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

Bourke L, Homer KE, Thaha MA, Steed L, Rosario DJ, Robb KA, Saxton JM, Taylor SJC

THE COCHRANE COLLABORATION®

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2013, Issue 9

http://www.thecochranelibrary.com

WILEY

TABLE OF CONTENTS

[Intervention Review]

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

Liam Bourke[1], Kate E Homer[1], Mohamed A Thaha[2], Liz Steed[1], Derek J Rosario[3], Karen A Robb[4], John M Saxton[5], Stephanie JC Taylor[6]

[1]Queen Mary University of London, Barts & The London School of Medicine and Dentistry, Centre for Primary Care and Public Health, London, UK. [2]Academic Surgical Unit, Centre for Digestive Diseases, Blizard Institute, Barts & The London School of Medicine & Dentistry, Queen Mary University London, London, UK. [3]Department of Oncology, University of Sheffield, Sheffield, UK. [4]Physiotherapy Department, Bart's Hospital, London, UK. [5]School of Allied Health Professions, University of East Anglia, Norwich, UK. [6]Queen Mary University of London, Barts & The London School of Medicine, Centre for Primary Care and Public Health, Blizard Institute, London, UK

Contact address: Liam Bourke, Queen Mary University of London, Barts & The London School of Medicine and Dentistry, Centre for Primary Care and Public Health, Blizard Institute, Yvonne Carter Building, 58 Turner Street, London, E1 2AB, UK. l.bourke@qmul.ac.uk.

Editorial group: Cochrane Gynaecological Cancer Group.
Publication status and date: New, published in Issue 9, 2013.
Review content assessed as up-to-date: 11 September 2013.

Citation: Bourke L, Homer KE, Thaha MA, Steed L, Rosario DJ, Robb KA, Saxton JM, Taylor SJC. Interventions for promoting habitual exercise in people living with and beyond cancer. *Cochrane Database of Systematic Reviews* 2013, Issue 9. Art. No.: CD010192. DOI: 10.1002/14651858.CD010192.pub2.

ABSTRACT

Background

The beneficial effects of regular exercise for people living with or beyond cancer are becoming apparent. However, how to promote exercise behaviour in sedentary cancer cohorts is not as well understood. A large majority of people living with or recovering from cancer do not meet exercise recommendations. Hence, reviewing the evidence on how to promote and sustain exercise behaviour is important.

Objectives

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

Search methods

We searched the following electronic databases: Cochrane Central Register of Controlled Trials (CENTRAL, *The Cochrane Library,* Issue 8, 2012), MEDLINE, EMBASE, AMED, CINAHL, PsycLIT/PsycINFO, SportDiscus and PEDro from inception to August 2012. We also searched the grey literature, wrote to leading experts in the field, wrote to charities and searched reference lists of other recent systematic reviews.

Selection criteria

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

Data collection and analysis

Two review authors working independently (LB and KH) screened all titles and abstracts to identify studies that might meet the inclusion criteria, or that cannot be safely excluded without assessment of the full text (e.g. when no abstract is available). All eligible papers were formally abstracted by at least two members of the review author team working independently (LB and KH) and using the data collection form. When possible, and if appropriate, we performed a fixed-effect meta-analysis of study outcomes. For continuous outcomes (e.g. cardiorespiratory fitness), we extracted the final value, the standard deviation of the outcome of interest and the number of participants assessed at follow-up in each treatment arm, to estimate 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 synthesised studies as a narrative.

Main results

Fourteen trials were included in this review, involving a total of 648 participants. Only studies involving breast, prostate or colorectal cancer were identified as eligible. Just six trials incorporated a target level of exercise that could meet current recommendations. Only three trials were identified that attempted to objectively validate independent exercise behaviour with accelerometers or heart rate monitoring. Adherence to exercise interventions, which is crucial for understanding treatment dose, is often poorly reported. It is important to note that the fundamental metrics of exercise behaviour (i.e. frequency, intensity and duration, repetitions, sets and intensity of resistance training), although easy to devise and report, are seldom included in published clinical trials.

None of the included trials reported that 75% or greater adherence (the stated primary outcome for this review) of the intervention group met current aerobic exercise recommendations at any given follow-up. Just two trials reported six weeks of resistance exercise behaviour that would meet the guideline recommendations. However, three trials reported adherence of 75% or greater to an aerobic exercise goal that was less than the current guideline recommendation of 150 minutes per week. All three incorporated both supervised and independent exercise components as part of the intervention, and none placed restrictions on the control group in terms of exercise behaviour. These three trials shared programme set goals and the following behaviour change techniques: generalisation of a target behaviour; prompting of self-monitoring of behaviour; and prompting of practise. Despite the uncertainty surrounding adherence in many of the included trials, interventions caused improvements in aerobic exercise tolerance at 8 to 12 weeks (from 7 studies, SMD 0.73, 95% confidence interval (CI) 0.51 to 0.95) in intervention participants compared with controls. At six months, aerobic exercise tolerance was also improved (from 5 studies, SMD 0.70, 95% CI 0.45 to 0.94), but it should be noted that four of the five trials used in this analysis had a high risk of bias, hence caution is warranted in interpretation of results. Attrition over the course of these interventions is typically low (median 6%).

Authors' conclusions

Interventions to promote exercise in cancer survivors who report better levels of adherence share some common behaviour change techniques. These involve setting programme goals, prompting practise and self-monitoring and encouraging participants to attempt to generalise behaviours learned in supervised exercise environments to other, non-supervised contexts. However, expecting most sedentary survivors to achieve current guideline recommendations of at least 150 minutes per week of aerobic exercise is likely to be unrealistic. As with all well-designed exercise programmes in any context, prescriptions should be designed around individual capabilities, and frequency, duration and intensity or sets, repetitions, intensity or resistance training should be generated on this basis.

PLAIN LANGUAGE SUMMARY

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

Question: What are the most effective ways to improve and sustain exercise behaviour in cancer survivors, that is, people living with and beyond cancer?

Background: Being regularly active for people living with and beyond cancer can have a wide range of beneficial effects. These range from improving quality of life to improving physical function. It might also reduce the risk of cancer recurrence and of dying from

cancer. We know that most people living with and beyond cancer are not regularly physically active. So, we need to understand how to get those individuals who are not currently exercising to begin to be active and how to help them maintain this change in behaviour.

Study characteristics: We included only studies that compared an exercise intervention with a usual care comparison. Only studies including sedentary people over the age of 18 with the same cancer diagnosis were eligible. Participants must have been put in a group at random. We searched for evidence from research databases up to August 2012.

Key results: This review included 14 trials involving 648 participants. Evidence suggests that we have a poor understanding of how to encourage people living with and beyond cancer to meet current exercise recommendations. Furthermore, how trial investigators report what their exercise programme involved and how much of it the participants actually did is not good. However, we did find some evidence that setting exercise goals, prompting people to exercise, getting people to monitor their own behaviour and getting people to think about how to do exercise outside of a supervised environment could be helpful. In addition, we found some evidence suggesting that study participants are better able to tolerate the exertion of undertaking exercise 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 whether investigators who were doing trial assessments knew to which group the person they were assessing had been randomly assigned.

BACKGROUND

Description of the condition

Approximately 25 million people worldwide are living with cancer (Kamangar 2006). As such, cancer represents one of the largest global health problems. Breast, prostate and bowel cancer account for most of the survivorship population (around 52%) (Maddams 2009). Recent evidence from Macmillan Cancer Support indicates that cancer survival rates have much improved over the past 30 years (Macmillan Cancer Support 2012). Coleman 2011 reported that relative survival has improved in breast, colorectal, lung and ovarian cancer over the period 1995-2007. This is good news for people living with the more common cancers who are undergoing, or recovering from, treatment. However, this also means that survivors are living longer with the consequences of cancer treatment, which frequently manifest as fatigue, reduced functional capacity and poorer health-related quality of life (HRQoL). Further, cancer survivors are significantly more likely to report poor health outcomes compared with those with no history of cancer or a chronic condition (Elliott 2011). Throughout this review, we will define a cancer survivor as someone 'living with or beyond cancer', in line with the Macmillan Cancer Support definition (Macmillan Cancer Support 2011).

Description of the intervention

The goal of any exercise regime is a sustained physiological challenge that, over time, will induce a spectrum of beneficial cardiovascular, respiratory, musculoskeletal, neurological and metabolic adaptations. In the context of living with or beyond disease, it is these adaptations that will likely translate to a range of benefits from improvements in HRQoL and physical function to reducing disease progression, secondary recurrence and mortality (Fong 2012; Ibrahim 2011). Evidence for this in cancer populations ranges from epidemiological observations to cause and effect derived from randomised controlled trials (RCTs). As such, the potential for habitual exercise to act as a useful adjunctive therapy is a growing area of research interest (Rock 2012). The UK Chief Medical Officer recommends that in adults, weekly activity should add up to at least 150 minutes of moderate intensity exercise, performed in bouts of 10 minutes or longer (Department of Health 2011; Rock 2012). For example, this could translate to 30 minutes of exercise that raises heart rate and breathing rate, five times per week. Alternatively, 75 minutes of vigorous intensity activity spread across the week can confer similar benefits. The general consensus is that such guidelines are also appropriate for adult cancer survivors (Rock 2012). However, encouraging people to participate in regular exercise from a background of a sedentary lifestyle is difficult, requiring attention to psychosocial and behavioural influences on exercise, as well as the physiological basis of exercise (Greaves 2011). A still greater challenge is to provide a support structure for physical activity until it becomes a pattern of sustained healthy behaviour. In this review, interventions of interest include any programmes that promote increased exercise behaviour in people living with and beyond cancer, with a particular focus on long-term change in exercise behaviour.

How the intervention might work

RCTs in people living with and beyond cancer have assessed various interventions aimed at promoting both short- and long-term exercise participation. These include approaches such as supervised exercise (Bourke 2011); home-based exercise (Courneya 2003); group-based patient education (Carmack Taylor 2006); information leaflets (Demark-Wahnefried 2007); cognitive behavioural therapy approaches (May 2008) and motivational interviewing (Bennett 2007). Tailored exercise interventions commonly comprise aerobic exercise training, resistance (strength) training or a combination of both, with or without behaviour change support. These approaches tend to vary in the extent to which they are based on behaviour change theory or employ specific behaviour change techniques.

Why it is important to do this review

A large majority of people living with and beyond cancer are not regularly active (for the purposes of this review, referred to as "sedentary") (Department of Health 2012). Systematic reviews and meta-analyses of interventions promoting exercise participation in people living with and beyond cancer have reported a range of benefits, including reduced fatigue and improved functional capacity/physical fitness and HRQoL (Cramp 2012; Demark-Wahnefried 2007; Fong 2012; McNeely 2006; Pekmezi 2011; Mishra 2012a; Mishra 2012b). However, most of the current evidence comes from trials with short-term interventions and follow-up, with any benefits likely to be transient if exercise behaviour is not sustained. Understanding which interventions are most efficacious in supporting long-term exercise behaviour would be very useful (Bourke 2012), not just because of the HRQoL benefits, but emerging observational data suggest that being regularly active can reduce the chances of dying from cancer after diagnosis. Physical activity in observational studies is usually estimated as the self-reported time spent exercising and is reported as metabolic equivalent task (MET)-hours per week, using typical MET values for specific activities (Ainsworth 2011). In breast, prostate and bowel cancer, increased post-diagnosis exercise behaviour has been reported to reduce cancer-specific mortality risk by 32% to 61%, with around 18 to 27 MET-hours per week of exercise conferring benefit (Haydon 2006; Holick 2008; Holmes 2005; Kenfield 2011; Meyerhardt 2006; Meyerhardt 2009; Nilsen 2006). Furthermore, providing an understanding of which behaviour change theories and behaviour change techniques are most efficacious in improving exercise behaviour will facilitate optimal design for future exercise interventions.

In the UK, the National Cancer Survivorship Initiative has highlighted physical symptoms as a consequence of treatment as an area of research with the highest priority (Richards 2011). Furthermore, from an international perspective, the recent Lancet Oncology Commission called for novel, more effective and less toxic interventions for delivering affordable cancer care (Sullivan 2011). Promoting habitual exercise participation could satisfy both of these high priority agendas.

We have deliberately chosen the term "habitual" over "regular" to reflect the intention to assess which interventions could improve and 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. Furthermore, "habitual" refers to the process of behavioural "habit forming", which suggests an automaticity of behaviour, thereby improving maintenance of behaviour change (Gardner 2011; Verplanken and Melkelvik 2009). Systematically reviewing variations in frequency, intensity and duration of exercise achieved, the theoretical basis of the intervention and behaviour change techniques used, adherence to these interventions, attrition, reported adverse events and duration of sustained meaningful exercise behaviour is crucial for informing future trial design (in under-studied cancer populations) and for facilitating the integration of exercise therapy into existing care pathways (when the evidence demonstrates efficacy for a given intervention). The purpose of this review is to summarise the existing literature on the effects of exercise-promoting interventions on short- and longer-term exercise behaviour in previously sedentary people living with and beyond cancer.

OBJECTIVES

Primary objective

To assess the effects of interventions 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 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

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 only RCTs that aimed to improve exercise behaviour compared with a usual care comparison group. 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 will be 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 trials involving adults (18 years of age or older) who had a sedentary lifestyle 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 trials 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 and Fowler 2009). Investigators must have reported frequency, duration and intensity of aerobic exercise behaviour or frequency, intensity, type, sets, repetitions and pattern of resistance of exercise behaviour that was prescribed in the intervention.

We acknowledge that the maximal aerobic capacity (VO_2max)/peak is often the most informative metric for setting aerobic exercise intensity; however, given the nature of the population involved (elderly, potentially with multiple co-morbidities), it is often difficult to conduct maximal testing protocols to prescribe intensity on the basis of these measures because of the requirements for medically qualified staff to be present during assessment. As such, for reasons of pragmatism, we accept that exercise intensity is more frequently reported in the cohorts in terms of age-predicted maximum heart rate max (HR_{max}) or on the Borg rating of perceived exertion (RPE) scale (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); and
- 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; and
- pattern (quantification of rest period in relation to sets and repetitions).

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.
- Trial recruitment rate.
- Intervention attrition rate.

Interventions were judged as successful in achieving exercise goals as identified in the study methods if investigators reported at least 75% adherence over a given follow-up period. 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 6 weeks of follow-up. Interventions were categorised according to whether they were 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 categorised 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. Categorising interventions according to this taxonomy resulted in 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

We searched the following electronic databases.

- CENTRAL (Cochrane Central Register of Controlled Trials).
- MEDLINE (Medical Literature Analysis and Retrieval System Online).
- EMBASE (the Excerpta Medica database).
- AMED (Allied and Alternative Medicine Database; covers occupational therapy, physiotherapy and complementary medicine).
- CINAHL (Cumulative Index to Nursing and Allied Health Literature).
- PsycINFO (Database of the American Psychological Association).
- SportDiscus (Sports Evidence Database).
- PEDro (Physiotherapy Evidence Database).

The MEDLINE search strategy is presented in Appendix 2. For databases other than MEDLINE, we adapted the search strategy accordingly: EMBASE (Appendix 3), AMED (Appendix 4), CINAHL (Appendix 5) and PsycINFO (Appendix 6).
The search strategies were developed with the Cochrane Gynaecological Cancer Group Information Manager (Jane Hayes) and included MeSH and text word terms as appropriate.

We attempted to identify all relevant articles on PubMed, using the 'related articles' feature, and performed further searches for newly published articles.

Searching other resources

We searched reference lists of retrieved articles and published reviews on the topic. We contacted the principal investigators of the identified studies, as well as 10 national and international experts in the field, to ask whether they were aware of any other relevant unpublished studies in the area.
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 (http://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:

- http://www.who.int/ictrp/en;
- *Meta*register (http://www.controlled-trials.com/rct);
- ClinicalTrials.gov (http://www.clinicaltrials.gov); and
- http://www.cancer.gov/clinicaltrials.

We screened the full text of any relevant papers identified through these searches. We also approached the principal investigators and major co-operative groups active in this area to ask for relevant data. Furthermore, we wrote to Cancer Research UK (CRUK), Macmillan Cancer Support, the World Cancer Research Fund (WCRF), the Association for International Cancer Research (AICR), 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

Selection of studies

We imported results from each database into the reference management software package Endnote, from which we removed duplicates and selected relevant articles for screening. After training on the first 100 references retrieved from two different databases was provided to ensure a consistent approach, two review authors (LB and KH) 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 (ST or DR). 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. We linked together multiple publications and reports on the same study. Studies that appeared to be relevant but are excluded at this stage were 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 trial (please also see Excluded studies).

Data extraction and management

We extracted the following data.

- Study details: author, year, research question/study aim; country where the research was carried out; 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); 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.

- Participant characteristics: primary cancer diagnosis; any cancer treatment currently undertaken; metastatic disease status; age; sex; socio-economic status; 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, repetitions and pattern of resistance exercise achieved; total duration of the intervention and total duration of sustained meaningful exercise behaviour as a result of the intervention. 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.

Two members of the group worked independently (LB and KH) to abstract data from all eligible papers using the data collection form. Data were to be entered into the Cochrane Collaboration's statistical software, Review Manager 2011, 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 the Cochrane Collaboration'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; and
- other sources of bias.

However, we did not include whether participants were blind to their allocation of intervention or to control groups, as it is often not possible (e.g. in a supervised exercise setting) to blind participants to an intervention while promoting exercise behaviour. Two review authors (LB and KH) applied the risk of bias tool independently, and differences were resolved by discussion with a third review author (ST or DR). 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 7.

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", Data synthesis.

Unit of analysis issues

We included no 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). Indeed, some trials have reported significant maintenance up to three months after cessation of the intervention.(Bourke 2011). Hence this learning effect distorts results. Furthermore, asking individuals to revert to sedentary behaviour could be considered unethical (Das and Horton 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. I^2 greater than or equal to 50% was considered significant heterogeneity. We addressed this by performing a sensitivity analysis that excludes any heterogeneous trials. We supplemented this with a test of homogeneity to determine the strength of evidence that the heterogeneity is 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 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 between treatment arms.

Dichotomous outcomes

For dichotomous outcomes (e.g. adverse effects, deaths), if it was not possible to use a hazard ratio, 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.

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. A fixed-effect model was to be used 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 vs non-elderly).
- Current treatment (currently undergoing treatment vs not currently undergoing treatment).
- Participants with metastatic disease (metastatic cohort vs non-metastatic cohort).
- Accordance with behaviour change theory.
- Interventions in obese individuals (mean body mass index (BMI) of intervention group > 30 kg/m^2 vs mean BMI of intervention group < 30 kg/m^2).

Sensitivity analysis

Methodological flaws were judged using the Cochrane Collaboration'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.

RESULTS

Description of studies

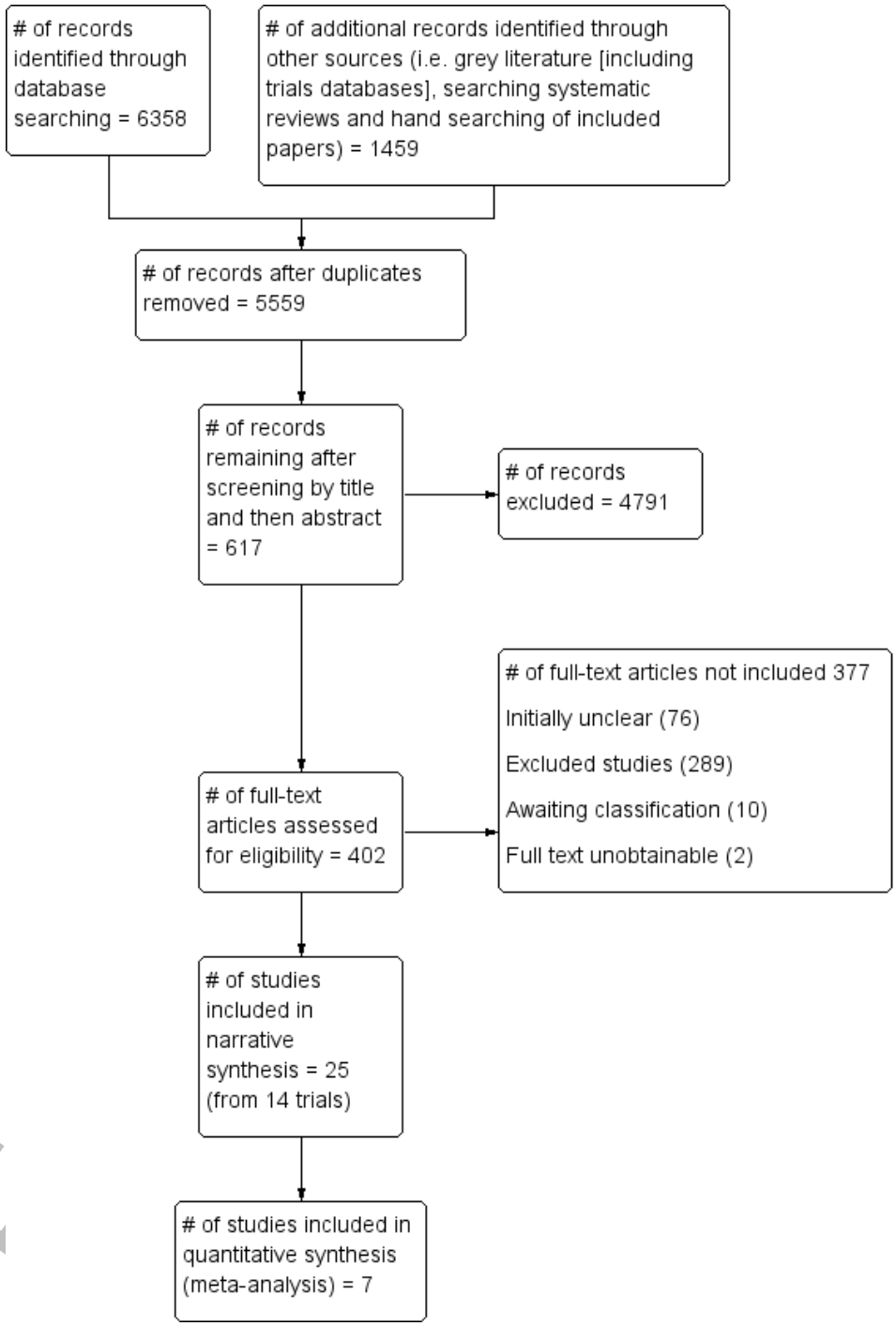
Please see Table 1, 'Summary of included studies'. See 'Characteristics of included studies'; 'Characteristics of excluded studies'; 'Characteristics of studies awaiting classification'; and 'Characteristics of ongoing studies'.

Results of the search

Figure 1 illustrates the process of the literature search and study selection for the review. We identified 4827 unique records from research databases and 732 records through grey literature and "snowballing" techniques, which included reference checking

from recent large systematic reviews (Fong 2012; Mishra 2012a; Mishra 2012b). 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 = 402). From these full text articles, 377 manuscripts were excluded, leaving 25 publications included in the review. Reasons for excluding these 377 publications are covered in the Excluded studies section below.

Figure 1. PRISMA flow diagram.



Included studies

After consensus agreement was reached by review authors (LB and KH), 14 trials were included in this review (Bourke 2011a; Bourke 2011b; Cadmus 2009; Daley 2007a; Drouin 2005; Hayes 2009; Kaltsatou 2011; Kim 2006; McKenzie 2003; Musanti 2012; Perna 2010; Pinto 2003; Pinto 2005; Pinto 2011). We also included in our analysis 11 follow-up papers that performed secondary analyses of data from a primary RCT. We sent 116 emails to request unpublished information for manuscripts that were unclear in reporting relative to our inclusion/exclusion criteria. We were able to include 15 and to exclude 34 published manuscripts on the basis of information received in correspondence from authors.

Only RCTs were included in the review. All included trials used a parallel-group design with baseline assessment and follow-up of 12 months maximum. All included trials 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 108, with a total of 648 participants included in this review (mean age range 51 to 72).

Participants

Most trials were conducted in breast cancer survivors (Cadmus 2009; Daley 2007a; Drouin 2005; Hayes 2009; Kaltsatou 2011; Kim 2006; McKenzie 2003; Musanti 2012; Perna 2010; Pinto 2005; Pinto 2003); only two trials involved colorectal cancer (Bourke 2011a; Pinto 2011), and one prostate cancer (Bourke 2011b). Of these trials, eight included participants who were currently undergoing active treatment inclusive of hormone-based therapy (Bourke 2011b; Cadmus 2009; Daley 2007a; Drouin 2005; Kim 2006; Musanti 2012; Perna 2010; Pinto 2005). We found only one study that reported data from participants with metastatic disease (Bourke 2011b) and two that were conducted in obese cohorts (i.e. mean BMI > 30 kg/m^2; Cadmus 2009; Drouin 2005). An overwhelming proportion of participants were white, and only one study reported data from an ethnically diverse sample (Perna 2010). Comorbidities at baseline were largely unclear or unreported; only Daley 2007a and Hayes 2009 reported on proportions with lymphedema, and Perna 2010 reported on proportions with clinically relevant depression scores.

Interventions

Eight trials prescribed exclusively aerobic exercise (Cadmus 2009; Daley 2007a; Drouin 2005; Kaltsatou 2011; Kim 2006; Pinto 2003; Pinto 2005; Pinto 2011); the remaining RCTs used a mix of aerobic and resistance training (no exclusively resistance training studies met our inclusion criteria). Seven trials used a combination of supervised and home-based exercise (Bourke 2011a; Bourke 2011b; Cadmus 2009; Hayes 2009; Kim 2006; Perna 2010; Pinto 2003), four trials opted to use an exclusively home-based design (Drouin 2005; Musanti 2012; Pinto 2005; Pinto 2011), and only three were exclusively supervised trials (Daley 2007a; Kaltsatou 2011; McKenzie 2003). Contact with exercise professionals or study researchers ranged from 20 times over 12 weeks (Hayes 2009) to weekly phone calls after an initial one-to-one exercise consultation (Pinto 2005; Pinto 2011). Of note, seven trials (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 trial, usually taking the form of direct instruction to refrain from changing exercise behaviour. Just six trials incorporated prescriptions that would meet the Rock 2012 recommendations for aerobic exercise (i.e.150 minutes per week; Cadmus 2009; Pinto 2011) or resistance exercise (i.e. resistance training strength training exercises at least two days per week; Bourke 2011a; Bourke 2011b; Musanti 2012; Perna 2010). Only three trials were identified that attempted to objectively validate independent exercise behaviour with accelerometers or heart rate monitoring (Cadmus 2009; Pinto 2005; Pinto 2011).

Full details of intervention (behaviour change technique (BCT)) coding according to the CALO-RE taxonomy can be seen in Table 2. Of the 14 interventions provided, only five were explicitly based on a theoretical model (Daley 2007a; Musanti 2012; Perna 2010; Pinto 2005; Pinto 2011); the trans-theoretical model was most common. All interventions had a target exercise level set by the programme. Only sjx trials set exercise goals in conjunction with participants (BCT # 5). In addition, all prompted practise of the behaviour (BCT #26), and all but four (Bourke 2011a; Hayes 2009; McKenzie 2003; Pinto 2005) 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. 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. It is important to note that when monitoring did occur (BCT #16), feedback on performance (BCT #19) was provided in only 4/10 (Cadmus 2009; Perna 2010; Pinto 2005; Pinto 2011). Similarly, in only two of six interventions (Daley 2007a; Perna 2010) for which participants had some input into setting of goals were these reviewed (BCT #10). Of note, few interventions (Cadmus 2009; Daley 2007a; Kim 2006; Perna 2010) reported providing information on the consequences of behaviour (BCT #1), although less than half reported problem solving with barriers identified (BCT

#8) and solutions facilitated (Bourke 2011b; Cadmus 2009; Daley 2007a; Perna 2010; Pinto 2005; Pinto 2011). Only three trials used techniques to increase social support (BCT #29; Cadmus 2009; Daley 2007a; Perna 2010).

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.
- Trials that failed to describe essential metrics of exercise prescription used in the intervention (e.g. frequency, intensity, duration).
- Trials involving active participants at baseline.
- Trials involving hospital inpatients.
- Interventions that provided follow-up of less than 6 weeks.
- Trials involving participants younger than 18 years of age.

Because of the volume of studies identified by the search, only the first occurrence of an exclusion criterion was noted in the publication, although frequently, trials exhibited several of the criteria listed above. Therefore, it was neither valid nor informative to present the number of papers excluded under each of the reasons listed above. The extent of exclusion at the full text screening stage (377 publications excluded from 402) provided the first indication of problems associated with quality of reporting in this research area. We sent emails to 116 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.

Only a subset of excluded studies could be included in the 'Characteristics of excluded studies' section. This is a result of the huge volume of trials 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 trials 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).

Risk of bias in included studies

Only three trials were judged not to include a high risk of bias (Bourke 2011a; Cadmus 2009; Drouin 2005). 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 and Figure 3. Seven trials stated that an intention-to-treat analysis was used (Bourke 2011a; Bourke 2011b; Cadmus 2009; Daley 2007a; Perna 2010; Pinto 2005; Pinto 2011).

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

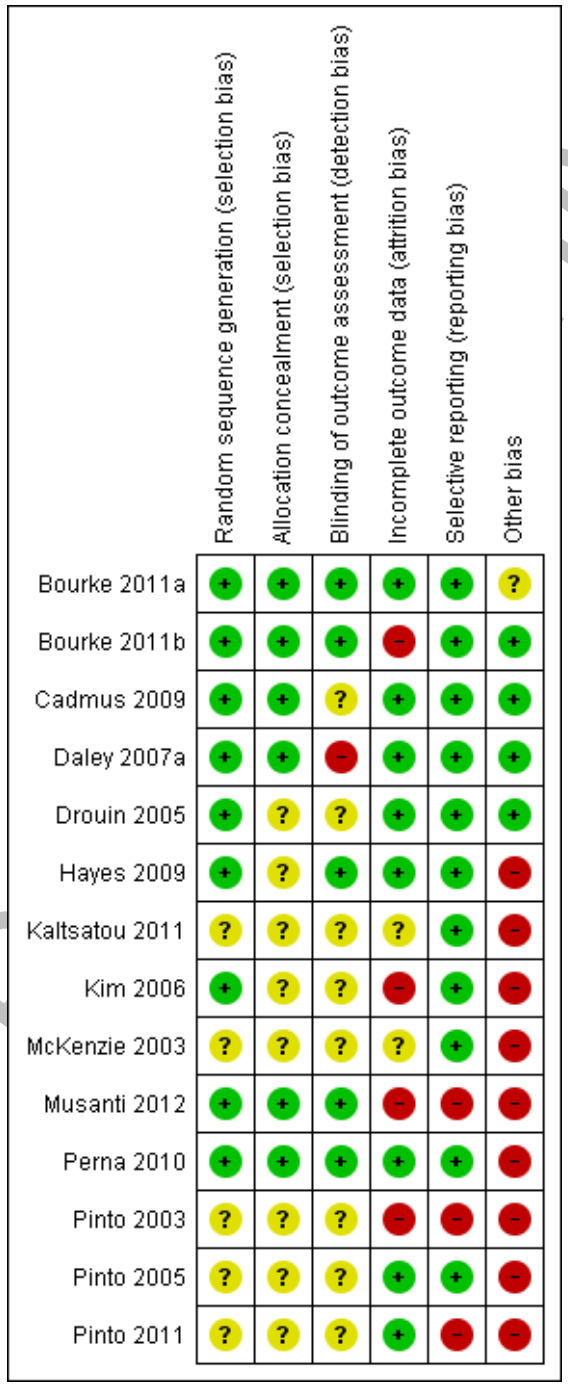
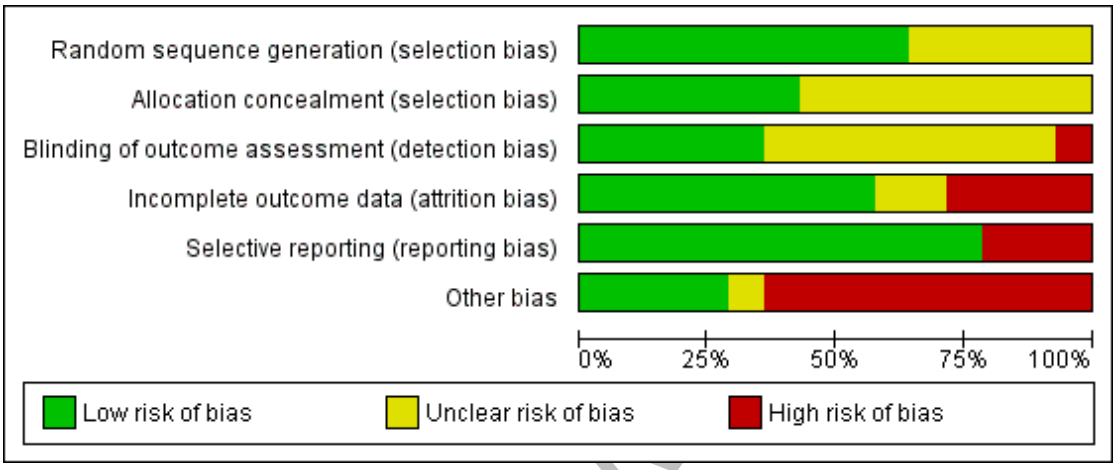


Figure 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Allocation

Most trials (8 out of 14) were not clear in their description of concealment in randomisation allocation. However, no trial was judged to have a high risk of bias in this respect.

Blinding

Only four trials explicitly stated whether they had undertaken blinding of study assessors (Bourke 2011a; Bourke 2011b; Daley 2007a; Hayes 2009). The remaining trials did not include enough information for the review authors to make a definitive judgement on this criterion.

Incomplete outcome data

Four trials were judged to have been subject to incomplete data outcome bias. Bourke 2011b reported a 44% attrition at six months of follow-up; 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. However, most studies (8 out of 14) were explicit in their reporting of outcomes.

Selective reporting

Most studies reported all listed outcomes; however, three trials 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.

Other potential sources of bias

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

Effects of interventions

Primary outcomes

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.

None of the trials 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. Only three trials reported adherence of 75% or greater to their specified aerobic exercise prescription (Bourke 2011a; Bourke 2011b; Cadmus 2009). It is notable that all three incorporated both a supervised and an independent exercise component as part of their intervention, and none placed restrictions on the control group in terms of exercise behaviour. Cadmus 2009 was likely the most successful study regarding the promotion of aerobic exercise behaviour, with 75% of the intervention group reporting between 90 and 119 minutes per week of moderate intensity exercise, at an average heart rate of 76% of predicted maximum, for six months. However, of these three trials, only Bourke 2011a and Bourke 2011b met the Rock 2012 exercise guidelines. Specifically, two to four sets of resistance exercise at 60% of one repetition max (RM) for eight to 12 repetitions were carried out twice per week for just six weeks. These three trials all shared the following BCTs.

- Programming a set goal.
- Prompting generalisation of a target behaviour.
- Prompting self-monitoring of behaviour.
- Prompting practise.

Aside from generalisation of a target behaviour, these three interventions did not differ from other interventions in terms of BCTs reported. Nor did trials explicitly state a theoretical basis. Other studies such as Daley 2007a and Perna 2010 were much more comprehensive in their reporting of BCTs and were based on recognised behaviour change theory. Several trials might have achieved adherence of 75% or greater, but because of unclear reporting, it was not possible to make a judgement on whether this criterion had been fulfilled. Reasons for judgement of unclear 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 4.
- Pinto 2011: judgement unsuccessful; three-day 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 (4 weeks in total). Home-based adherence is not clear.

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. Among trials with at least 75% adherence, only Cadmus 2009 reported behaviour in these terms. However, this trial demonstrated adherence rates of 75% or more only for 90 to 119 minutes per week of moderate intensity exercise. The overall mean (standard deviation (SD)) reported for minutes of moderate intensity physical activity at six months of follow-up was 161.7 (114.7) minutes, as reported by the 7-Day Physical Activity Log, with adherence reported as 61%. The other two trials (Bourke 2011a; Bourke 2011b) reported overall exercise behaviour using Godin Leisure Index questionnaire (Godin 1986) scores (without full objective validation). Further, at the same follow-up point of six months, Bourke 2011b reported 44% attrition and hence was judged as having a high risk of bias. Bourke 2011a reported outcomes at just 12 weeks of follow-up. Hence, a meta-analysis of moderate intensity exercise behaviour at any given follow-up was judged to be not informative. Insuficent data were available for a synthesis of evidence to be conducted around free living energy expenditure. Planned subgroup analysis was not deemed informative because of the lack of identified studies.

Secondary outcomes

A meta-analysis of change in aerobic exercise tolerance was carried out on seven trials that reported these outcomes and also re-

ported means for final value scores. Standardised mean differences (SMDs) were used to produce effect estimates as variation in how trials 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* (i.e. SD = $\sqrt{N}$ * (upper limit-lower limit)/(t distribution *2), and from standard errors (SEs) using SD = SE*$\sqrt{N}$, when they were not reported. Length of follow-up ranged from eight (Kim 2006; Daley 2007a) to 12 weeks (Bourke 2011a; Bourke 2011b; Musanti 2012; Pinto 2005; Pinto 2011; see Analysis 1.1). Aerobic exercise tolerance was significantly better in intervention versus control groups in 330 participants: SMD 0.73, 95% CI 0.51 to 0.95). We then removed trials with a high risk of bias relative to this outcome and repeated the analysis with the three remaining trials (Bourke 2011a; Bourke 2011b; Pinto 2005; see Analysis 1.2); aerobic exercise tolerance was significantly better in intervention versus control groups in 154 participants: SMD 0.84, 95% CI 0.51 to 1.17). We were unable to analyse subgroups outlined in the protocol (i.e. by cancer site, type of intervention, etc) because of a lack of included studies reporting changes in aerobic exercise tolerance or fitness. Five trials included data from a follow-up of six months (Bourke 2011b; Daley 2007a; Kaltsatou 2011; Pinto 2005; Pinto 2011) showing that aerobic exercise tolerance was significantly better at six months in intervention versus control groups in 271 participants: SMD 0.70, 95% CI 0.45 to 0.94; see Analysis 1.3). However, it should be highlighted that four of these trials have a high risk of bias, which could affect this outcome at six months, specifically, a high risk of reporting bias at six months in the Bourke 2011b trial; no adherence data in the Kaltsatou 2011 trial; substantial contamination among controls in the Pinto 2011 trial; and non-blinded assessors in the Daley 2007a trial. 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). Data were extracted from the combined aerobic and resistance training arm of Musanti 2012.

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.

Three trials that used resistance exercise as a component of the intervention reported changes in lower (Bourke 2011a; Bourke 2011b) and upper limb (Musanti 2012) strength. All three trials had reported strength changes at 12 weeks of follow-up, and we were able to extract means and SDs. Limb strength was significantly better in intervention versus control groups for 91 participants: SMD 0.51, 95% CI 0.19 to 0.93; see Analysis 2.1). After one trial was removed for high risk of bias (Musanti 2012), the moderate effect size was still apparent in 68 participants, but it was no longer significant: SMD 0.47, 95% CI -0.01 to 0.96; see Analysis 2.2).

Just six trials produced CONSORT diagrams (Bourke 2011a; Bourke 2011b; Cadmus 2009; Daley 2007a; Pinto 2005; Pinto 2011). Intervention attrition rates from the included trials ranged from 25% (Pinto 2003) to 0% (Drouin 2005) (median 6%), with five trials not clearly reporting attrition in the intervention arm (Kaltsatou 2011; Kim 2006; McKenzie 2003; Musanti 2012; Perna 2010). Eight trials reported adverse effects (Bourke 2011a; Bourke 2011b; Cadmus 2009; Daley 2007a; Kim 2006; Musanti 2012; Pinto 2005; Pinto 2011); these ranged from minor (e.g. musculoskeletal problems; Musanti 2012) to major events (e.g. death; Kim 2006). However, only one study (Cadmus 2009) was explicit as to which of these adverse effects were caused by inclusion of the participant in the intervention group (two instances of plantar fasciitis). The trial recruitment rate ranged from 10% (Bourke 2011a) to 89% (Perna 2010). Eight trials reported a priori sample size estimates (Cadmus 2009; Daley 2007a; Hayes 2009; Kaltsatou 2011; Musanti 2012; Pinto 2003; Pinto 2011; Perna 2010), and only three (Cadmus 2009; Hayes 2009; Perna 2010) met their recruitment target.

DISCUSSION

Summary of main results

Review findings indicate that currently, convincing evidence are lacking to suggest that existing exercise interventions are useful for achieving the Rock 2012 guidelines of 150 minutes per week of aerobic exercise and twice per week of resistance exercise in sedentary cancer cohorts. Adherence to exercise interventions, which is crucial for understanding treatment dose, is frequently poorly reported. It is important to note that the fundamental metrics of exercise behaviour (i.e. frequency, intensity and duration, or repetitions, sets and intensity of resistance training), although easy to devise and report, are seldom included in published clinical trials. Attempts to reproduce any exercise prescription without detailing these metrics are fraught with problems; most likely, this is not possible. The supportive evidence that we have synthesised as a narrative suggests that interventions that combine supervision of exercise training in tandem with a requirement for independent exercise are likely to promote better adherence. Behaviour change techniques (BCTs) that include programming set goals, prompting self-monitoring and practicing and generalising behaviour are a common feature of interventions that have reported better adherence.

Despite the uncertainty surrounding adherence in many of the included trials, interventions caused improvement in aerobic exercise tolerance at 8 to 12 weeks: SMD 0.73, 95% CI 0.51 to 0.95) in intervention participants compared with controls. At six months, aerobic exercise tolerance was also improved: SMD 0.70, 95% CI 0.45 to 0.94), but it should be noted that four of the five trials

used in this analysis had a high risk of bias, hence caution is warranted in interpretation of findings. Such improvements could be interpreted as reassuring that some of the lack of clarity around adherence extends only to reporting issues rather than reflecting real problems with fidelity. Alternatively, this result could have arisen from the rapid, relatively large early gains in function expected in sedentary participants as the result of exercise training, which could mask smaller changes among non-adherers. Further, aerobic exercise tolerance should not be considered as definitive evidence of changes in aerobic fitness (with the accompanying spectrum of underlying physiological adaptations). It could simply reflect the fact that individuals have become accustomed to the feeling of exertion from exercise testing and better tolerance towards perceptions of fatigue. Just one of the included trials (Drouin 2005) reported using established cardiopulmonary exercise testing protocols to measure changes in fitness (e.g. VO_2 peak derived from Douglas bag or online gas analysis systems). However, this study did not report data that we could use in our meta-analysis (i.e. only medians and ranges were reported). It is interesting to note that reported attrition over the intervention period for trials included in this review was typically low (median 6%), although it is difficult to interpret adverse effect reports and to identify adverse effects that are attributable to participation in these interventions.

Overall completeness and applicability of evidence

This systematic review included 14 trials, all of which were RCTs. These trials randomly assigned 648 participants to exercise or comparison groups. A large majority of these trials included women with breast cancer. One trial involved men with advanced prostate cancer, and two trials involved colorectal cancer survivors. Although these three primary cancers account for most of the population living with and beyond cancer, other common cancers such as lymphoma and lung cancer do not appear at all in this review. Less common cancers also are not represented in the evidence base. Furthermore, an overwhelming majority of participants were white, and only one trial included an ethnically diverse population. As such, other ethnicities are substantially underrepresented. 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", 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. Such individuals would be erroneously designated as "sedentary". However, given the population under study, it is likely that such contamination would be minimal. We set a threshold of 75% adherence for any trial to be judged "successful" in this review. This decision was based on previous reports from a review of adherence to exercise schemes in older adults (Martin 2001). This threshold of course is open to debate in the context of cancer specifically, but it was believed that this level represents a minimum for achieving balance between a meaningful dose of the stated exercise prescription and what is realistic for most people living with and beyond cancer. Thirteen of the 14 included trials were conducted in Northern America or Western Europe, and one trial was completed in Australia. All are considered high income nations according to the World Health Organization (WHO) taxonomy. No evidence was derived from developing countries, and it is uncertain whether the resources and/or infrastructure 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. An overwhelming majority of trials 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 trial design, they are prone to multifarious 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/wk of energy expenditure. It is admirable that two trials attempted to validate self-reported independent exercise behaviour by using accelerometers (Pinto 2005; Pinto 2011); however, data either were not supportive of exercise behaviour recorded by participants or were not reported in their entirety.

Analysis by behaviour change theory and outcome (e.g. aerobic exercise tolerance) was not possible given that few trials stated a theoretical basis for their intervention. 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. 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 trials (Courneya 2010), and we recognise the distinction. However, it should be noted by the reader that all three trials that we judged as successful (i.e. reported 75% or greater adherence over the intervention period) 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 trial. 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. 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.

Quality of the evidence

Most of the uncertainty in judging trial bias came from lack of clarity around randomisation procedures and blinding of study outcome assessors. Most of the trials in this review were judged to include at least one element of high risk of non-standard bias, as described in the 'Other sources of bias' outcome. Of note, we chose to refrain from judging trials 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 et al recommendations) are freely available to the public, and given their ease of access via the Internet, the validity of a "sham" condition is dubious. The 'Summary of findings' and 'Risk of bias' tables and Figure 2 and Figure 3 provide a summary of the quality of evidence.

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. 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 people living with or beyond cancer than any other systematic review in this field. More than 400 papers were screened at full text stage for eligibility, and we sent 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. We were able to perform single extraction only to generate the CALO-RE taxonomy data (undertaken by LS).

Agreements and disagreements with other studies or reviews

To the review authors' knowledge, this is the first comprehensive review to evaluate RCTs with respect to their success in promoting exercise behaviour in sedentary cancer cohorts. A recent systematic review of predictors of adherence to exercise in people living with and beyond cancer (Husebø 2013) found that the transtheoretical model of behaviour change and the theory of planned behaviour were significantly associated with better exercise adherence. The current review does not explicitly support such conclusions. It should be noted that key differences are evident in each review methodology, with the present review including only RCTs and people who were sedentary at baseline. Other recent high-profile systematic reviews (e.g. Fong 2012) have focused on potential health-related outcomes of exercise intervention for people living with and beyond cancer. In this respect, Fong 2012 similarly reported improvements in aerobic exercise tolerance and muscle strength. One substantial difference in the methodology of the present review when compared with other Cochrane reviews in this area (e.g. Mishra 2012a; Mishra 2012b) is that we included only studies in which the essential metrics of exercise behaviour are reported.

AUTHORS' CONCLUSIONS

Implications for practice

Service provision to promote exercise in sedentary people living with and beyond cancer should incorporate components of both supervised and independent exercise requirements. Setting programme goals, prompting practise and self-monitoring, and encouraging people to attempt to generalise behaviour learned in supervised exercise environments to other non-supervised contexts are common components of interventions that report meaningful adherence. However, expecting most sedentary survivors to achieve at least 150 minutes per week of aerobic exercise is likely to be unrealistic. As with all well-designed exercise programmes in any context, prescriptions should be designed around individual capabilities and frequency, duration and intensity or sets, repetitions and intensity, or resistance training should be generated on this basis. Using these essential metrics of exercise prescription not only will help achieve a balance between safe yet effective exercise, but also will ensure that meaningful re-evaluation over time can be undertaken, as adaptation or disease progression dictates. Relevant training in exercise prescription for people living with and beyond cancer can be undertaken through established reputable bodies such as the American College of Sports Medicine, which runs courses in collaboration with the American Cancer Society.

Implications for research

Recently, in the largest survey of cancer survivors (covering multiple cancer types) to have been conducted in Europe (N = 3300), the UK Department of Health reported that less than 25% of people living with and beyond cancer are achieving 30 minutes of exercise on five or more days per week (Department of Health 2012). This is a clear indicator that an overwhelming majority of cancer survivors are not active. It is therefore of critical importance that:

- future research is primarily targeted towards a better understanding of effective promotion of exercise behaviour in sedentary individuals living with or beyond cancer;

- trials are explicit about baseline exercise behaviour and about how it was assessed;

- all trials report as standard frequency, intensity and duration of aerobic exercise, as well as repetitions, sets and intensity of resistance exercise used in intervention prescriptions;

- standardisation of adherence reporting is achieved in clinical trials investigating the effects of exercise in cancer survivors. We recommend that adherence is reported as a single proportion of the cohort who attended/performed exercise according to the set prescription;

- accelerometers do not appear to be a helpful tool for objectively validating exercise behaviour in the trials that we have reviewed. We recommend the use of heart rate monitoring during set, purposeful bouts of exercise; and

- reporting of behaviour change techniques employed in such interventions is standardised. Adoption of the CALO-RE taxonomy or the broader BCT v1 taxonomy is recommended.

By achieving these standardisations, oncology scientists and clinicians will help bring the discipline up to the level of acceptable rigor that will elucidate dose response of exercise interventions for given health outcomes. This should afford an opportunity for practitioners to communicate achievable exercise recommendations for sedentary people living with and beyond cancer.

ACKNOWLEDGEMENTS

We thank Jane Hayes for designing the search strategy and Clare Jess, Gail Quinn and Dr Chris Williams for their contributions to the editorial process. We thank Mr David Salisbury for assisting with the organisation of the screening process. We thank Dr Dawn Carnes for independently reviewing the risk of bias in the lead authors' published trials. We would like to thank Mr John Batchelor for assistance in drafting the plain language summary of findings.

The National Institute for Health Research (NIHR) is the largest single funder of the Cochrane Gynaecological Cancer Group. The views and opinions expressed herein are those of the authors and do not necessarily reflect those of the NIHR, the NHS or the Department of Health.

REFERENCES

References to studies included in this review

Bourke 2011a ***{published data only}***

Bourke L, Thompson G, Gibson DJ, Daley A, Crank H, Adam I, et al.Pragmatic lifestyle intervention in patients recovering from colon cancer: a randomized controlled pilot study. *Archives of Physical Medicine & Rehabilitation* 2011;**92**:749–55.

Bourke 2011b ***{published data only}***

Bourke L, Doll H, Crank H, Daley A, Rosario D, Saxton JM. Lifestyle intervention in men with advanced prostate cancer receiving androgen suppression therapy: a feasibility study. *Cancer Epidemiology Biomarkers and Prevention* 2011; **20**:647–57.

Cadmus 2009 ***{published data only}***

* Cadmus LA, Salovey P, Yu H, Chung G, Kasl S, Irwin ML. Exercise and quality of life during and after treatment for breast cancer: results of two randomized controlled trials. *Psycho-oncology* 2009;**18**:343–52.

Irwin ML, Alvarez-Reeves M, Cadmus L, Mierzejewski E, Mayne ST, Yu H, et al.Exercise improves body fat, lean mass and bone mass in breast cancer survivors. *Obesity (Silver Spring)* 2009;**17**:1534–41.

Irwin ML, Cadmus L, Alvarez-Reeves M, O'Neil M, Mierzejewski E, Latka R, et al.Recruiting and retaining breast cancer survivors into a randomized controlled exercise trial: the Yale Exercise and Survivorship Study. *Cancer* 2008;**112**:2593–606.

Irwin ML, Varma K, Alvarez-Reeves M, Cadmus L, Wiley A, Chung GG, et al.Randomized controlled trial of aerobic exercise on insulin and insulin-like growth factors in breast cancer survivors: the Yale Exercise and Survivorship study. *Cancer Epidemiology Biomarkers and Prevention* 2009;**18**: 306–13.

Latka RN, Alvarez-Reeves M, Cadmus L, Irwin ML. Adherence to a randomized controlled trial of aerobic exercise in breast cancer survivors: the Yale exercise and survivorship study. *Journal of Cancer Survivorship* 2009;**3**: 148–57.

Daley 2007a ***{published and unpublished data}***

Daley AJ, Crank H, Mutrie N, Saxton JM, Coleman R. Determinants of adherence to exercise in women treated for breast cancer. *European Journal of Oncology Nursing* 2007; **11**:392–9.

* Daley AJ, Crank H, Saxton JM, Mutrie N, Coleman R, Roalfe A. Randomized trial of exercise therapy in women treated for breast cancer. *Journal of Clinical Oncology* 2007; **25**:1713–21.

Drouin 2005 ***{published and unpublished data}***

* Drouin JS, Armstrong H, Krause S, Orr J, Birk TJ, Hryniuk WM, et al.Effects of aerobic exercise training on peak aerobic capacity, fatigue, and psychological factors

during radiation for breast cancer. *Rehabilitation Oncology* 2005;**23**:11–7.
Drouin JS, Birk TJ, Wirth JC. Random control clinical trial on effect of aerobic exercise training on weight management during radiation treatment for breast cancer. *Rehabilitation Oncology* 2006;**24**:6–10.
Drouin JS, Young TJ, Beeler J, Byrne K, Birk TJ, Hryniuk WM, et al.Random control clinical trial on the effects of aerobic exercise training on erythrocyte levels during radiation treatment for breast cancer. *Cancer* 2006;**107**: 2490–5.

Hayes 2009 ***{published and unpublished data}***
Hayes SC, Reul-Hirche H, Turner J. Exercise and secondary lymphedema: safety, potential benefits, and research issues. *Medicine and Science in Sports and Exercise* 2009;**41**:483–9.

Kaltsatou 2011 ***{published and unpublished data}***
Kaltsatou A, Mameletzi D, Douka S. Physical and psychological benefits of a 24-week traditional dance program in breast cancer survivors. *Journal of Bodywork & Movement Therapies* 2011;**15**:162–7.

Kim 2006 ***{published and unpublished data}***
Kim CJ, Kang DH, Smith BA, Landers KA. Cardiopulmonary responses and adherence to exercise in women newly diagnosed with breast cancer undergoing adjuvant therapy. *Cancer Nursing* 2006;**29**:156–65.

McKenzie 2003 ***{published and unpublished data}***
McKenzie DC, Kalda AL. Effect of upper extremity exercise on secondary lymphedema in breast cancer patients: a pilot study. *Journal of Clinical Oncology* 2003;**21**:463–6.

Musanti 2012 ***{published data only}***
Musanti R. A study of exercise modality and physical self-esteem in breast cancer survivors. *Medicine and Science in Sports and Exercise* 2012;**44**:352–61.

Perna 2010 ***{published and unpublished data}***
Perna FM, Craft L, Freund KM, Skrinar G, Stone M, Kachnic L, et al.The effect of a cognitive behavioral exercise intervention on clinical depression in a multiethnic sample of women with breast cancer: a randomized controlled trial. *International Journal of Sport and Exercise Psychology* 2010;**8**: 36–47.

Pinto 2003 ***{published data only}***
Pinto BM, Clark MM, Maruyama NC, Feder SI. Psychological and fitness changes associated with exercise participation among women with breast cancer. *Psycho-oncology* 2003;**12**:118–26.

Pinto 2005 ***{published and unpublished data}***
* Pinto BM, Frierson GM, Rabin C, Trunzo JJ, Marcus BH. Home-based physical activity intervention for breast cancer patients. *Journal of Clinical Oncology* 2005;**23**:3577–87.
Pinto BM, Rabin C, Dunsiger S. Home-based exercise among cancer survivors: adherence and its predictors. *Psycho-oncology* 2009;**18**:369–76.
Pinto BM, Rabin C, Papandonatos GD, Frierson GM, Trunzo JJ, Marcus BH. Maintenance of effects of a home-based physical activity program among breast cancer survivors. *Support Care Cancer* 2008;**16**:1279–89.
Pinto BM, Trunzo JJ, Rabin C, Cady B, Fenton MA, Herman A, et al.Random control clinical trial on effect of aerobic exercise training on weight management during radiation treatment for breast cancer. *Journal of Clinical Psychology in Medical Settings* 2004;**11**:171–8.
Rabin C, Pinto BM, Frierson G. Mediators of a randomized controlled physical activity intervention for breast cancer survivors. *Journal of Sport and Exercise Psychology* 2006;**28**: 269–84.

Pinto 2011 ***{published and unpublished data}***
Pinto BM, Papandonatos GD, Goldstein MG, Marcus BH, Farrell N. Home-based physical activity intervention for colorectal cancer survivors. Psycho-oncology Epub 2011; September 9; doi: 10.1002/pon.2047.

References to studies excluded from this review

Ahmed 2006 ***{published data only}***
Ahmed RL, Thomas W, Yee D, Schmitz KH. Randomized controlled trial of weight training and lymphedema in breast cancer survivors. *Journal of Clinical Oncology* 2006; **24**:2765–72.

Ames 2011 ***{published data only}***
Ames SC, Tan WW, Ames GE, Stone RL, Rizzo TD Jr, Crook JE, et al.A pilot investigation of a multidisciplinary quality of life intervention for men with biochemical recurrence of prostate cancer. *Psycho-oncology* 2011;**20**: 435–40.

Anderson 2012 ***{published data only}***
Anderson RT, Kimmick GG, McCoy TP, Hopkins J, Levine E, Miller G, et al.A randomized trial of exercise on well-being and function following breast cancer surgery: the RESTORE trial. *Journal of Cancer Survivorship* 2012;**6**: 172–81.

Arbane 2011 ***{published and unpublished data}***
Arbane G, Tropman D, Jackson D, Garrod R. Evaluation of an early exercise intervention after thoracotomy for non-small cell lung cancer (NSCLC), effects on quality of life, muscle strength and exercise tolerance: randomised controlled trial. *Lung Cancer* 2011;**71**:229–34.

Battaglini 2007 ***{published and unpublished data}***
Battaglini C, Bottaro M, Dennehy C, Rae L, Shields E, Kirk D, et al.The effects of an individualized exercise intervention on body composition in breast cancer patients undergoing treatment. *Sao Paulo Medical Journal* 2007;**125**:22–8.

Battaglini 2008 ***{published and unpublished data}***
Battaglini CL, Mihalik JP, Bottaro M, Dennehy C, Petschauer MA, Hairston LS, et al.Effect of exercise on the caloric intake of breast cancer patients undergoing treatment. *Brazilian Journal of Medical and Biological Research* 2008;**41**:709–15.

Campbell 2005 ***{published data only}***
Campbell A, Mutrie N, White F, McGuire F, Kearney N. A pilot study of a supervised group exercise programme as a rehabilitation treatment for women with breast cancer

receiving adjuvant treatment. *European Journal of Oncology Nursing* 2005;**9**:56–63.

Cantarero-Villanueva 2011 ***{published and unpublished data}***
Cantarero-Villanueva I, Fernández-Lao C, Díaz-Rodriguez L, Fernández-de-las-Peñas C, del Moral-Avila R, Arroyo-Morales M. A multimodal exercise program and multimedia support reduce cancer-related fatigue in breast cancer survivors: a randomised controlled clinical trial. *European Journal of Integrative Medicine* 2011;**3**:e189-e200.

Cantarero-Villanueva 2012 ***{published and unpublished data}***
Cantarero-Villanueva I, Fernández-Lao C, Del Moral-Avila R, Fernández-de-Las-Peñas C, Feriche-Fernández-Castanys MB, Arroyo-Morales M. Effectiveness of core stability exercises and recovery myofascial release massage on fatigue in breast cancer survivors: a randomized controlled clinical trial. Evidence-Based Complementary and Alternative Medicine Epub 2011 Jul 17. [DOI: 10.1155/2012/620619]

Carmack Taylor 2004 ***{published data only}***
Carmack Taylor CL, Smith MA, de Moor C, Dunn AL, Pettaway C, Sellin R, et al.Quality of life intervention for prostate cancer patients: design and baseline characteristics of the Active for Life After Cancer trial. *Controlled Clinical Trials* 2004;**25**:265–85.

Carmack Taylor 2006 ***{published data only}***
Carmack Taylor CL, Demoor C, Smith MA, Dunn AL, Basen-Engquist K, Nielsen I, et al.Active for Life After Cancer: a randomized trial examining a lifestyle physical activity program for prostate cancer patients. *Psycho-oncology* 2006;**15**:847–62.

Carmack Taylor 2007 ***{published data only}***
Carmack Taylor CL, de Moor C, Basen-Engquist K, Smith MA, Dunn AL, Badr H, et al.Moderator analyses of participants in the Active for Life After Cancer trial: implications for physical activity group intervention studies. *Annals of Behavioral Medicine* 2007;**33**:99–104.

Carson 2009 ***{published and unpublished data}***
Carson JW, Carson KM, Porter LS, Keefe FJ, Seewaldt VL. Yoga of Awareness program for menopausal symptoms in breast cancer survivors: results from a randomized trial. *Supportive Care in Cancer* 2009;**17**:1301–9.

Cho 2006 ***{published data only}***
Cho OH, Yoo YS, Kim NC. Efficacy of comprehensive group rehabilitation for women with early breast cancer in South Korea. *Nursing and Health Sciences* 2006;**8**:140–6.

Coleman 2003 ***{published data only}***
Coleman EA, Hall-Barrow J, Coon S, Stewart CB. Facilitating exercise adherence for patients with multiple myeloma. *Clinical Journal of Oncology Nursing* 2003;**7**:529–34.

Culos Reed 2010 ***{published data only}***
Culos-Reed SN, Robinson JW, Lau H, Stephenson L, Keats M, Norris S, et al.Physical activity for men receiving androgen deprivation therapy for prostate cancer: benefits from a 16-week intervention. *Supportive Care in Cancer* 2010;**18**:591–9.

Danhauer 2009 ***{published data only}***
Danhauer SC, Mihalko SL, Russell GB, Campbell CR, Felder L, Daley K, et al.Restorative yoga for women with breast cancer: finding from a randomized pilot study. *Psycho-oncology* 2009;**18**:360–8.

Daubenmier 2006 ***{published data only}***
Daubenmier JJ, Weidner G, Marlin R, Crutchfield L, Dunn-Emke S, Chi C, et al.Lifestyle and health-related quality of life of men with prostate cancer managed with active surveillance. *Urology* 2006;**67**:125–30.

DeNysschen 2011 ***{published data only}***
DeNysschen CA, Brown JK, Cho MH, Dodd MJ. Nutritional symptom and body composition outcomes of aerobic exercise in women with breast cancer. *Clinical Nursing Research* 2011;**20**:29–46.

Dolan 2010 ***{published data only}***
Dolan LB, Gelmon K, Courneya KS, Mackey JR, Segal RJ, Lane K, et al.Hemoglobin and aerobic fitness changes with supervised exercise training in breast cancer patients receiving chemotherapy. *Cancer Epidemiology Biomarkers & Prevention* 2010;**19**:2826–32.

Donnelly 2011 ***{published and unpublished data}***
Donnelly CM, Blaney JM, Lowe-Strong A, Rankin JP, Campbell A, McCrum-Gardner E, et al.A randomised controlled trial testing the feasibility and efficacy of a physical activity behavioural change intervention in managing fatigue with gynaecological cancer survivors. *Gynecologic Oncology* 2011;**122**:618–24.

Emslie 2007 ***{published data only}***
Emslie C, Whyte F, Campbell A, Mutrie N, Lee L, Ritchie D, et al.'I wouldn't have been interested in just sitting round a table talking about cancer'; exploring the experiences of women with breast cancer in a group exercise trial. *Health Education Research* 2007;**22**:827–38.

Fernandez-Lao 2012 ***{published and unpublished data}***
Fernández-Lao C, Cantarero-Villanueva I, Fernández-de-Las-Peñas C, del Moral-Ávila R, Castro-Sánchez AM, Arroyo-Morales M. Effectiveness of a multidimensional physical therapy program on pain, pressure hypersensitivity, and trigger points in breast cancer survivors: a randomized controlled clinical trial. *The Clinical Journal of Pain* 2012;**28**:113–21.

Frattaroli 2008 ***{published data only}***
Frattaroli J, Weidner G, Dnistrian AM, Kemp C, Daubenmier JJ, Marlin RO, et al.Clinical events in prostate cancer lifestyle trial: results from two years of follow-up. *Urology* 2008;**72**:1319–23.

Galvao 2010 ***{published data only}***
Galvão DA, Taaffe DR, Spry N, Joseph D, Newton RU. Combined resistance and aerobic exercise program reverses muscle loss in men undergoing androgen suppression therapy for prostate cancer without bone metastases: a randomized controlled trial. *Journal of Clinical Oncology* 2010;**28**:340–7.

Galvao 2011 *{published data only}*
Galvão DA, Taaffe DR, Spry N, Joseph D, Newton RU. Acute versus chronic exposure to androgen suppression for prostate cancer: impact on the exercise response. *The Journal of Urology* 2011;**186**:1291–7.

Gomez 2011 *{published data only}*
Gómez AM, Martínez C, Fiuza-Luces C, Herrero F, Pérez M, Madero L, et al.Exercise training and cytokines in breast cancer survivors. *International Journal of Sports Medicine* 2011;**32**:461–7.

Haines 2010 *{published data only}*
Haines TP, Sinnamon P, Wetzig NG, Lehman M, Walpole E, Pratt T, et al.Multimodal exercise improves quality of life of women being treated for breast cancer, but at what cost? Randomized trial with economic evaluation. *Breast Cancer Research and Treatment* 2010;**124**:163–75.

Hayes 2011 *{published and unpublished data}*
Hayes S, Rye S, Battistutta D, Yates P, Pyke C, Bashford J, et al.Design and implementation of the Exercise for

Health trial- a pragmatic exercise intervention for women with breast cancer. *Contemporary Clinical Trials* 2011;**32**: 577–85.

Headley 2004 *{published data only}*
Headley JA, Ownby KK, John LD. The effect of seated exercise on fatigue and quality of life in women with advanced breast cancer. *Oncology Nursing Forum* 2004;**31**: 977–83.

Heim 2007 *{published data only}*
Heim ME, v d Malsburg ML, Niklas A. Randomized controlled trial of a structured training program in breast cancer patients with tumor-related chronic fatigue. *Onkologie* 2007;**30**:429–34.

Herrero 2006 *{published data only}*
Herrero F, San Juan AF, Fleck SJ, Balmer J, Pérez M, Cañete S, et al.Combined aerobic and resistance training in breast cancer survivors: a randomized, controlled pilot trial. *International Journal of Sports Medicine* 2006;**27**:573–80.

Kavanagh 2009 *{published data only}*
Kavanagh MB, von Gruenigen VE, Courneya KS, Gibbons HE, Waggoner SE, Lerner E. Effects of a lifestyle intervention on nutrient intake in overweight/obese endometrial cancer survivors. *The European e-Journal of Clinical Nutrition and Metabolism* 2009;**4**:e143–e147.

Kilbreath 2006 *{published data only}*
Kilbreath S, Refshauge K, Beith J, Lee M. Resistance and stretching shoulder exercises early following axillary surgery for breast cancer. *Rehabilitation Oncology* 2006;**24**:9–14.

Kilbreath 2012 *{published data only}*
Kilbreath SL, Refshauge KM, Beith JM, Ward LC, Lee M, Simpson JM, et al.Upper limb progressive resistance training and stretching exercises following surgery for early breast cancer: a randomized controlled trial. *Breast Cancer Research and Treatment* 2012;**133**:667–76.

Kim 2010 *{published data only}*
Kim do S, Sim YJ, Jeong HJ, Kim GC. Effect of active resistive exercise on breast cancer-related lymphedema: a randomized controlled trial. *Archives of Physical Medicine and Rehabilitation* 2010;**91**:1844–8.

Klinkhammer-Schalke 2012 *{published data only}*
Klinkhammer-Schalke M, Koller M, Steinger B, Ehret C, Ernst B, Wyatt JC, et al.Regensburg QoL Study Group. Direct improvement of quality of life using a tailored quality of life diagnosis and therapy pathway: randomised trial in 200 women with breast cancer. *British Journal of Cancer* 2012;**106**:826–38.

Ligibel 2008 *{published and unpublished data}*
Ligibel JA, Campbell N, Partridge A, Chen WY, Salinardi T, Chen H, et al.Impact of a mixed strength and endurance exercise intervention on insulin levels in breast cancer survivors. *Journal of Clinical Oncology* 2008;**26**:907–12.

Ligibel 2009 *{published and unpublished data}*
Ligibel JA, Giobbie-Hurder A, Olenczuk D, Campbell N, Salinardi T, Winer EP, et al.Impact of a mixed strength and endurance exercise intervention on levels of adiponectin, high molecular weight adiponectin and leptin in breast cancer survivors. *Cancer Causes & Control* 2009;**20**:1523–8.

MacVicar 1989 *{published data only}*
MacVicar MG, Winningham ML, Nickel JL. Effects of aerobic interval training on cancer patients' functional capacity. *Nursing Research* 1989;**38**:348–51.

Manassero 2007 *{published data only}*
Manassero F, Traversi C, Ales V, Pistolesi D, Panicucci E, Valent F, et al.Contribution of early intensive prolonged pelvic floor exercises on urinary continence recovery after bladder neck-sparing radical prostatectomy: results of a prospective controlled randomized trial. *Neurourology and Urodynamics* 2007;**26**:985-9.

McClure 2010 *{published data only}*
McClure MK, McClure RJ, Day R, Brufsky AM. Randomized controlled trial of the Breast Cancer Recovery Program for women with breast cancer-related lymphedema. *The American Journal of Occupational Therapy* 2010;**64**: 59–72.

McGuire 2011 *{published data only}*
McGuire R, Waltman N, Zimmerman L. Intervention components promoting adherence to strength training exercise in breast cancer survivors with bone loss. *Western Journal of Nursing Research* 2011;**33**:671–89.

McNeely 2004 *{published and unpublished data}*
McNeely ML, Parliament M, Courneya KS, Seikaly H, Jha N, Scrimger R, et al.A pilot study of a randomized controlled trial to evaluate the effects of progressive resistance exercise training on shoulder dysfunction caused by spinal accessory neurapraxia/neurectomy in head and neck cancer survivors. *Head and Neck* 2004;**26**:518–30.

Mock 1994 *{published data only}*
Mock V, Burke MB, Sheehan P, Creaton EM, Winningham ML, McKenney-Tedder S, et al.A nursing rehabilitation

program for women with breast cancer receiving adjuvant chemotherapy. *Oncology Nursing Forum* 1994;**21**:899–907.

Mock 1997 *{published data only}*
Mock V, Dow KH, Meares CJ, Grimm PM, Dienemann JA, Haisfield-Wolfe ME, et al.Effects of exercise on fatigue, physical functioning, and emotional distress during radiation therapy for breast cancer. *Oncology Nursing Forum* 1997;**24**:991–1000.

Mock 2005 *{published data only}*
Mock V, Frangakis C, Davidson NE, Ropka ME, Pickett M, Poniatowski B, et al.Exercise manages fatigue during breast cancer treatment: a randomized controlled trial. *Psycho-oncology* 2005;**14**:464–77.

Monga 2007 *{published data only}*
Monga U, Garber SL, Thornby J, Vallbona C, Kerrigan AJ, Monga TN, et al.Exercise prevents fatigue and improves quality of life in prostate cancer patients undergoing radiotherapy. *Archives of Physical Medicine and Rehabilitation* 2007;**88**:1416–22.

Mulero Portela 2008 *{published and unpublished data}*
Portela AL, Santaella CL, Gómez CC, Burch A. Feasibility of an exercise program for Puerto Rican women who are breast cancer survivors. *Rehabilitation Oncology* 2008;**26**: 20–31.

Mustian 2008 *{published data only}*
Mustian KM, Palesh OG, Flecksteiner SA. Tai Chi Chuan for breast cancer survivors. *Medicine and Sport Science* 2008; **52**:209–17.

Mutrie 2007 *{published and unpublished data}*
Mutrie N, Campbell AM, Whyte F, McConnachie A, Emslie C, Lee L, et al.Benefits of supervised group exercise programme for women being treated for early stage breast cancer: pragmatic randomised controlled trial. *BMJ* 2007; **334**:517.

Nieman 1995 *{published data only}*
Nieman DC, Cook VD, Henson DA, Suttles J, Rejeski WJ, Ribisl PM, et al.Moderate exercise training and natural killer cell cytotoxic activity in breast cancer patients. *International Journal of Sports Medicine* 1995;**16**:334–7.

Nikander 2007 *{published data only}*
Nikander R, Sievänen H, Ojala K, Oivanen T, Kellokumpu-Lehtinen PL, Saarto T. Effect of a vigorous aerobic regimen

on physical performance in breast cancer patients- a randomized controlled pilot trial. *Acta Oncologica* 2007;**46**: 181–6.

Ohira 2006 *{published data only}*
Ohira T, Schmitz KH, Ahmed RL, Yee D. Effects of weight training on quality of life in recent breast cancer survivors: the Weight Training for Breast Cancer Survivors (WTBS) study. *Cancer* 2006;**106**:2076–83.

Ornish 2005 *{published data only}*
Ornish D, Weidner G, Fair WR, Marlin R, Pettengill EB, Raisin CJ, et al.Intensive lifestyle changes may affect the progression of prostate cancer. *The Journal of Urology* 2005; **174**:1065–9.

Ornish 2008a *{published data only}*
Ornish D, Magbanua MJ, Weidner G, Weinberg V, Kemp C, Green C, et al.Changes in prostate gene expression in men undergoing an intensive nutrition and lifestyle intervention. *Proceedings of the National Academy of Sciences in the United States of America* 2008a;**105**:8369–74.

Ornish 2008b *{published data only}*
Ornish D, Lin J, Daubenmier J, Weidner G, Epel E, Kemp C, et al.Increased telomerase activity and comprehensive lifestyle changes: a pilot study. *The Lancet Oncology* 2008; **9**:1048–57.

Payne 2008 *{published data only}*
Payne JK, Held J, Thorpe J, Shaw H. Effect of exercise on biomarkers, fatigue, sleep disturbances, and depressive symptoms in older women with breast cancer receiving hormonal therapy. *Oncology Nursing Forum* 2008;**35**: 635–42.

Pickett 2002 *{published data only}*
Pickett M, Mock V, Ropka ME, Cameron L, Coleman M, Podewils L. Adherence to moderate-intensity exercise during breast cancer therapy. *Cancer Practice* 2002;**10**:284–92.

Rahnama 2010 *{published and unpublished data}*
Rahnama N, Nouri R, Rahmaninia F, Damirchi A, Emami H. The effects of exercise training on maximum aerobic capacity, resting heart rate, blood pressure and anthropometric variables of postmenopausal women with breast cancer. *Journal of Research in Medical Sciences* 2010; **15**:78–83.

Rogers 2009 *{published and unpublished data}*
Rogers LQ, Hopkins-Price P, Vicari S, Pamenter R, Courneya KS, Markwell S, et al.A randomized trial to increase physical activity in breast cancer survivors. *Medicine and Science in Sports and Exercise* 2009;**41**:935–46.

Rogers 2012 *{published and unpublished data}*
Rogers LQ, Fogleman A, Trammell R, Hopkins-Price P, Vicari S, Rao K, et al.Effects of a physical activity behavior change intervention on inflammation and related health outcomes in breast cancer survivors: pilot randomized trial. *Integrative Cancer Therapies* 2012;**4**(2013):323–35. [DOI: 10.1177/1534735412449687]

Sandel 2005 *{published data only}*
Sandel SL, Judge JO, Landry N, Faria L, Ouellette R, Majczak M. Dance and movement program improves quality-of-life measures in breast cancer survivors. *Cancer Nursing* 2005;**28**:301–9.

Schmitz 2009 *{published and unpublished data}*
Schmitz KH, Ahmed RL, Troxel A, Cheville A, Smith R, Lewis-Grant L, et al.Weight lifting in women with breast-cancer-related lymphedema. *New England Journal of Medicine* 2009;**361**:664–73.

Schmitz 2010 *{published and unpublished data}*
Schmitz KH, Ahmed RL, Troxel AB, Cheville A, Lewis-Grant L, Smith R, et al.Weight lifting for women at risk for breast cancer-related lymphedema: a randomized trial. *JAMA* 2010;**304**:2699–705.

Segal 2001 *{published and unpublished data}*
Segal R, Evans W, Johnson D, Smith J, Colletta S, Gayton J, et al.Structured exercise improves physical functioning in women with stages I and II breast cancer: results of a randomized controlled trial. *Journal of Clinical Oncology* 2001;**19**:657–65.

Segal 2003 *{published and unpublished data}*
Segal RJ, Reid RD, Courneya KS, Malone SC, Parliament MB, Scott CG, et al.Resistance exercise in men receiving androgen deprivation therapy for prostate cancer. *Journal of Clinical Oncology* 2003;**21**:1653–9.

Segal 2009 *{published and unpublished data}*
Segal RJ, Reid RD, Courneya KS, Sigal RJ, Kenny GP, Prud'Homme DG, et al.Randomized controlled trial of resistance or aerobic exercise in men receiving radiation therapy for prostate cancer. *Journal of Clinical Oncology* 2009;**27**:344–51.

von Gruengien 2008 *{published and unpublished data}*
von Gruenigen VE, Courneya KS, Gibbons HE, Kavanagh MB, Waggoner SE, Lerner E. Feasibility and effectiveness of a lifestyle intervention program in obese endometrial cancer patients: a randomized trial. *Gynecologic Oncology* 2008; **109**:19–26.

von Gruengien 2009 *{published and unpublished data}*
von Gruenigen VE, Gibbons HE, Kavanagh MB, Janata JW, Lerner E, Courneya KS. A randomized trial of a lifestyle intervention in obese endometrial cancer survivors: quality of life outcomes and mediators of behavior change. *Health and Quality of Life Outcomes* 2009;**7**:17.

von Gruengien 2012 *{published and unpublished data}*
von Gruenigen V, Frasure H, Kavanagh MB, Janata J, Waggoner S, Rose P, et al.Survivors of uterine cancer empowered by exercise and healthy diet (SUCCEED): a randomized controlled trial. *Gynecologic Oncology* 2012; **125**:699–704.

Waltman 2010 *{published and unpublished data}*
Waltman NL, Twiss JJ, Ott CD, Gross GJ, Lindsey AM, Moore TE, et al.The effect of weight training on bone mineral density and bone turnover in post menopausal breast cancer survivors with bone loss: a 24-month randomized controlled trial. *Osteoporosis International* 2010; **21**:1361–9.

Wang 2012 *{published data only}*
Wang Q, Suo J, Jiang J, Wang C, Zhao YQ, Cao X. Effectiveness of fast-track rehabilitation vs conventional care in laparoscopic colorectal resection for elderly patients: a randomized trial. *Colorectal Disease* 2012;**14**:1009–13.

Yang 2011 *{published data only}*
Yang CY, Tsai JC, Huang YC, Lin CC. Effects of a home-based walking program on perceived symptom and mood status in postoperative breast cancer women receiving adjuvant chemotherapy. *Journal of Advanced Nursing* 2011; **67**:158–68.

Yeo 2012 *{published and unpublished data}*
Yeo TP, Burrell SA, Sauter PK, Kennedy EP, Lavu H, Leiby BE, et al.A progressive postresection walking program significantly improves fatigue and health-related quality of life in pancreas and periampullary cancer patients. *Journal of the American College of Surgeons* 2012;**214**:463–75.

Yuen 2007 *{published and unpublished data}*
Yuen HK, Sword D. Home-based exercise to alleviate fatigue and improve functional capacity among breast cancer survivors. *Journal of Allied Health* 2007;**36**:e257–75.

References to studies awaiting assessment

Bai 2004 *{published data only}*

Chen 2010 *{published data only}*

Cho 2004 *{published data only}*

Dong 2006 *{published data only}*

Guo 2004 *{published data only}*

LeVu 1997 *{published data only}*

Oliveira 2010 *{published data only}*

Park 2006 *{published data only}*

Wang 2005 *{published data only}*

Zhang 2005 *{published data only}*

Additional references

Ainsworth 2011
Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr, Tudor-Locke C, et al.Compendium of physical activities: a second update of codes and MET values. *Medicine and Science in Sports and Exercise* 2011;**43** (8):1575–81.

Bandura 2000
Bandura A. Exercise of human agency through collective efficacy. *Current Directions in Psychological Science* 2000;**9** (3):75–8.

Bandura 2002
Bandura A. Social cognitive theory in cultural context. *Applied Psychology: An International Review* 2002;**51**: 269–90.

Bennett 2007
Bennett JA, Lyons KS, Winters-Stone K, Nail LM, Scherer J. Motivational interviewing to increase physical activity in long-term cancer survivors: a randomized controlled trial. *Nursing Research* 2007;**56**(1):18–27.

Borg 1982
Borg G A. Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise* 1982;**14**(5): 377–81.

Bourke 2011
Bourke L, Doll H, Crank H, Daley A, Rosario DJ, Saxton J. Lifestyle intervention in men with advanced prostate cancer receiving androgen suppression therapy: a feasibility study. *Cancer Epidemiology, Biomarkers and Prevention* 2011;**20**(4): 647–57.

Bourke 2012
Bourke L, Rosario D, Copeland R, Taylor S. Physical activity for cancer survivors. *BMJ* 2012;**344**:d7998.

Carver 1982
Carver CS, Scheier MF. Control theory: a useful conceptual framework for personality-social, clinical, and health psychology. *Psychological Bulletin* 1982;**92**:111–35.

Coleman 2011
Coleman MP, Forman D, Bryant H, Butler J, Rachet B, Maringe C, et al.Cancer survival in Australia, Canada, Denmark, Norway, Sweden, and the UK, 1995-2007 (the International Cancer Benchmarking Partnership): an analysis of population-based cancer registry data. Lancet 2011; Vol. 377:127–38.

Courneya 2003
Courneya KS, Friedenreich CM, Quinney HA, Fields AL, Jones LW, Fairey AS. A randomized trial of exercise and quality of life in colorectal cancer survivors. *European Journal of Cancer Care* 2003;**12**(4):347–57.

Courneya 2010
Courneya KS. Efficacy, effectiveness, and behavior change trials in exercise research. *International Journal of Behavioural Nutrition and Physical Activity* 2010;**7**:81.

Cramp 2012
Cramp F, Daniel J. Exercise for the management of cancer-related fatigue in adults. *Cochrane Database of Systematic Reviews* 2012, Issue 11. [DOI: 10.1002/14651858.CD006145.pub3]

Das and Horton 2012
Das P, Horton R. Rethinking our approach to physical activity. *Lancet* 2012;**380**:189–190.

Demark-Wahnefried 2007
Demark-Wahnefried W, Clipp EC, Lipkus IM, Lobach D, Snyder DC, Sloane R, et al.Main outcomes of the FRESH START trial: a sequentially tailored, diet and exercise mailed print intervention among breast and prostate cancer survivors. *Journal of Clinical Oncology* 2007;**25**(19):2709–18.

Department of Health 2011
Department of Health Physical Activity Health Improvement and Protection. Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers. http://www.dh.gov.uk/prod˙consum˙dh/groups/dh˙digitalassets/documents/digitalasset/dh˙128210.pdf [accessed 4 January 2012].

Department of Health 2012
Department of Health. Quality of Life of Cancer Survivors in England: report on a pilot survey using Patient Reported Outcome Measures (PROMS), 2012. https://www.gov.uk/government/uploads/system/uploads/attachment˙data/file/127273/9284-TSO-2900701-PROMS.pdf [accessed 01/02/2013].

Elliott 2011
Elliott J, Fallows A, Staetsky L, Smith PWF, Foster CL, Maher EJ, et al.The health and well-being of cancer survivors in the UK: findings from a population-based survey. *British Journal of Cancer* 2011;**105**:S11-S20.

Fong 2012
Fong DY, Ho JW, Hui BP, Lee AM, Macfarlane DJ, Leung SS, et al.Physical activity for cancer survivors: meta-analysis of randomised controlled trials. *BMJ* 2012;**344**:e70.

Galway 2012
Galway K, Black A, Cantwell M, Cardwell CR, Mills M, Donnelly M. Psychosocial interventions to improve quality of life and emotional well being for recently diagnosed cancer patients. *Cochrane Database of Systematic Reviews* 2012;**11**:CD007064.

Gardner 2011
Gardner B, de Bruijn GJ, Lally P. A systematic review and meta-analysis of applications of the Self-Report Habit Index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine* 2011;**42**:174–87.

Godin 1986
Godin G, Jobin J, Bouillon J. Assessment of leisure time exercise behavior by self-report: a concurrent validity study. *Canadian Journal of Public Health* 1986;**77**:359–62.

Greaves 2011
Greaves CJ, Sheppard KE, Abraham C, Hardeman W, Roden M, Evans PH, et al.Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC Public Health* 2011;**11**:119.

Haydon 2006
Haydon AM, Macinnis RJ, English DR, Giles GG. Effect of physical activity and body size on survival after diagnosis with colorectal cancer. *Gut* 2006;**55**(1):62–7.

Higgins 2011
Higgins JPT, Green S (Editors). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. www.cochrane-handboook.org.

Holick 2008
Holick CN, Newcomb PA, Trentham-Dietz A, Titus-Ernstoff L, Bersch AJ, Stampfer MJ, et al.Physical activity and survival after diagnosis of invasive breast cancer. *Cancer Epidemiology, Biomarkers and Prevention* 2008;**17**(2):379–86.

Holmes 2005
Holmes MD, Chen WY, Feskanich D, Kroenke CH, Colditz GA. Physical activity and survival after breast cancer diagnosis. *JAMA* 2005;**293**(20):2479–86.

Husebø 2013
Husebø AM, Dyrstad SM, Søreide JA, Bru E. Predicting exercise adherence in cancer patients and survivors: a systematic review and meta-analysis of motivational and behavioural factors. *Journal of Clinical Nursing* 2013;**22**:4–21.

Ibrahim 2011
Ibrahim EM, Al-homaidh A. Physical activity and survival after breast cancer diagnosis: meta-analysis of published studies. *Medical Oncology* 2011;**28**:753–65.

Kamangar 2006
Kamangar F, Dores GM, Anderson WF. Patterns of cancer incidence, mortality, and prevalence across five continents: defining priorities to reduce cancer disparities in different geographic regions of the world. *Journal of Clinical Oncology* 2006;**24**(14):2137–50.

Kenfield 2011
Kenfield SA, Stampfer MJ, Giovannucci E, Chan JM. Physical activity and survival after prostate cancer diagnosis in the health professionals follow-up study. *Journal of Clinical Oncology* 2011;**29**(6):726–32.

Macmillan Cancer Support 2011
Macmillan Cancer Support. Move More. http://www.macmillan.org.uk/Cancerinformation/Livingwithandaftercancer/Physicalactivity/Physicalactivity.aspx (accessed 4 January 2012).

Macmillan Cancer Support 2012
Macmillan Cancer Support. Survivorship across the UK. http://www.macmillan.org.uk/GetInvolved/Campaigns/Weareaforceforchange/Survivorship/Survivorship˙across˙the˙UK.aspx (accessed 4 January 2012).

Maddams 2009
Maddams J, Brewster D, Gavin A, Steward J, Elliott J, Utley M, et al. Cancer prevalence in the United Kingdom: estimates for 2008. *British Journal of Cancer* 2009;**101**(3): 541–7.

Martin 2001
Martin KA, Sinden AR. Who will stay and who will go? A review of older adults' adherence to randomized controlled trials of exercise. *Journal of Aging and Physical Activity* 2001; **9**:91–114.

May 2008
May AM, Van Weert E, Korstjens I, Hoekstra-Weebers JE, Van Der Schans CP, Zonderland ML, et al.Improved physical fitness of cancer survivors: a randomised controlled trial comparing physical training with physical and cognitive-behavioural training. *Acta Oncologica* 2008;**47**(5): 825–34.

McNeely 2006
McNeely ML, Campbell KL, Rowe BH, Klassen TP, Mackey JR, Courneya KS. Effects of exercise on breast cancer patients and survivors: a systematic review and meta-analysis. *Canadian Medical Association Journal* 2006;**175** (1):34–41.

Meyerhardt 2006
Meyerhardt JA, Giovannucci EL, Holmes MD, Chan AT, Chan JA, Colditz GA, et al.Physical activity and survival after colorectal cancer diagnosis. *Journal of Clinical Oncology* 2006;**24**(22):3527–34.

Meyerhardt 2009
Meyerhardt JA, Giovannucci EL, Ogino S, Kirkner GJ, Chan AT, Willett W, et al.Physical activity and male colorectal cancer survival. *Archives of Internal Medicine* 2009;**169**(22):2102–8.

Michie 2011
Michie S, Ashford S, Sniehotta FF, Dombrowski SU, Bishop A, French DP. A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: the CALO-RE taxonomy. *Psychology & Health* 2011;**26**(11):1479–98.

Mishra 2012a
Mishra SI, Scherer RW, Snyder C, Geigle PM, Berlanstein DR, Topaloglu O. Exercise interventions on health-related quality of life for people with cancer during active treatment. *Cochrane Database of Systematic Reviews.* 2012; **8**:CD008465.

Mishra 2012b
Mishra SI, Scherer RW, Geigle PM, Berlanstein DR, Topaloglu O, Gotay CC, et al.Exercise interventions on health-related quality of life for cancer survivors. *Cochrane Database of Systematic Reviews* 2012;**8**:CD007566.

NICE 2007
National Institute for Health and Clinical Excellence (NICE). NICE public health guidance 6. Behaviour change at population, community and individual levels. October 2007. http://www.nice.org.uk/PH6 (accessed 4 January 2012).

Nilsen 2006
Nilsen TI, Romundstad PR, Vatten LJ. Recreational physical activity and risk of prostate cancer: a prospective population-based study in Norway (the HUNT study). *International Journal of Cancer* 2006;**119**(12):2943–7.

Pekmezi 2011
Pekmezi DW, Demark-Wahnefried W. Updated evidence in support of diet and exercise interventions in cancer survivors. *Acta Oncologica* 2011;**50**(2):167–78.

Review Manager 2011
The Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager (RevMan). 5.1. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2011.

Richards 2011
Richards M, Corner J, Maher J. The National Cancer Survivorship Initiative: new and emerging evidence on the ongoing needs of cancer survivors. *British Journal of Cancer* 2011;**105 Suppl 1**:S1–4.

Rock 2012
Rock CL, Doyle C, Demark-Wahnefried W, Meyerhardt J, Courneya KS, Schwartz AL, et al.Nutrition and physical activity guidelines for cancer survivors. *CA: A Cancer Journal for Clinicians* 2012;**62**(4):242–74.

Sullivan 2011
Sullivan R, Peppercorn J, Sikora K, Zalcberg J, Meropol NJ, Amir E, et al.Delivering affordable cancer care in high-income countries. *Lancet Oncology* 2011;**12**(10):933–80.

Verplanken and Melkelvik 2009
Verplanken B, Melkelvik O. Predicting habit: the case of physical exercise. *Psychology of Sport and Exercise* 2009;**9**: 15–26.

Warren 2010

Warren JM, Ekelund U, Besson H, Mezzani A, Geladas N, Vanhees L, Experts Panel. Assessment of physical activity- a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. *European Journal of Cardiovascular Prevention & Rehabilitation* 2010;**17**:127–39.

Winter and Fowler 2009

Winter EM, Fowler N. Exercise defined and quantified according to the Systeme International d'Unites. *Journal of Sports Sciences* 2009;**27**(5):447–60.

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

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

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) resected 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 • Number of participants in each arm: 9 intervention, 9 control • Trial 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	• 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 • Free living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: attendance at supervised session with HR monitors, exercise diaries and Godin 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	Randomization 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

Bourke 2011a (*Continued*)

		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 2011b

Methods	• Study design: RCT participant level randomisation • Study location (WHO income taxonomy): Sheffield, UK (high) • Funding source: Sheffield Hallam University • Inclusion criteria: sedentary men with histologically confirmed, non-localised prostate cancer who had been receiving AST for at least six months • Exclusion criteria: those with unstable angina, uncontrolled hypertension, recent myocardial infarction, pacemakers and painful or unstable bony metastases, and those already undertaking regular physical activity (men engaging in purposeful exercise or physical activity of at least moderate intensity for 30 minutes or longer, three times per week), were excluded • CONSORT diagram included: yes • Number of participants in each arm: 25 intervention, 25 control • Trial recruitment rate: 50/78 • Length of follow-up: length of intervention = 12 weeks, length of follow-up from baseline = 6 months
Participants	• Primary cancer diagnosis: prostate cancer T3/T4 • Current cancer treatment: undergoing androgen suppression therapy for a minimum of six months before • Metastatic disease: yes • Age, years, mean (SD): control: 72.2 (7.7), intervention: 71.3 (6.4) • Sex: male • BMI: mean (SD): control: 27.4 (2.7), intervention: 28.0 (3.2) • Ethnicity: 100% white • Comorbidities reported: unclear
Interventions	• Group or individual intervention: group • Setting: university rehabilitation suite • Exercise prescription components: aerobic and resistance • Theoretical basis: not stated • CALO-RE taxonomy components: #8, #15, #16, #21, #26, #27 • Frequency of contact with researchers or exercise professionals: 18 supervised exercise sessions • Instructions given to controls: Men were asked to continue their current exercise/ dietary behaviours 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 2011b (*Continued*)

	• Free living energy expenditure: unclear
Process measures	• Method of measuring exercise behaviour: attendance at supervised sessions with heart rate monitors, exercise diaries and Godin LSI questionnaire • Aerobic exercise frequency: three or more times per week • Aerobic exercise duration: 30 minutes or longer per session • 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 of Perceived Exertion (RPE) Scale • Description of aerobic exercise mode: cycle/rowing ergometers, treadmill work. Plus brisk walking, cycling and gym exercise • 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% 1 RM • Description of resistance exercise: body weight resistance and free weights targeting large skeletal muscle groups
Compliance	• Intervention uptake: 25/25 • Adherence: Attendance at the supervised exercise sessions was 360 of 378 sessions (95%). Compliance with the self-directed exercise aspect of the lifestyle intervention was also very good, with 329 of 378 sessions (87%) completed (i.e. participants reporting in their log books at least 25 to 30 minutes of aerobic exercise) • Attrition: Four men in the intervention gap at 12 weeks and three men in the control group at 12 weeks were lost to follow-up. 10 men in the intervention group failed to complete six-month follow-up, 12 men in the control group failed to complete six-month follow-up. Overall, 84% and 60% of the intervention arm completed three and six months of follow-up • Adverse effects: Two men in the intervention arm were discontinued because of cardiac complications before the 12-week assessments. Two more reported musculoskeletal complaints before the six-month assessment. Five men in the control group reported various health problems that prohibited them from attending the six-month assessment • Achieves Rock et al guidelines: 6 weeks of resistance training
Description of usual care	Men randomly assigned to standard care were followed up in the urology clinic as normal and were seen by an oncology nurse specialist and a urologist
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomization was carried out remotely, using nQuery statistical software (nQuery Advisor 6.01; Statistical Solutions)

Bourke 2011b (*Continued*)

Allocation concealment (selection bias)	Low risk	Randomization 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	Physiological and functional fitness outcomes were assessed by a trained technician blinded to group allocation. Responses on the self-administered questionnaires were checked for completeness by the researcher in the presence of the respondent
Incomplete outcome data (attrition bias) All outcomes	High risk	44% attrition at six-month postintervention follow-up
Selective reporting (reporting bias)	Low risk	None; all outcomes reported
Other bias	Low risk	None

Cadmus 2009

Methods	• Study design: RCT participant level randomisation • Study location (WHO income taxonomy): US, 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 postdiagnosis, > 12 months postcompletion of adjuvant treatment, physically able to exercise with physician consent to begin an exercise programme, sedentary activity pattern (< 60 min/wk) with physician consent to begin an exercise programme • 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 • Number of participants in each arm: 37 intervention, 38 control • Trial 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	• 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: 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/wk 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 transtheoretical model stage of change. Specifically, a lower BMI and a higher degree of readiness to change physical activity behavior were associated with better adherence • Attrition: 6 of 75 in total. 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 lymphedema during the study • Achieves Rock et al guidelines: 33% reported 150 minutes/wk of moderate intensity aerobic exercise at an average of 76% HR for six months
Description of usual care	Unclear
Notes	Only YES trial 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 IM-

Cadmus 2009 (*Continued*)

		PACT 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

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 "preparers" as defined by the transtheoretical 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 • Number of participants in each arm: 34; 36; 38 (intervention; sham; control, respectively) • Trial 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	• Group or individual intervention: one-to-one supervised sessions • Setting: university rehabilitation suite • Exercise prescription components: aerobic • Theoretical basis: transtheoretical 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 behavioral 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 • 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 trials 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 trials 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): US, 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 • 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 • Number of participants in each arm: 13 intervention, 8 placebo stretching controls • Trial 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	• 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 • 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

Drouin 2005 (*Continued*)

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/wk of moderate intensity exercise (intensity was assessed by RPE) • Exclusion criteria: no other exclusion criteria were applied • CONSORT diagram included: no • Number of participants in each arm: 16 intervention, 16 control • Trial 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	• 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 lesion 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 postintervention (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

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 • Number of participants in each arm: 14, 13 (intervention vs control) • Trial recruitment rate: unclear • 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	• 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-sec 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

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): US (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 • Number of participants in each arm: 22 intervention,19 control • Trial 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	• Group or individual intervention: unclear • 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 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

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 • Trial 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 trial • 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	• Group or individual intervention: unclear • Setting: supervised • 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 kilojoules 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, tricep extension, and bicep 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
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	High risk	Adherence to prescribed exercise not reported

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 • 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 • Number of participants in each arm: flexibility group (n = 13), aerobic group (n = 12), resistance group (n = 17), aerobic and resistance group (n = 13). Overall N = 55 • Trial 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	• 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 • 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 poststudy 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
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, US (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 • Number of participants in each arm: 51 participants in total. Numbers randomly assigned to each arm are unclear • Trial 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	• Group or supervised intervention: unclear • Setting: supervised hospital-based and subsequently home-based intervention • Exercise prescription components: aerobic and resistance • Theoretical basis: transtheoretical model • CALO-RE taxonomy components: #1, #5, #8, #9, #10, #12, #15, #16, #19, #20, #21, #22, #23, #24, #25, #26, #29, #35 • 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 (bicep 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 • 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

Perna 2010 (*Continued*)

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, US (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 • Number of participants in each arm: 12 in the intervention group versus 12 in the wait list control group • Trial 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 • BMI: overall mean (SD): 26.8 (4.1) • Ethnicity: all white • Comorbidities reported: unclear
Interventions	• 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: #5, #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

Pinto 2003 (*Continued*)

	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 - "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 postassessments 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
Notes	*We estimated trial recruitment rate on the basis of numbers randomly assigned of those approached and eligible

Pinto 2003 (*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	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 subscales)

Pinto 2005

Methods	• Study design: RCT individual participant level randomisation • Study location (WHO income taxonomy): Rhode Island, US (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 • Number of participants in each arm: 43 in the intervention group and 43 in the control group • Trial 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 • Comorbidities reported: unclear
Interventions	• Group or supervised intervention: individual • Setting: home based • Exercise prescription components: aerobic • Theoretical basis: transtheoretical 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/wk) 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/h • 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 (eg, 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/h). ○ 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/wk 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
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 trial outcomes. Author advised that accelerometer data should have been reported as kcal/h)

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

Pinto 2005 (*Continued*)

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). Ojective 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, US (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/wk at moderate intensity PA or < 20 minutes/wk 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 • Number of participants in each arm: 20 in the intervention group and 26 in the control group • Trial 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 • BMI: mean (SD): control: 29.4 (6.1), intervention: 27.9 (6.0) • Ethnicity: 1 of 46 nonwhite • Comorbidities reported: unclear
Interventions	• Group or supervised intervention: individual • Setting: home based and facilitated with phone calls • Exercise prescription components: aerobic • Theoretical basis: transtheoretical 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/wk of PA 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
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

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

Study	Reason for exclusion
Ahmed 2006	Sedentary status at baseline is unclear
Ames 2011	Exercise prescription metrics are unclear

(*Continued*)

Anderson 2012	Sedentary status at baseline is unclear
Arbane 2011	Author advised that baseline sedentary status was not assessed
Battaglini 2007	Author advised that baseline sedentary status was not assessed
Battaglini 2008	Linked to Battaglini 2007
Campbell 2005	Unclear if participants were meeting the baseline moderate exercise sedentary criteria
Cantarero-Villanueva 2011	Intervention exercise prescription metrics unclear
Cantarero-Villanueva 2012	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
Cho 2006	Sedentary status at baseline is unclear
Coleman 2003	Exercise prescription metrics are unclear
Culos Reed 2010	Exercise prescription metrics are unclear
Danhauer 2009	Sedentary status at baseline is unclear
Daubenmier 2006	Linked to Ornish 2005
DeNysschen 2011	Sedentary status at baseline is unclear
Dolan 2010	START trial includes non sedentary participants
Donnelly 2011	Author advised that cohort was not sedentary at baseline.
Emslie 2007	Linked to Mutrie 2007
Fernandez-Lao 2012	Intervention exercise prescription metrics unclear
Frattaroli 2008	Linked to Ornish 2005
Galvao 2010	Sedentary status at baseline is unclear
Galvao 2011	Linked to Galvao 2010

(*Continued*)

Gomez 2011	Cohort not sedentary at baseline
Haines 2010	Sedentary status at baseline is unclear
Hayes 2011	Author advised that baseline sedentary status was not assessed
Headley 2004	Sedentary status at baseline is unclear
Heim 2007	Sedentary status at baseline is unclear
Herrero 2006	Sedentary status at baseline is unclear
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
Klinkhammer-Schalke 2012	Sedentary status at baseline is unclear
Ligibel 2008	Author advised that exercise intensity was not clear
Ligibel 2009	Linked to Ligibel 2008
MacVicar 1989	Sedentary status at baseline is unclear
Manassero 2007	Exercise prescription metrics are unclear
McClure 2010	Sedentary status at baseline is unclear
McGuire 2011	Linked to Waltman 2010
McNeely 2004	Author advised that cohort was not sedentary
Mock 1994	Sedentary status at baseline is unclear
Mock 1997	Sedentary status at baseline is unclear
Mock 2005	Sedentary status at baseline is unclear
Monga 2007	Sedentary status at baseline is unclear
Mulero Portela 2008	Author advised that baseline sedentary status was not assessed
Mustian 2008	Exercise prescription metrics are unclear

(*Continued*)

Mutrie 2007	Author advised that cohort was not sedentary at baseline
Nieman 1995	Sedentary status at baseline is unclear
Nikander 2007	Sedentary status at baseline is unclear
Ohira 2006	Linked to Schmitz 2005
Ornish 2005	Sedentary status at baseline is unclear
Ornish 2008a	Linked to Ornish 2005
Ornish 2008b	Linked to Ornish 2005
Payne 2008	Sedentary status at baseline is unclear
Pickett 2002	Sedentary status at baseline is unclear
Rahnama 2010	Author not able to confirm sedentary status
Rogers 2009	Author advised that cohort was not sedentary at baseline
Rogers 2012	Author advised that cohort was not sedentary at baseline
Sandel 2005	Sedentary status at baseline is unclear
Schmitz 2009	Author advised intensity not assessed
Schmitz 2010	Author advised intensity not assessed
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
von Gruengien 2008	Author advised that cohort was not sedentary at baseline
von Gruengien 2009	Linked to von Gruengien 2008
von Gruengien 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
Yang 2011	Sedentary status at baseline is unclear

(*Continued*)

Yeo 2012	Author not able to clarify exercise metrics
Yuen 2007	Author advised that cohort was not sedentary at baseline

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

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

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	

Oliveira 2010 (*Continued*)

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)	7	330	Std. Mean Difference (IV, Fixed, 95% CI)	0.73 [0.51, 0.95]
2 Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up sensitivity analysis)	3	154	Std. Mean Difference (IV, Fixed, 95% CI)	0.84 [0.51, 1.17]
3 Aerobic exercise tolerance (all cancers: 6 months)	5	271	Std. Mean Difference (IV, Fixed, 95% CI)	0.70 [0.45, 0.94]

Comparison 2. Strength tests (all cancers)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Strength tests	3	91	Std. Mean Difference (IV, Fixed, 95% CI)	0.51 [0.09, 0.93]
2 Strength tests (all cancers: sensitivity analysis)	2	68	Std. Mean Difference (IV, Fixed, 95% CI)	0.47 [-0.01, 0.96]

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

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

Comparison: 1 Aerobic exercise tolerance

Outcome: 1 Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up)

Study or subgroup	Experimental N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Fixed,95% CI	Weight	Std. Mean Difference IV,Fixed,95% CI
Bourke 2011a	9	528.2 (114.5)	9	376.7 (125.7)		4.8 %	1.20 [0.18, 2.22]
Bourke 2011b	25	495.8 (125)	25	379.8 (129.2)		14.8 %	0.90 [0.31, 1.48]
Daley 2007a	33	35 (4.4)	33	31.5 (5.1)		20.2 %	0.73 [0.23, 1.23]
Kim 2006	22	1810.1 (369.4)	19	1630.4 (351.5)		12.9 %	0.49 [-0.14, 1.11]
Musanti 2012	11	24.7 (4.1)	12	23 (4.3)		7.4 %	0.39 [-0.44, 1.22]
Pinto 2005	43	-16.3 (2.1)	43	-17.9 (2.2)		26.3 %	0.74 [0.30, 1.17]
Pinto 2011	20	27.7 (5.3)	26	23.7 (4.7)		13.7 %	0.79 [0.18, 1.40]
Total (95% CI)	**163**		**167**			**100.0 %**	**0.73 [0.51, 0.95]**

Heterogeneity: Chi^2 = 2.40, df = 6 (P = 0.88); I^2 =0.0%

Test for overall effect: Z = 6.38 (P < 0.00001)

Test for subgroup differences: Not applicable

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

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

Comparison: 1 Aerobic exercise tolerance

Outcome: 2 Aerobic exercise tolerance (all cancers: 8 to 12 weeks of follow-up sensitivity analysis)

Study or subgroup	Experimental N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Fixed,95% CI	Weight	Std. Mean Difference IV,Fixed,95% CI
Bourke 2011a	9	528.2 (114.5)	9	376.7 (125.7)		10.5 %	1.20 [0.18, 2.22]
Bourke 2011b	25	495.8 (125)	25	379.8 (129.2)		32.2 %	0.90 [0.31, 1.48]
Pinto 2005	43	-16.3 (2.1)	43	-17.9 (2.2)		57.4 %	0.74 [0.30, 1.17]
Total (95% CI)	**77**		**77**			**100.0 %**	**0.84 [0.51, 1.17]**

Heterogeneity: $Chi^2 = 0.72$, df = 2 (P = 0.70); $I^2 = 0.0\%$

Test for overall effect: Z = 4.95 (P < 0.00001)

Test for subgroup differences: Not applicable

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

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

Comparison: 1 Aerobic exercise tolerance

Outcome: 3 Aerobic exercise tolerance (all cancers: 6 months)

Study or subgroup	Experimental N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Fixed,95% CI	Weight	Std. Mean Difference IV,Fixed,95% CI
Bourke 2011b	25	435.8 (118.5)	25	351 (114.4)		18.5 %	0.72 [0.14, 1.29]
Daley 2007a	31	33.8 (4.8)	31	30.5 (4)		22.9 %	0.74 [0.22, 1.25]
Kaltsatou 2011	14	483.3 (85.9)	13	403.1 (71.9)		9.4 %	0.98 [0.17, 1.78]
Pinto 2005	43	-16.79 (1.7)	43	-17.71 (1.6)		32.7 %	0.55 [0.12, 0.98]
Pinto 2011	20	28.4 (5.5)	26	24.4 (5)		16.6 %	0.75 [0.15, 1.36]
Total (95% CI)	**133**		**138**			**100.0 %**	**0.70 [0.45, 0.94]**

Heterogeneity: $Chi^2 = 0.96$, df = 4 (P = 0.92); $I^2 = 0.0\%$

Test for overall effect: Z = 5.55 (P < 0.00001)

Test for subgroup differences: Not applicable

Analysis 2.1. Comparison 2 Strength tests (all cancers), Outcome 1 Strength tests.

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

Comparison: 2 Strength tests (all cancers)

Outcome: 1 Strength tests

Study or subgroup	Experimental N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Fixed,95% CI	Weight	Std. Mean Difference IV,Fixed,95% CI
Bourke 2011a	9	189.2 (27.7)	9	169 (45.6)		19.7 %	0.51 [-0.43, 1.45]
Bourke 2011b	25	190.3 (40.9)	25	169.2 (48.8)		55.5 %	0.46 [-0.10, 1.02]
Musanti 2012	11	48.3 (14.8)	12	36.75 (20)		24.8 %	0.63 [-0.21, 1.47]
Total (95% CI)	**45**		**46**			**100.0 %**	**0.51 [0.09, 0.93]**

Heterogeneity: Chi² = 0.10, df = 2 (P = 0.95); I² =0.0%

Test for overall effect: Z = 2.40 (P = 0.017)

Test for subgroup differences: Not applicable

Analysis 2.2. Comparison 2 Strength tests (all cancers), Outcome 2 Strength tests (all cancers: sensitivity analysis).

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

Comparison: 2 Strength tests (all cancers)

Outcome: 2 Strength tests (all cancers: sensitivity analysis)

Study or subgroup	Experimental N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Fixed,95% CI	Weight	Std. Mean Difference IV,Fixed,95% CI
Bourke 2011a	9	189.2 (27.7)	9	169 (45.6)		26.2 %	0.51 [-0.43, 1.45]
Bourke 2011b	25	190.3 (40.9)	25	169.2 (48.8)		73.8 %	0.46 [-0.10, 1.02]
Total (95% CI)	**34**		**34**			**100.0 %**	**0.47 [-0.01, 0.96]**

Heterogeneity: Chi² = 0.01, df = 1 (P = 0.93); I² =0.0%

Test for overall effect: Z = 1.92 (P = 0.054)

Test for subgroup differences: Not applicable

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/ wk 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	No	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 aver-	Unclear	No	Yes	None reported

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

				aged 3.6 days per week of aerobic exercise over an 8-week period				
Kaltsatou 2011	Aerobic	14, 13 (intervention vs control)	Unclear	Not reported	Not reported	Yes; method of measuring exercise and adherence not reported	No	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 session. Overall adherence was 78.3% ± 20.1%	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 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 trial these date relate
Pinto 2003	Aerobic	12, 12 (intervention vs control)	Unclear	Participants attended a mean of 88% of the 36-session supervised exercise pro-	Yes	Yes; 38% lost to follow-up. Exercise tolerance test was performed but no con-	Yes	None reported; however, it is unclear why the six controls dropped out

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

				gramme		trol group comparison data were reported		
Pinto 2005	Aerobic	43, 43 (intervention vs control)	Unclear	At week 12, intervention participants reported a mean of 128.53 minutes/wk of moderate intensity exercise. However, no changes were reported in the accelerometer data in the intervention group (change score = -0.33 kcal/h)	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 guidelines at three months	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*)

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
Bourke 2011b	Aerobic and resistance	25, 25 (intervention vs control)	Six weeks of resistance exercise twice a week	95% attendance at supervised exercise sessions. Compliance with self-directed exercise aspect of the lifestyle intervention was 87%	Yes	Yes; high dropout rate at postintervention six-month follow-up assessment	Yes	Two men in the intervention arm were discontinued because of cardiac complications before the 12-week assessments. Two more reported musculoskeletal complaints before the six-month assessment. Five men reported various health problems in the control group that prohibited them from attending the six-month assessment
Hayes 2009	Aerobic and resistance	16, 16 (intervention vs control)	Unclear	Most women (88%) allocated to the intervention	Unclear	Yes; adherence data on unsupervised aspect of the inter-	No	None reported

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

				group participated in 70% or more of scheduled supervised exercise sessions		vention are not clear		
McKenzie 2003	Aerobic and resistance	7, 7 (intervention vs control)	No	Unclear	Unclear	Yes; adherence to exercise not reported	No	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 supervised hospital-based exercise sessions (only 4	Unclear	Yes; numbers randomly assigned to intervention and control groups are unclear, as are numbers completing in each arm	No	Unclear

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

				weeks in duration), and 76.9% completed all 12 sessions. Home-based component (8 weeks in duration)				

AET = aerobic exercise tolerance.

Table 2. Behaviour change components

Behaviour change technique	Bourke 2011a	Bourke 2011b	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. 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	X
5. Goal setting (behaviour)			X	X						X		X	X	X
6. Goal setting (outcome)														
7. Action planning														
8. Barrier iden-		X	X	X						X			X	X

Table 2. Behaviour change components (*Continued*)

tification/ Problem solving													
9. Setting of graded tasks			X	X		X	X	X	X	X		X		X
10. Prompt review of behaviour 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 contin-				X										

Table 2. Behaviour change components (*Continued*)

gent on successful behaviour														
14. Shaping														
15. Prompt generalisation of a target behaviour	X	X	X							X		X		
16. Prompt self-monitoring of behaviour	X	X	X	X	X				X	X		X	X	X
17. Prompt self-monitoring of behaviour outcome			X	X	X				X				X	X
18. Prompt focus on past success				X										
19. Feedback			X							X			X	X

Table 2. Behaviour change components (*Continued*)

on performance provided														
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				X						X				X

Table 2. Behaviour change components (*Continued*)

cues														
24. Environmental restructuring										X				X
25. Agreement on behaviour 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	X												
28. Facilitating social comparison														
29. Planning social support/ social change			X	X						X				
30. Prompt iden-														

Table 2. Behaviour change components (*Continued*)

tification 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						X				
36. Stress management/ emotional control											X			

Table 2. Behaviour change components (*Continued*)

training														
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 = transtheroretical model.

APPENDICES

Appendix 1. CENTRAL search strategy

#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

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

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
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

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 Ovid
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

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

Appendix 8. 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

CONTRIBUTIONS OF AUTHORS

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

DECLARATIONS OF INTEREST

The authors have no conflicts of interest to report.

SOURCES OF SUPPORT

Internal sources

- None, Not specified.

External sources

- None, Not specified.

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 have provided a justification for exclusion of cross-over trials and for when during the screening process they were screened out (please see Unit of analysis issues).

- We did not examine funnel plots because too few studies were identified (please see Assessment of risk of bias in included studies).

- We reported only a subset of excluded trials because of the large number of manuscripts that needed to be full text screened and the large proportion of these that were excluded (please see Excluded studies).

- We highlighted when a manuscript reported insufficient information to allow judgement of an aspect of bias (please see Other potential sources of bias).

- We were not able to find any trials 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.