 9
11. 3 and 10
12. exp Health Behavior/
13. risk reduction behavior/
14. ((promot* or motivat* or advis* or encourag* or assist* or develop* or stimulat* or help* or support* or organis* or aid* or assist* or endors* or prompt* or driv* or inspire* or lead* or inspir* or further* or advocat* or recommend* or endorse* or foster* or champion*) adj5 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*)).ti,ab.
15. 12 or 13 or 14
16. 11 and 15
17. randomized controlled trial.pt.
18. controlled clinical trial.pt.
19. randomized.ab.
20. placebo.ab.
21. clinical trials as topic.sh.
22. randomly.ab.
23. trial.ti.
24. 17 or 18 or 19 or 20 or 21 or 22 or 23
25. (animals not (humans and animals)).sh.
26. 24 not 25
27. 16 and 26

key:

mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier
pt=publication type
ab=abstract
ti=title
sh=subject heading

MEDLINE 2012 search

1. exp Neoplasms/
2. (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*).mp.
3. 1 or 2
4. exp Exercise/
5. exp Exercise Movement Techniques/
6. exp Exercise Therapy/
7. Physical Fitness/
8. (physical* adj5 (fit* or activ*)).mp.
9. (exercis* or aerobic* or resistance* or strength* or walk* or endurance*).mp.
10. 4 or 5 or 6 or 7 or 8 or 9
11. Patient Education as Topic/
12. Patient education handout/
13. (educat* or inform* or teach* or supervis* or communicat* or leaflet*).mp.
14. Survivors/ or survivor*.mp.
15. exp Behavior Therapy/
16. (behaviour* or behavior* or cognit* or CBT).mp.
17. exp Motivation/
18. Interview, Psychological/
19. (motivat* or interview*).mp.
20. 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
21. 3 and 10 and 20
22. randomized controlled trial.pt.
23. controlled clinical trial.pt.
24. randomized.ab.
25. placebo.ab.
26. clinical trials as topic.sh.
27. randomly.ab.
28. trial.ti.

29. 22 or 23 or 24 or 25 or 26 or 27 or 28
30. 21 and 29
31. exp animals/ not humans.sh.
32. 30 not 31

key:
mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier
pt=publication type
ab=abstract
ti=title
sh=subject heading

Appendix 3. Embase search strategy

Embase 2018 update search

1. exp neoplasm/
2. (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*).ti,ab.
3. 1 or 2
4. exp exercise/
5. exp kinesiotherapy/
6. fitness/
7. (physical* adj5 (fit* or activ*)).ti,ab.
8. (exercis* or aerobic* or resistance* or strength* or walk* or endurance* or lifestyle* or behav*).mp.
9. 4 or 5 or 6 or 7 or 8
10. 3 and 9
11. exp health behavior/
12. risk reduction/
13. ((promot* or motivat* or advis* or encourag* or assist* or develop* or stimulat* or help* or support* or organis* or aid* or assist* or endors* or prompt* or driv* or inspire* or lead* or inspir* or further* or advocat* or recommend* or endorse* or foster* or champion*) adj5 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*)).ti,ab.
14. 11 or 12 or 13
15. 10 and 14
16. crossover procedure/
17. double-blind procedure/
18. randomized controlled trial/
19. single-blind procedure/
20. random*.mp.
21. factorial*.mp.
22. (crossover* or cross over* or cross-over*).mp.
23. placebo*.mp.
24. (double* adj blind*).mp.
25. (singl* adj blind*).mp.
26. assign*.mp.
27. allocat*.mp.
28. volunteer*.mp.
29. 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28
30. 15 and 29
31. (exp animal/ or nonhuman/ or exp animal experiment/) not human/
32. 30 not 31

key:
[mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]

Embase 2012 search

1 exp neoplasm/
2 (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*).mp.
3 1 or 2

4 exp exercise/
5 exp kinesiotherapy/
6 fitness/
7 (physical* adj5 (fit* or activ*)).mp.
8 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*).mp.
9 4 or 5 or 6 or 7 or 8
10 patient education/
11 (educat* or inform* or teach* or supervis* or communicat* or leaflet*).mp.
12 survivor/ or survivor*.mp.
13 behavior therapy/
14 cognitive therapy/
15 (behaviour* or behavior* or cognit* or CBT).mp.
16 motivation/
17 interview/
18 (motivat* or interview*).mp.
19 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
20 3 and 9 and 19
21 crossover procedure/
22 double-blind procedure/
23 randomized controlled trial/
24 single-blind procedure/
25 random*.mp.
26 factorial*.mp.
27 (crossover* or cross over* or cross-over*).mp.
28 placebo*.mp.
29 (double* adj blind*).mp.
30 (singl* adj blind*).mp.
31 assign*.mp.
32 allocat*.mp.
33 volunteer*.mp.
34 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33
35 20 and 34
36 (exp animal/ or nonhuman/ or exp animal experiment/) not human/
37 35 not 36

key:
[mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]

Appendix 4. AMED search strategy

Amed Ovid 2018 update search

1 exp neoplasms/
2 (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*).mp.
3 1 or 2
4 exp exercise/
5 exp exercise therapy/
6 physical fitness/
7 (physical* adj5 (fit* or activ*)).mp.
8 (exercis* or aerobic* or resistance* or strength* or walk* or endurance* or lifestyle* or behav*).mp.
9 4 or 5 or 6 or 7 or 8
10 exp Health behavior/
11 ((promot* or motivat* or advis* or encourag* or assist* or develop* or stimulat* or help* or support* or organis* or aid* or assist* or endors* or prompt* or driv* or inspire* or lead* or inspir* or further* or advocat* or recommend* or endorse* or foster* or champion*) adj5 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*)).ti,ab.
12 10 or 11
13 3 and 9 and 12

key:
mp=abstract, heading words, title

Amed Ovid 2012 search

1 exp neoplasms/
2 (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*).mp.
3 1 or 2
4 exp exercise/
5 exp exercise therapy/
6 physical fitness/
7 (physical* adj5 (fit* or activ*)).mp.
8 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*).mp.
9 4 or 5 or 6 or 7 or 8
10 exp patient education/
11 (educat* or inform* or teach* or supervis* or communicat* or leaflet*).mp.
12 survivors/ or survivor*.mp.
13 exp behavior therapy/
14 (behaviour* or behavior* or cognit* or CBT).mp.
15 exp motivation/
16 interviews/
17 (motivat* or interview*).mp.
18 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
19 3 and 9 and 18

key:
mp=abstract, heading words, title

Appendix 5. CINAHL search strategy

CINAHL 2018 update search

1 exp NEOPLASMS/
2 (cancer* OR tumor* OR tumour* OR neoplas* OR malignan* OR carcinoma* OR adenocarcinoma* OR choriocarcinoma* OR leukemia* OR leukaemia* OR metastat* OR sarcoma* OR teratoma*).af
3 1 OR 2
4 exp EXERCISE/
5 exp THERAPEUTIC EXERCISE/
6 exp PHYSICAL FITNESS/
7 (physical* AND (fit* OR activ*)).af
8 (exercis* OR aerobic* OR resistance* OR strength* OR walk* OR endurance* or lifestyle* or behave*).af
9 4 OR 5 OR 6 OR 7 OR 8
10 3 and 9
11 exp BEHAVIOR THERAPY/
12. (risk reduction*) AND (behav*)
13 ((promot* or motivat* or advis* or encourag* or assist* or develop* or stimulat* or help* or support* or organis* or aid* or assist* or endors* or prompt* or driv* or inspire* or lead* or inspir* or further* or advocat* or recommend* or endorse* or foster* or champion*) adj5 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*)).ti,ab.
14 11 or 12 or 13
15 10 AND 14
16 Randomized controlled trials
17 Randomised controlled trials
18 16 or 17
19 15 AND 18

key
af=any field

CINAHL 2012 search

1 exp NEOPLASMS/
2 (cancer* OR tumor* OR tumour* OR neoplas* OR malignan* OR carcinoma* OR adenocarcinoma* OR choriocarcinoma* OR leukemia* OR leukaemia* OR metastat* OR sarcoma* OR teratoma*).af
3 1 OR 2
4 exp EXERCISE/
5 exp THERAPEUTIC EXERCISE/

6 exp PHYSICAL FITNESS/
7 (physical* AND (fit* OR activ*)).af
8 (exercis* OR aerobic* OR resistance* OR strength* OR walk* OR endurance*).af
9 4 OR 5 OR 6 OR 7 OR 8
10 exp PATIENT EDUCATION/
11 (educat* OR inform* OR teach* OR supervis* OR communicat* OR leaflet*).af
12 CANCER SURVIVORS/
13 survivor*.af
14 exp BEHAVIOR THERAPY/
15 (behaviour* OR behavior* OR cognit* OR CBT).af
16 exp MOTIVATION/
17 MOTIVATIONAL INTERVIEWING/
18 (motivat* OR interview*).af
19 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18
20 3 AND 9 AND 19
21 RANDOMIZED CONTROLLED TRIALS/
22 20 and 21

Appendix 6. PsycINFO search strategy

PsycINFO 2018 update search

1 neoplasms.af
2 ((cancer* OR tumor* OR tumour* OR neoplas* OR malignan* OR carcinoma* OR adenocarcinoma* OR choriocarcinoma* OR leukemia* OR leukaemia* OR metastat* OR sarcoma* OR teratoma*)).ti,ab
3 exercise.af
4 (physical AND fitness).af
5 ((physical* adj5 (fit* OR activ*))).ti,ab
6 ((exercis* OR aerobic* OR resistance* OR strength* OR walk* OR endurance* OR lifestyle* OR behave*)).af
7 1 OR 2
8 3 OR 4 OR 5 OR 6
9 (health AND behaviour).af
10 (risk AND reduction AND behaviour).af
11 (((promot* OR motivat* OR advis* OR encourag* OR assist* OR develop* OR stimulat* OR help* OR support* OR organis* OR aid* OR assist* OR endors* OR prompt* OR driv* OR inspire* OR lead* OR inspir* OR further* OR advocat* OR recommend* OR endorse* OR foster* OR champion*) adj5 (exercis* OR aerobic* OR resistance* OR strength* OR walk* OR endurance*))).ti,ab
12 9 OR 10 OR 11
13 7 AND 8 AND 12

PsycINFO Ovid 2012 search

1 exp neoplasms/
2 (cancer* or tumor* or tumour* or neoplas* or malignan* or carcinoma* or adenocarcinoma* or choriocarcinoma* or leukemia* or leukaemia* or metastat* or sarcoma* or teratoma*).mp.
3 1 or 2
4 exp exercise/
5 physical fitness/
6 (physical* adj5 (fit* or activ*)).mp.
7 (exercis* or aerobic* or resistance* or strength* or walk* or endurance*).mp.
8 4 or 5 or 6 or 7
9 client education/
10 (educat* or inform* or teach* or supervis* or communicat* or leaflet*).mp.
11 survivors/ or survivor*.mp.
12 exp cognitive behavior therapy/
13 exp behavior therapy/
14 (behaviour* or behavior* or cognit* or CBT).mp.
15 exp motivation/
16 motivational interviewing/
17 (motivat* or interview*).mp.
18 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
19 3 and 8 and 18
20 clinical trials/

21 (random* or trial* or group* or placebo*).mp. mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures
22 20 or 21
23 19 and 22

key:
[mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]

Appendix 7. PEDro search strategy

PEDro 2012 search

- Title and abstract: “cancer”
- Therapy: fitness training (selected)
- Sub discipline: oncology (selected)
- Method: clinical trial (selected)

Appendix 8. SPORTS DISCUS search strategy (EBSCO host)

Sports discus update 2018 search

1. TX cancer* OR tumor* OR tumour* OR neoplas* OR malignan* OR carcinoma* OR adenocarcinoma* OR choriocarcinoma* OR leukemia* OR leukaemia* OR metastat* OR sarcoma* OR teratoma* (26,616)

2. TX randomi*ed controlled trial (12,682)

3. (TX randomi*ed controlled trial) AND (S4 AND S5) (636)

4. Limiters - Published Date: 20120101-20171231 (411)

Appendix 9. Cochrane Collaboration’s tool for assessing risk of bias

Random sequence generation

• Low risk of bias (e.g. participants assigned to treatments on basis of a computer-generated random sequence or a table of random numbers)
• High risk of bias (e.g. participants assigned to treatments on basis of date of birth, clinic ID number or surname, or no attempt to randomly assign participants)
• Unclear risk of bias (e.g. not reported, information not available)

Allocation concealment

• Low risk of bias (e.g. when the allocation sequence could not be foretold)
• High risk of bias (e.g. allocation sequence could be foretold by participants, investigators or treatment providers)
• Unclear risk of bias (e.g. not reported)

Blinding of participants and personnel

• Low risk of bias, if participants and personnel were adequately blinded
• High risk of bias, if participants were not blinded to the intervention that the participant received
• Unclear risk of bias, if this was not reported or was unclear

Blinding of outcome assessors

• Low risk of bias, if outcome assessors were adequately blinded
• High risk of bias, if outcome assessors were not blinded to the intervention that the participant received
• Unclear risk of bias, if this was not reported or was unclear

Incomplete outcome data

We recorded the proportions of participants whose outcomes were not reported at the end of the study. We coded a satisfactory level of loss to follow-up for each outcome as follows

• Low risk of bias, if fewer than 20% of participants were lost to follow-up and reasons for loss to follow-up were similar in both treatment arms
• High risk of bias, if more than 20% of participants were lost to follow-up or reasons for loss to follow-up differed between treatment arms

• Unclear risk of bias, if loss to follow-up was not reported

Selective reporting of outcomes

• Low risk of bias (e.g. review reports all outcomes specified in the protocol)
• High risk of bias (e.g. if it is suspected that outcomes have been selectively reported)
• Unclear risk of bias (e.g. if it is unclear whether outcomes were selectively reported)

Other bias

• Low risk of bias, if no other source of bias is suspected and the trial appears to be methodologically sound
• High risk of bias, if it is suspected that the trial was prone to an additional bias
• Unclear risk of bias, if uncertainty exists about whether an additional bias may have been present

WHAT'S NEW

Date	Event	Description
24 September 2018	Amended	Text amendment.

HISTORY

Protocol first published: Issue 11, 2012
Review first published: Issue 9, 2013

Date	Event	Description
3 May 2018	New search has been performed	Literature searches updated to 3 May 2018.
3 May 2018	New citation required but conclusions have not changed	Review updated with the inclusion of 10 additional studies but conclusions remain unchanged.

CONTRIBUTIONS OF AUTHORS

All authors contributed to the design, development and drafting of the protocol for this review. RT, LS, RG and HQ conducted screening and data extraction, with assistance from LB. LS and RT conducted analysis of the studies according to the CALO-RE taxonomy. MAT, LS, DJR, KAR, SJCT and JMS assisted with interpretation of results and drafting of the final report. RT led the final report.

DECLARATIONS OF INTEREST

Rebecca Turner:
Liz Steed: None known
Helen Quirk: None known
Rosa Greasley: None known
John Saxton: None known
Stephanie Taylor: None known
Derek Rosario: None known
Mohamed Thaha: None known
Liam Bourke: received honoraria for lecturing from Sanofi and Astellas and research funding from the NIHR and CRUK.

SOURCES OF SUPPORT

Internal sources

- None, Other.

External sources

- None, Other.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

- We have highlighted reasons why we contacted corresponding authors and have quantified how many times we attempted to do this by email (please see Selection of studies; Excluded studies).
- We did not examine funnel plots because too few studies were identified (please see Assessment of risk of bias in included studies).
- We carried out a GRADE assessment on the quality of our meta-analysis data and included a 'Summary of findings' table (Summary of findings for the main comparison) with this information.
- We were not able to find any studies describing 'pattern' of resistance exercise (i.e. the period of rest in between sets) and hence did not discount any studies for not reporting this. We judged that it would be more informative to include the studies that we found than to not report on resistance exercise interventions at all.
- In the 2018 update, we added contact with healthcare professionals to our secondary objectives. Healthcare professionals have a role to play in the integration of exercise in the cancer care pathway and therefore it would be useful to understand if the exercise studies incorporate healthcare professionals in the role of recruitment or behavioural support during the intervention.
- In the 2018 update, we did not search Metaregister (http://www.controlled-trials.com/rct) website as it is now unavailable.

INDEX TERMS

Medical Subject Headings (MeSH)

*Cancer Survivors; *Exercise; *Habits; *Sedentary Behavior; Breast Neoplasms [rehabilitation]; Colorectal Neoplasms [rehabilitation]; Exercise Tolerance [physiology]; Health Promotion; Muscle Strength; Neoplasms [*rehabilitation]; Patient Compliance [statistics & numerical data]; Prostatic Neoplasms [rehabilitation]; Randomized Controlled Trials as Topic; Time Factors

MeSH check words

Female; Humans; Male