

The Effectiveness of Exercise Interventions for Improving Health-Related Quality of Life From Diagnosis Through Active Cancer Treatment

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About 1.6 million Americans faced a new diagnosis of cancer in 2014 (American Cancer Society, 2014). Most of those individuals will undergo one or more cancer treatments, such as surgery, radiation, chemotherapy, hormone therapy, immunotherapy, targeted treatments, or bone marrow transplantation. In addition to possibly curing or mitigating the effects of the disease, cancer therapies may affect the well-being of people with cancer during the weeks, months, or years of the treatment regimen.

Quality of life, or health-related quality of life (HRQOL) when used in reference to medical conditions and treatments, refers to a person's overall functioning and well-being. HRQOL is subjective and multidimensional and includes psychological, social, physical, spiritual, and occupational functioning, as well as somatic experiences, such as symptoms (International Society for Quality of Life Research [ISOQOL], 2013). With a diagnosis or active treatment, people with cancer experience many adverse outcomes that negatively affect HRQOL (Aziz, 2007; Aziz & Rowland, 2003; Cramp & Byron-Daniel, 2012; Ganz et al., 2004; Lee et al., 2007).

The benefits of exercise for a number of outcomes, including health status, length of survival, HRQOL, and risk of premature death, are gaining attention (Cramp & Byron-Daniel, 2012; Stevinson, Lawlor, & Fox, 2004; Warburton, Nicol, & Bredin, 2006). Despite this large and growing body of evidence documenting exercise's beneficial effects (Courneya & Friedenreich, 2007), people with cancer often participate in low levels of exercise or do not exercise at all (Blanchard et al., 2003; Courneya & Friedenreich, 2007). Systematic reviews on the effects of exercise interventions immediately before or during active cancer treatment exist (Cramp & Byron-Daniel, 2012; McNeely et al., 2006; Stevinson et al., 2004); however, no systematic review has examined the effect of exercise on (a) overall HRQOL, HRQOL

Purpose/Objectives: To evaluate the effectiveness of exercise interventions on overall health-related quality of life (HRQOL) and its domains among adults scheduled to, or actively undergoing, cancer treatment.

Data Sources: 11 electronic databases were searched through November 2011. In addition, the authors searched PubMed's related article feature, trial registries, and reference lists of included trials and related reviews.

Data Synthesis: 56 trials with 4,826 participants met the inclusion criteria. At 12 weeks, people exposed to exercise interventions had greater improvement in overall HRQOL, physical functioning, role functioning, social functioning, and fatigue. Improvement in HRQOL was associated with moderate-to-vigorous intensity exercise interventions.

Conclusions: Exercise can be a useful tool for managing HRQOL and HRQOL domains for people scheduled to, or actively undergoing, cancer treatment. More methodologically rigorous trials are needed to examine the attributes of exercise programs most effective for improving HRQOL.

Implications for Nursing: Evidence from this review supports the incorporation of exercise programs of moderate-to-vigorous intensity for the management of HRQOL among people scheduled to, or actively undergoing, cancer treatment into clinical guidelines through the Oncology Nursing Society's Putting Evidence Into Practice resources.

Key Words: quality of life; health status; anxiety; depression; fatigue; exercise; survivors; yoga; resistance training; physical activity

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domains (e.g., physical, psychological, economic, social, spiritual well-being), or both; or (b) disease- or treatment-related symptoms (e.g., chronic fatigue) among adults with cancer immediately before or during active cancer treatment.

This review, originally published as a Cochrane systematic review (Mishra, Scherer, Snyder, et al., 2012), seeks to answer the question: What are the effects of exercise interventions on HRQOL and HRQOL domains

in adults from diagnosis through their active cancer treatment period? This review complements the authors' review on the effects of exercise interventions on HRQOL or its domains among people who had completed cancer treatment (Mishra, Scherer, Geigle, et al., 2012).

Methods

Eligibility Criteria

The authors included randomized, controlled trials (RCTs) and quasi-randomized, controlled clinical trials that assessed and reported on effects of exercise interventions on HRQOL or a HRQOL domain as an outcome among people undergoing treatment or scheduled to initiate treatment. Additional inclusion criteria were that participants were diagnosed with cancer as adults (aged 18 years and older) and that the trials compared exercise with no exercise, another intervention, or usual care (e.g., with no specific exercise program prescribed). The authors excluded trials that included people who were terminally ill, receiving hospice care, or both; and trials in which fewer than one-third of the participants were undergoing treatment for either the primary or recurrent cancer.

The authors used the American College of Sports Medicine (1998, 2005) definition for exercise: any physi-

cal activity causing an increase in energy expenditure involving a planned or structured movement of the body performed in a systematic manner in terms of frequency, intensity, and duration, and designed to maintain or enhance health-related outcomes. Exercise intensity was based on the American College of Sports Medicine (2005) definition. When a quantitative measure of exercise intensity (e.g., rate of perceived exertion or heart rate) was not available, the authors' classification of the exercise intervention as mild, moderate, or vigorous was used.

Patient-reported outcomes from the included trials were categorized into four follow-up intervals (12 weeks, greater than 12 weeks but less than 6 months, 6 months, and greater than 6 months following the exercise intervention) and included overall HRQOL; HRQOL domains including physical function, psychological function, social and economic role function, spiritual well-being, pain, vitality, general health perceptions, and positive attributes; and disease- and treatment-related symptoms.

Information Sources and Data Collection

The Cochrane review (Mishra, Scherer, Snyder, et al., 2012) described the search strategy in detail. In brief, the authors conducted a comprehensive search of 11 electronic databases through November 2011, without any date or language limits, to obtain eligible trials for the review. Following an initial screening of titles and abstracts, reviewer pairs independently read full-text copies of trials scored as eligible or possibly eligible to confirm eligibility (see Figure 1) and then extracted data from eligible trials using a standardized data collection form. For each included study, the parameters of the Cochrane risk-of-bias tool for RCTs and controlled clinical trials were graded as having high, low, or an unclear risk of bias (Higgins, Altman, & Sterne, 2001). Mishra, Scherer, Snyder, et al. (2012) offers details on these parameters. Differences between paired reviewers were resolved through consensus or the involvement of a third reviewer. The authors attempted to contact trial authors for missing or additional data.

Data Synthesis and Analysis

The authors combined data from trials in a meta-analysis if the data showed no significant clinical heterogeneity. All trials were pooled for a random-effects meta-analysis to determine the pooled intervention effect estimate (odds ratio [OR] and 95% confidence interval [CI]). Because authors reported trial results either as change in score from baseline to follow-up or follow-up values, meta-analyses for both types of measures and for each follow-up time period were completed. In addition, a weighted mean difference (WMD) was used when trials measured the HRQOL

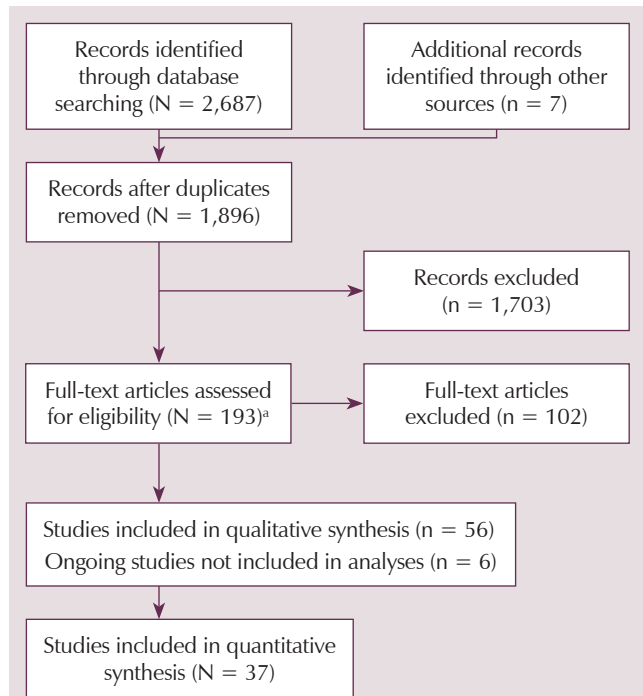


Figure 1. PRISMA Flow Diagram of Study Selection Process

outcome using the same measure or scale and used a standardized mean difference (SMD) when trials measured the HRQOL outcome using different measures or scales. Differences in this type of analysis are reported in terms of units of standard deviation. Although sometimes difficult to interpret, this analysis allows comparisons across numerous instruments measuring the same concept. In addition, a qualitative rather than quantitative analysis of HRQOL or HRQOL domains was performed when significant clinical or statistical heterogeneity was noted. Prespecified subgroup analyses of treatment effect were based on exercise intensity (mild, moderate, or vigorous) and cancer type (breast cancer versus other cancers). The unit of analysis was the person with cancer randomized to each arm of the trial. See Mishra, Scherer, Snyder, et al. (2012) for additional details on the data synthesis and analysis, as well as subgroup analysis strategies.

Results

Trial Characteristics

The authors identified 1,896 unique trials, of which 56 met the eligibility criteria and were included in the qualitative synthesis; 37 of these trials were included in the meta-analyses. The majority of trials ($n = 54$) were parallel RCTs. One trial (Courneya et al., 2003) randomized clusters of psychotherapy classes and two trials (Dimeo et al., 1999; Mock et al., 1997) used a quasi-experimental design. The majority of trials ($n = 52$) were two-arm trials (exercise and comparison arms); four trials were three-arm trials that included a variation of the exercise arm such as aerobic or resistance (Courneya et al., 2007; Segal et al., 2009), yoga or stretching (Haddad et al., 2011), or home-based or

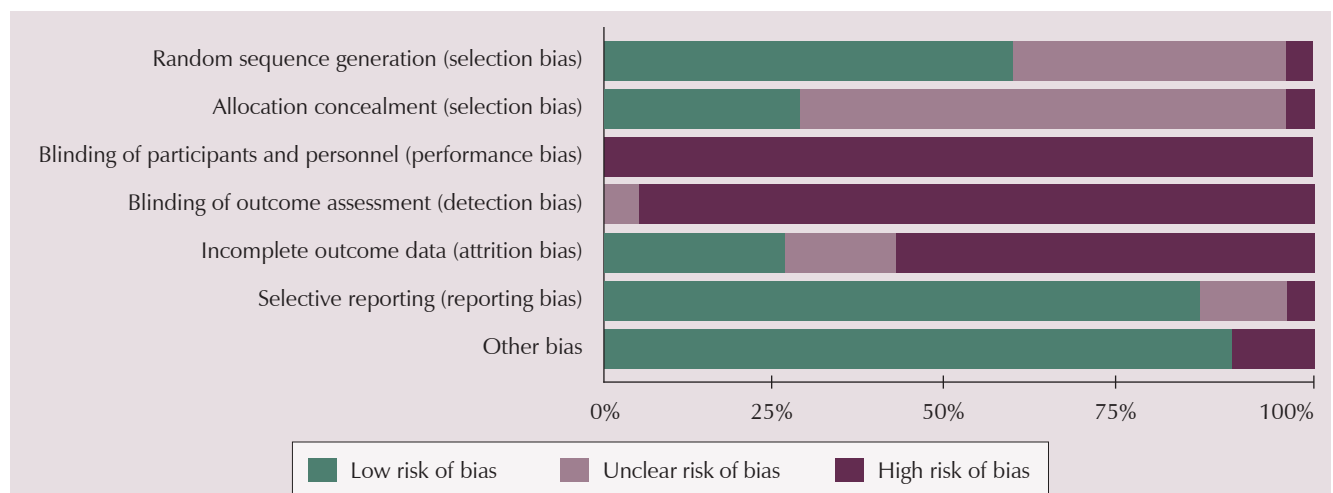
supervised exercise (Segal et al., 2001). See Appendix A for details on trial characteristics.

Participants

Of the 4,826 participants randomized in each trial to the exercise or comparison arms, 2,286 (range = 9–337) were randomized to the exercise and 1,985 (range = 5–134) to the comparison group. Six trials did not report the number of participants randomized to the exercise or comparison arms. Thirty trials investigated participants with breast cancer only. Thirty-six trials were conducted among participants who were currently undergoing treatment, 10 trials were conducted among participants scheduled to undergo treatment, and the remaining 10 trials were conducted among participants during and after cancer treatment, where at least two-thirds of the participants were still undergoing active treatment.

Intervention

The included trials prescribed exercise programs such as walking, yoga, resistance or strength training, conditioning exercises, or some combination. Thirty-two trials implemented an aerobic exercise program, and 14 trials implemented a combined aerobic and anaerobic program. Forty-one trials reported a definite length of the exercise intervention, which ranged from 3 (Chang et al., 2008; Cheville et al., 2010) to 26 weeks (Cadmus et al., 2009; Segal et al., 2001), and an additional 13 trials linked the length of the exercise intervention to the duration of hospitalization or cancer treatment. Thirty-three trials assessed HRQOL or HRQOL domains immediately following the exercise intervention. Methods to measure exercise intensity varied, with the majority of trials ($n = 28$) using a relatively objective intensity



Note. This graph represents the review authors' judgments about each risk of bias item presented as percentages across all included studies.

Figure 2. Risk of Bias

measure (i.e., age-predicted maximum heart rate, maximal oxygen consumption, or Borg scale).

Risk of Bias Within Trials

The risk of bias across all trials was moderate to high. Because it was impossible to conceal assignment to the exercise program, all trials demonstrated a high risk of performance bias, in which systematic differences in outcomes measures are the result of knowing the intervention assigned to a study participant. Several of the trials also were subject to detection, attrition, and selection bias (see Figure 2).

Effects of the Interventions

Various instruments were used to measure HRQOL or HRQOL domains in the included trials. (For a complete listing of these instruments, please contact the first author of this article.) These were grouped by domain for analyses. The included trials showed differences in HRQOL and HRQOL domains as measured at different time points between baseline and follow-up. Results were reported as change from baseline or simply as follow-up scores. The authors preferentially report pooled results for change scores as these take into account baseline variability. Because trials reported data using different time periods and types of measures, the authors conducted a large number of meta-analyses, leading to the possibility of spurious significant results. To interpret the data, the authors present all results in Table 1 to assess the consistency of effects across various time frames and different types of measures. Consistent results lead the authors to be more confident in a finding of significant results.

Overall Health-Related Quality of Life

Changes in HRQOL scores from baseline to follow-up demonstrated that overall HRQOL following an exercise intervention was significantly higher compared with a control intervention at 12 weeks, but not at follow-up between 12 weeks and 6 months or at 6 months (see Table 2). Similar results were found when the authors looked at HRQOL follow-up scores rather than change in scores from baseline to follow-up.

Similar results were reported in four trials without extractable data (Brown et al., 2006; DiSipio et al., 2009; Gomes et al., 2011; Headley et al., 2004). However, in some cases, the difference in HRQOL was reported as less of a decrease rather than an increase in HRQOL during treatment.

Given the presence of significant heterogeneity in the meta-analysis at a 12 week follow-up (insufficient data available for longer follow-up periods), the authors assessed whether there was an intervention effect in the prespecified subgroups. Participants with cancers other than breast cancer (SMD = 0.55; 95% CI [0.19, 0.92]), but

not those with breast cancer (SMD = 0.4; 95% CI [-0.11, 0.92]), showed a positive effect with exercise. A moderate-to-vigorous exercise intervention showed a significant effect on HRQOL at 12 weeks (SMD = 0.51; 95% CI [0.13, 0.89]) in contrast to mild intensity exercise, which showed no difference (SMD = 0.45; 95% CI [-0.3, 1.19]).

Health-Related Quality of Life Domains

The following HRQOL domains showed consistency across follow-up time periods or types of measures.

Fatigue: A significant effect of exercise on reducing fatigue was observed at 12 weeks, whether measured as difference between baseline and follow-up or as scores at follow-up. Although a significant change in fatigue was not observed at longer follow-up times when looking at the difference between baseline and follow-up scores, the authors did note a significant effect at longer time points when reported as follow-up scores.

Subgroup analyses showed a positive effect from exercise on fatigue in participants with cancers other than breast cancer at 12 weeks (SMD = -0.72; 95% CI [-1.23, -0.2]), but not for breast cancer survivors. Exercise also showed a positive effect when reported as moderate-to-vigorous intensity, but only at the 12-week follow-up (SMD = -0.93; 95% CI [-1.6, -0.26]). The effect of exercise remained significant when the authors excluded trials with participants who had completed treatment (SMD = -0.78; 95% CI [-1.29, -0.27]).

Physical functioning: The effect of exercise on physical functioning was consistent at 12 weeks and at 6 months whether measured as difference between baseline and follow-up or as scores at follow-up. This effect, however, was not present at follow-up between 12 weeks and 6 months. There were no significant effects of the exercise intervention on physical functioning based on subgroups by type of cancer or intensity of exercise (data not shown). Three of four trials in which the current authors were unable to extract data also reported a significant difference between treatment groups in physical functioning (Haddad et al., 2011; Mock et al., 1997; Oh et al., 2008) and one reported no difference (Headley et al., 2004).

Role function: Pooling results of trials evaluating role function showed a significant effect of exercise on role function compared with control for change from baseline to the 12-week follow-up and differences in follow-up scores at 12 weeks and 6 months but not at other time points. Subgroup analyses (data not shown) revealed a significant effect for trials examining types of cancer other than breast (SMD = 0.58; 95% CI [0.04, 1.12]), and when excluding trials that included participants who had completed treatment (SMD = 0.75; 95% CI [0.14, 1.36]) when looking at change from baseline to 12-week follow-up. No effect of exercise intensity was noted. Role function also was measured in two trials

Table 1. Standardized or Weighted Mean Differences and 95% Confidence Interval (CI) Between Control and Exercise Group for Health-Related Quality of Life (HRQOL) and Its Domains by Time Points

Domain	Change in Scores From Baseline to 12 Weeks		Scores at 12 Weeks		Change in Scores From Baseline to > 12 Weeks and Up to 6 Months		Scores at > 12 Weeks and Up to 6 Months		Change in Scores From Baseline to 6 Months		Scores at 6 Months	
	\bar{X}	95% CI	\bar{X}	95% CI	\bar{X}	95% CI	\bar{X}	95% CI	\bar{X}	95% CI	\bar{X}	95% CI
HRQOL	0.47	[0.16, 0.79]	0.33	[0.12, 0.55]	1.25	[-0.03, 2.53]	0.25	[0.07, 0.43]	0.14	[-0.11, 0.39]	0.13	[-0.09, 0.35]
Anxiety	-0.17	[-0.41, 0.06]	-0.4	[-0.81, -0.11]	-0.16	[-0.44, 0.12]	-0.2	[-0.57, 0.17]	-0.18	[-0.49, 0.12]	-0.44	[-0.71, -0.17]
Body image	–	–	0.29	[-0.06, 0.64]	0.41	[0.12, 0.69]	0.21	[-0.07, 0.49]	0.2	[-0.06, 0.47]	0.19	[-0.08, 0.45]
Breast cancer concerns ^a	-0.37	[-1.93, 1.2]	1.21	[-0.65, 3.07]	–	–	–	–	0.24	[-1.6, 2.08]	1.45	[0.08, 2.81]
Cognitive function	-0.21	[-0.6, 0.19]	-0.16	[-0.31, -0.01]	–	–	-0.26	[-0.79, 0.27]	-0.23	[-0.89, 0.43]	-0.32	[-0.84, 0.2]
Depression	-0.27	[-0.61, 0.08]	-0.55	[-0.87, -0.22]	-0.04	[-0.32, 0.24]	-0.21	[-0.43, 0.01]	-0.08	[-0.35, 0.19]	-0.29	[-0.48, -0.09]
Emotional well-being	0.52	[-0.04, 1.07]	0.05	[-0.18, 0.28]	–	–	0.59	[0.12, 1.07]	-0.17	[-0.46, 0.11]	0.25	[-0.08, 0.57]
Fatigue	-0.73	[-1.14, -0.31]	-0.38	[-0.57, -0.18]	-0.11	[-0.37, 0.14]	-0.19	[-0.33, -0.05]	0.03	[-0.14, 0.19]	-0.18	[-0.35, -0.00]
General health perspective	1.03	[-1.16, 3.21]	0.33	[0.01, 0.64]	–	–	0.2	[-0.32, 0.73]	0.09	[-0.2, 0.37]	0.05	[-0.43, 0.54]
Pain	1.68	[-1.48, 4.84]	-0.2	[0.41, 0.00]	-0.09	[-0.49, 0.26]	-0.17	[-0.39, 0.06]	-0.08	[-0.24, 0.45]	-1.05	[-1.83, -0.26]
Physical function	0.69	[0.16, 1.22]	0.28	[0.11, 0.45]	-0.18	[-0.53, 0.17]	0.33	[-0.17, 0.82]	0.28	[8.18, 0.55]	0.29	[0.07, 0.5]
Prostate cancer concerns	0.41	[0.15, 0.67]	0.22	[-0.04, 0.48]	0.28	[-0.1, 0.65]	0.27	[-0.04, 0.58]	–	–	–	–
Role function	0.48	[0.07, 0.9]	0.17	[8.55, 0.34]	–	–	0.32	[-0.37, 1]	0.07	[-0.46, 0.6]	0.32	[0.03, 0.61]
Sleep disturbance	-0.55	[-1.95, 0.85]	-0.4	[-0.67, -0.14]	–	–	-0.36	[-0.86, 0.14]	-0.11	[-0.76, 0.55]	-0.69	[-1.45, 0.07]
Social functioning	0.54	[0.03, 1.05]	0.16	[0.04, 0.27]	–	–	0.09	[-0.26, 0.44]	-0.07	[-0.42, 0.29]	0.24	[0.03, 0.44]
Spiritual function	0.01	[-0.3, 0.31]	0.46	[0.14, 0.77]	–	–	–	–	–	–	–	–

^a All values reported for breast cancer concerns are weighted mean differences.

Note. Values are reported as change in score on HRQOL from baseline to follow-up or as scores recorded on HRQOL forms at follow-up visits. Positive values indicate an improvement in HRQOL or its domains except for fatigue, anxiety, depression, cognitive function, pain, and sleep disturbance. In these cases a negative value indicates an improvement in HRQOL domain.

Note. Significant findings are in bold. If no data were provided for a time point, the cell contains a dash.

from which the current authors were unable to extract data; those trials reported no change in role function in either the exercise or control group (Headley et al., 2004; Oh et al., 2008).

Social functioning: The authors observed a significant effect of exercise compared with a control intervention on social functioning at the 12-week follow-up, whether measured as the pooled result of

Table 2. Overall HRQOL Change Score at Follow-Up

Study or Subgroup	Exercise			Control			Weight (%)	Standard \bar{X} Difference
	\bar{X}	SD	Total	\bar{X}	SD	Total		IV, Random, 95% CI
1.1.1 Up to 12 Weeks ^a								
Arbane et al., 2009	-0.79	14.65	21	4.35	21.6	23	8.3	-0.27 [-0.87, 0.32]
Campbell et al., 2005	11.9	13.8	10	-2.9	16.1	9	5.6	0.95 [-0.01, 1.91]
Courneya et al., 2008	13.4	27	26	20.3	29.1	29	8.8	-0.24 [-0.77, 0.29]
Monga et al., 2007	7.4	10.4	11	-6.4	9.8	10	5.6	1.31 [0.35, 2.27]
Mustain et al., 2009	6	18.3	19	-0.67	11.51	19	7.9	0.43 [-0.22, 1.07]
Oh et al., 2010	8.86	9	54	-0.13	8.6	54	9.9	1.01 [0.61, 1.42]
Rogers et al., 2009	4.5	8.4	20	2.9	12	18	7.9	0.15 [-0.49, 0.79]
Segal et al., 2003	2	9.1	82	-3.3	10.2	73	10.5	0.55 [0.23, 0.87]
Segal et al., 2009	2.27	8.8	40	-2.48	8.5	20	8.7	0.54 [-0.01, 1.08]
Segal et al., 2009	0.75	8.4	40	-2.48	8.5	21	8.8	0.38 [-0.15, 0.91]
Targ & Levine, 2002	4.98	16.1	79	6.62	21.7	88	10.6	-0.08 [-0.39, 0.22]
Yang et al., 2011	1.41	1.4	19	-0.23	0.36	21	7.3	1.61 [0.89, 2.33]
Subtotal	-	-	421	-	-	385	100	0.47 [0.16, 0.79]
1.1.2 More Than 12 Weeks to Less Than 6 Months ^b								
Courneya & Friedenreich, 2007	4.8	23.3	74	-1	13.7	36	20.4	0.28 [-0.12, 0.68]
Courneya & Friedenreich, 2007	5.9	25.6	76	-1	13.7	37	20.4	0.31 [-0.09, 0.7]
Culos-Reed et al., 2010	2.7	0.9	53	-2.33	0.88	47	19	5.6 [4.72, 6.49]
Mustain et al., 2009	8.76	16.51	19	8.55	11.28	19	19.8	0.01 [-0.62, 0.65]
Segal et al., 2009	2.35	7.5	40	-0.17	7.5	41	20.3	0.33 [-0.11, 0.77]
Subtotal	-	-	262	-	-	180	100	1.25 [-0.03, 2.53]
1.1.3 6 Months ^c								
Courneya & Friedenreich, 2007	20.1	26.8	68	18.2	25.69	30	33.7	0.07 [-0.36, 0.5]
Courneya & Friedenreich, 2007	20.5	27	73	18.2	25.69	30	34.4	0.09 [-0.34, 0.51]
Donnelly et al., 2011	3.7	7.3	22	3.4	15	23	18.2	0.02 [-0.56, 0.61]
Rogers et al., 2009	3.4	11	19	-3.5	10.8	17	13.8	0.62 [-0.05, 1.29]
Subtotal	-	-	182	-	-	100	100	0.14 [-0.11, 0.39]

^a Heterogeneity $\tau^2 = 0.22$; $\chi^2 = 46.31$, $df = 11$ ($p < 0.00001$); $I^2 = 76\%$. Test for overall effect: $Z = 2.97$ ($p = 0.003$)

^b Heterogeneity $\tau^2 = 2.05$; $\chi^2 = 132.26$, $df = 4$ ($p = 0.00001$); $I^2 = 97\%$. Test for overall effect: $Z = 1.92$ ($p = 0.06$)

^c Heterogeneity $\tau^2 = 0.00$; $\chi^2 = 2.26$, $df = 3$ ($p = 0.52$); $I^2 = 0\%$. Test for overall effect: $Z = 1.13$ ($p = 0.26$)

CI—confidence interval; HRQOL—health-related quality of life

Note. Test for subgroup differences: $\chi^2 = 4.83$, $df = 2$ ($p = 0.09$), $I^2 = 58.6\%$

trials evaluating change from baseline to follow-up or when comparing follow-up scores. A significant effect was also observed at the six-month follow-up, but only when comparing follow-up scores. Subgroup analyses showed that a positive treatment effect was still present if limited to trial participants with breast cancer or other types of cancer (data not shown). One trial where data were not extracted reported no difference in social functioning between the exercise and control groups (Headley et al., 2004), whereas a second had reported a significant effect on social functioning with exercise without a corresponding effect in the control group (Oh et al., 2008).

Other domains: The authors observed a pattern of significant findings for three domains (anxiety, depression, and pain) in which the scores at the 12-week follow-up and at the six-month follow-up in the exercise group were significantly different from those in the control group. In addition, the authors observed isolated instances of significant findings for body image, breast cancer concerns, cognitive function, emotional well-being, general health perspective, prostate cancer concerns, sleep disturbance, and spirituality, but only at a single time point or using a single type of measure.

Discussion

This review provides evidence to suggest an exercise intervention positively impacts overall HRQOL and HRQOL domains of fatigue, physical function, role function, and social function among people newly diagnosed with cancer and about to undergo treatment or actively undergoing treatment. The positive effects were consistent across various time frames and different types of tools or scales used to measure these outcomes. Exercise interventions exhibited significantly greater positive impact on HRQOL among people with cancers other than breast cancer. In addition, moderate-to-vigorous intensity exercise interventions resulted in greater improvements in HRQOL.

Several, but not all, results documented through this review concur with other systematic reviews (Craft, Vaniterson, Helenowski, Rademaker, & Courneya, 2012; Cramp & Byron-Daniel, 2012; Cramp & Daniel, 2008; Cramp, James, & Lambert, 2010; Duijts, Faber, Oldenburg, van Beurden, & Aaronson, 2011; Ferrer, Huedo-Medina, Johnson, Ryan, & Pescatello, 2011; Speck, Courneya, Masse, Duval, & Schmitz, 2010) that evaluated the effectiveness of exercise interventions on HRQOL or HRQOL domains. Unlike the current article, other systematic reviews examined effects of exercise interventions on HRQOL among both people who were undergoing cancer treatment and those who had completed treatment, with only one review (Speck et al., 2010) presenting findings by treatment

Knowledge Translation

Evidence from this review shows that moderate-to-vigorous intensity exercise programs have beneficial effects on health-related quality of life (HRQOL).

Exercise programs also had positive effects on HRQOL domains because they enhanced physical, role, and social functioning and reduced fatigue.

Exercise programs can be incorporated into management plans for people scheduled for or actively undergoing cancer treatment.

status. Similar to other reviewers, the current authors have documented significant positive effects of exercise interventions on global HRQOL and fatigue (Cramp & Byron-Daniel, 2012; Cramp & Daniel, 2008). Unlike other reviews, the current authors observed patterns (at a particular follow-up period or in change scores) but not consistent positive effects on anxiety (Duijts et al., 2011), depression (Craft et al., 2012; Duijts et al., 2011), breast cancer-specific concerns (Speck et al., 2010), and body image and stress (Duijts et al., 2011). In addition, Ferrer et al. (2011) reported positive changes in HRQOL based on exercise type and gender (i.e., among women). Some factors that could explain differences in findings between previous reviews and the current review include differences in treatment status of trial participants, types of exercise programs, and instruments used to assess HRQOL outcomes.

Although there are significant advances in research on the benefits of exercise on HRQOL, several areas need additional study to expand the knowledge base. The field could benefit from parsimoniously defined conceptual frameworks or theoretical models that could better inform design and implementation of exercise interventions and assessment of HRQOL outcomes, effect modifiers, mediators, and confounders. These models and frameworks could help postulate and test strategies to sustain changes in exercise behaviors to ensure maintenance of positive effects on HRQOL and HRQOL domains, optimal follow-up periods from the end of the intervention to document changes in behavior, and exercise program-specific elements (i.e., frequency, duration, dose, intensity, type [aerobic and/or anaerobic]) that enhance HRQOL and its domains. In addition, comparison of findings on HRQOL and HRQOL domains across trials is limited because of the heterogeneous measures used to document outcomes. Efforts such as the Patient-Reported Outcomes Measurement Information System (PROMIS) may help address this issue (Cella et al., 2010; National Cancer Institute, 2014). The need for rigorously designed RCTs to conduct efficacy trials cannot be understated. However, all

reviewed eligible trials had a common limitation: failure to provide a context within which the exercise intervention effected the outcome. Using mixed-method designs (Creswell, 2014) will enrich the understanding of the intervention delivery and uptake and provide contextually meaningful insights into the processes of behavior change. In addition, the field will benefit by moving from efficacy trials to pragmatic trials (Glasgow, 2013; Glasgow, Magid, Beck, Ritzwoller, & Estabrooks, 2005; Riley, Glasgow, Etheredge, & Abernethy, 2013; Stange, Breslau, Dietrich, & Glasgow, 2012) and by improving the dissemination and implementation (Brownson, Colditz, & Proctor, 2012; Glasgow et al., 2005; Lobb & Colditz, 2013; Tunis, Stryer, & Clancy, 2003) of evidence into practice and policy.

The positive results reported here need to be interpreted with caution. The trials included in the review had varying levels of risk of bias. In addition, the numerous measures used to assess overall HRQOL and HRQOL domains coupled with the heterogeneity of exercise programs not only in the type of program (aerobic or anaerobic) but in the intensity, frequency, duration, and context (home or facility, individual or group, professionally led or not) make comparisons very challenging. The possibility of biased selection of trials included in the review exists. To minimize this bias, two independent reviewers selected trials for inclusion. There also was the possibility of publication bias. The authors prepared funnel plots (Mishra, Scherer, Snyder, et al., 2012) to assess publication bias for outcomes such as global HRQOL, fatigue, and physical functioning for baseline to follow-up and for follow-up values. Visual inspection of these plots revealed slight asymmetry indicating some publication bias in this area of research. It also is possible that the review missed some potentially eligible trials in the gray literature. Given the strength of associations and concordance of findings across various time frames and different types of measures, it is unlikely that adding trials from the grey literature would significantly affect the findings. The detailed search across 11 electronic databases, correspondence with authors and experts, search of websites, and review of reference lists of retrieved articles makes the authors confident that they accessed most (if not all) of

the available literature that met the search criteria. In addition, the multiple comparisons within this review could well result in spurious significant findings by chance. To assess the robustness of the authors' analytical results, findings were compared across time periods and across metrics (i.e., change from baseline versus follow-up scores). Consistent findings across time and metrics increased the authors' confidence in the results.

Conclusions

Evidence from this review suggests that exercise programs, particularly those of moderate-to-vigorous intensity, have beneficial effects on HRQOL and HRQOL domains and can be integrated into the management plans of people scheduled for or undergoing cancer treatment. In addition, evidence from the review supports the incorporation of exercise programs for the management of HRQOL among people scheduled for or undergoing cancer treatment into clinical guidelines, such as the Oncology Nursing Society's Putting Evidence Into Practice resource.

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials							
Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Adamsen et al., 2009	Men and women with various cancers who had a history of exercise	269 total participants; 135 in the exercise group and 134 in control	In treatment	Physical training, relaxation training, body awareness and restorative training, and massage	The intervention lasted six weeks with follow-up at the end of the intervention.	Equivalent to 43 metabolic equivalent of task (MET) hours per week; duration was 90 minutes of high-intensity and 30 minutes of low-intensity exercise.	Group format in a facility with professional supervision
Arbane et al., 2009	Men with lung cancer. Exercise history not reported.	51 total participants; 25 in the exercise group and 26 in control	In treatment	Training plus usual care during hospital stay; after discharge, monthly home visits and weekly telephone calls	The intervention lasted 12 weeks with follow-up at the end of the intervention	Not reported	Not reported
Banerjee et al., 2007	Women with breast cancer. Exercise history not reported.	68 total participants; 35 in the exercise group and 33 in control	In treatment	Integrated yoga program and special techniques for patients, including guided imagery of cancer cells, positive thought provocations, and chanting of various sounds	The intervention lasted six weeks with follow-up at the end of the intervention.	Intensity was not reported; duration was 90 minutes.	Group format in a facility or at home with professional supervision
Battaglini et al., 2008	Women with breast cancer. Exercise history not reported.	20 total participants; groups sizes not reported	Scheduled	Individualized exercise program, which included cardiovascular, resistance, and flexibility training	The intervention lasted 16 weeks with follow-up at the end of the intervention.	Intensity was 40%–60% of predicted maximum exercise capacity; duration was 60 minutes.	Group format in a facility with professional supervision
Bourke et al., 2011	Men with prostate cancer who had a history of exercise	50 total participants; 25 in the exercise group and 25 in control	In treatment	Resistance exercises (body weight resistance and free weights), self-directed exercise (e.g., brisk walking, cycling, gym exercise), and small group healthy eating seminars	The intervention lasted 12 weeks, with follow-up six months after completion.	Aerobic exercise was 55%–85% of the age-predicted maximum heart rate, 11–15 on the Borg scale, or both. Anaerobic was not reported. Duration was 30 minutes.	Individual format in a facility or at home with professional supervision
Brown et al., 2006	Men and women with various cancers. Exercise history not reported.	115 total participants; 57 in the exercise group and 58 in control	Scheduled	Structured multidisciplinary intervention including seated active range of motion exercises, progressing to resistive exercises, stretching exercises, functional lower extremity exercises (e.g., marching in place), and educational sessions coinciding with exercise sessions	The intervention lasted four weeks, with follow-up at 4, 7, and 27 weeks after baseline.	Intensity was not reported; duration was 90 minutes.	Group format in a facility with professional supervision
Cadmus et al., 2009	Women with breast cancer. Exercise history not reported.	75 total participants; 37 in the exercise group and 38 in control	In treatment	Exercise (not specified) program with weekly telephone calls, information, heart monitor, and activity logs	The intervention lasted six months with follow-up at the end of the intervention.	Intensity was 60%–80% of predicted maximal heart rate; duration was 30 minutes.	Individual format at home with professional supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)							
Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Caldwell, 2009	Women with breast cancer. Exercise history not reported.	25 total participants; 13 in the exercise group and 12 in control	Scheduled	Strength training/functional endurance regimen, including biceps curl, arm raises, chair stands, one-foot stands, side leg raises, and walking	The intervention lasted 12 weeks with follow-up at six months.	Mild intensity; duration was based on participant ability and endurance.	Individual format at home with professional supervision
Campbell et al., 2005	Women with breast cancer who had a history of exercise	22 total participants; 12 in the exercise group and 10 in control	In treatment	Exercise program consisting of walking, cycling, low-level aerobics, muscle-strengthening exercises, circuits, cool down, relaxation period, and discussion targeting different motivational factors	The intervention lasted 12 weeks, with follow-up at the end of the intervention.	Intensity was 60%–75% of the age-adjusted maximum heart rate; duration was not reported.	Group format in a facility; professional supervision was not reported
Chandwani et al., 2010	Women with breast cancer who had a history of exercise	71 total participants (10 withdrew); 30 in the exercise group and 31 in control	Scheduled	Yoga, which included preparatory warm-up movements synchronized with breathing, maintenance in selected postures (forward-, backward-, and side-bending asanas in sitting and standing positions, cobra posture, crocodile, and half-shoulder stand with support), deep relaxation technique (in corpse posture), alternate-nostril breathing (pranayama), and meditation	The intervention lasted six weeks with follow-up at three months.	Mild intensity; duration was 60 minutes.	Group format (but most women had one-on-one sessions) in a facility with professional supervision
Chang et al., 2008	Men and women with acute myelogenous leukemia. Exercise history not reported.	24 total participants; 12 in the exercise group and 12 in control	In treatment	Walking exercise program	The intervention lasted three weeks, with follow-up at the end of the intervention.	Intensity was resting heart rate plus 30; duration was 12 minutes.	Individual format in a facility with professional supervision
Cheville et al., 2010	Men and women with various cancers. Exercise history not reported.	103 total participants; 49 in the exercise group and 54 in control	In treatment	Multidisciplinary program, including physical therapy; conditioning exercises (flexibility and strengthening activities; cognitive, emotional, social, and spiritual components centered around specific topics; and coping strategies	The intervention lasted three weeks, with follow-up at six months.	Intensity was not reported; duration was 90 minutes, with 30 minutes of physical therapy conditioning exercises.	Group format in a facility and at home with professional supervision
Cohen et al., 2004	Men and women with lymphoma with a history of exercise	39 total participants; 20 in the exercise group and 19 in control	In treatment and post-treatment	Tibetan yoga, including controlled breathing and visualization, mindfulness postures from the Tsa lung, and preliminary set of postures from the Trul khor (sngon 'gro).	The intervention lasted seven weeks with follow-up at one week, one month, and three months postintervention.	Mild intensity; duration was not reported.	Group and individual format, in a facility and at home, with professional supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)							
Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Courneya et al., 2003	Men and women with various cancers with a history of exercise	108 total participants; 60 in the exercise group and 48 in control	In treatment and post-treatment	Walking or alternate mode of exercise (e.g., swimming, cycling) and group psychotherapy	The intervention lasted 10 weeks with follow-up at the end of the intervention.	Intensity was 65%–75% of the estimated maximum heart rate, as soon as safely possible; duration was 20–30 minutes.	Individual format in a facility and at home with professional supervision
Courneya et al., 2007	Women with breast cancer with a history of exercise	242 total participants; 160 in the exercise group and 82 in control	In treatment	Aerobic exercise intervention (exercise group 1), including cycle ergometer, treadmill, or elliptical; and resistance exercise intervention (exercise group 2), including leg extension, leg curl, leg press, calf raises, chest press, seated row, triceps extension, biceps curls, and modified curl-ups.	The intervention lasted the length of the chemotherapy sessions (median of 17 weeks). Follow-up was at six months.	Aerobic: 60% of VO ₂ max during weeks 1–6; 70% during weeks 7–12; and 80% after week 12; resistance: 60%–70% of estimated one repetition maximum, resistance with 10% increase when participants completed more than 12 repetitions; aerobic: 15 minutes during weeks 1–3 and increased by 5 minutes every three weeks up to 45 minutes at week 18; resistance not reported.	Individual format in a facility with professional supervision
Courneya et al., 2008	Women or men with breast (primary) or metastatic disease with a history of exercise	55 total participants; 26 in the exercise group and 29 in control	In treatment	Cycle ergometry and darbepoetin alfa treatment	The intervention lasted 12 weeks, with follow-up one to two weeks post-intervention.	Intensity was 60%–100% of baseline peak power output; duration was not reported.	Individual format in a facility with professional supervision
Courneya et al., 2009	Men and women with lymphoma with a history of exercise	122 total participants; 60 in the exercise group and 62 in control	In treatment and post-treatment	Cycle ergometry and interval training	The intervention lasted 12 weeks with follow-up at six months.	Intensity was 60% of peak power output, increasing by 5% each week to 75% by week 4; duration was 15–20 minutes for weeks 1–4; increased by 5 minutes per week to 40–45 minutes in week 9.	Group format at a facility with professional supervision
Crowley, 2003	Women with breast cancer. Exercise history not reported.	22 total participants; 13 in the exercise group and 9 in control	In treatment	Aerobic: walking Anaerobic: strength training by progressive resistance training using exercise tubing	The intervention lasted 13 weeks with follow-up at the end of the intervention.	Aerobic intensity was 60% of the target heart rate; intensity for anaerobic was not reported; duration was not reported.	Individual format in the home with professional supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)

Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Culos-Reed et al., 2010	Men with prostate cancer. Exercise history not reported.	100 total participants; 53 in the exercise group and 47 in control	Scheduled	Walking, stretching, light resistance (i.e., theraband), and education or discussion	The intervention lasted 16 weeks with follow-up at 12 months.	Moderate intensity; the home-based component was 60 minutes in duration and the group-based component was 90 minutes.	Group and individual format in a facility or a home. Professional supervision was only during the group-based format.
Danhauer et al., 2009	Women with breast cancer with a history of exercise	44 total participants; 22 in the exercise group and 22 in control	In treatment and post-treatment	Restorative yoga that combined physical postures (asanas), breathing (pranayama), and deep relaxation (savasana). Poses included mountain pose; arm and shoulder stretch; supported forward fold; seated sun salutation; and reclining twist with a bolster	The intervention lasted 10 weeks with follow-up at the end of the intervention.	Mild intensity for 75 minutes	Group format in a facility with professional supervision
de Oliveira et al., 2010	Women with breast cancer. Exercise history not reported.	55 total participants; 28 in the exercise group and 27 in control	In treatment	Kinesitherapy of the upper limb, including 19 different exercises	The intervention lasted the length of radiation with follow-up at six months.	Intensity was not reported; duration was 45 minutes.	Individual format in a facility; professional supervision was not reported
Dimeo et al., 1999	Men and women with various cancers. Exercise history not reported.	62 total participants; 29 in the exercise group and 33 in control	In treatment	Biking on an ergometer in the supine position following an interval training pattern	The intervention lasted the length of hospitalization with follow-up to the end of the intervention.	Intensity was heart rate equivalent to at least 50% of the cardiac reserve, calculated as 220 minus age minus resting heart rate; duration was 30 minutes.	Individual format in a facility; professional supervision was not reported
DiSipio et al., 2009	Women with breast cancer. Exercise not reported.	337 total participants	In treatment	Exercise (not specified)	Not reported	Not reported	Not reported
Dominique et al., 2010	Patients with breast cancer	101 total participants; 58 in the exercise group and 43 in control	In treatment	Yoga postures, visualization, relaxation, meditation, and breathing exercises	The intervention lasted eight weeks with follow-up at the end of the intervention.	Intensity was not reported; duration was 90 minutes.	Format not reported, but it took place in a facility or at home with professional supervision
Donnelly et al., 2011	Women with gynecologic cancer. Exercise history not reported.	33 total participants; 16 in the exercise group and 17 in control	In treatment and post-treatment	Physical activity, including walking and strengthening exercises	The intervention lasted 12 weeks with follow-up at six months.	Moderate intensity; duration was 30 minutes.	Individual format at home with professional supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)

Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Galvao et al., 2010	Men with prostate cancer. Exercise history not reported.	57 total participants; 29 in the exercise group and 28 in control	In treatment	Combined progressive resistance (i.e., chest press, seated row, shoulder press, triceps extension, leg press, leg extension and leg curl, abdominal crunches), aerobic training (i.e., cycling or walking/jogging), and general flexibility exercises	The intervention lasted 12 weeks with follow-up at the end of the intervention.	Intensity was 65%–80% of the maximum heart rate and perceived exertion of 11–13 (6–20 point, Borg scale); duration of aerobic exercise was 15–20 minutes.	Group format in a facility with professional supervision
Gomes et al., 2011	Women with breast cancer. Exercise history not reported.	54 total participants	In treatment	Exercise orientation (not specified) program	The intervention length was not reported; however, follow-up was at the end of the intervention.	Not reported	Individual format in the home setting; professional supervision was unclear.
Griffith et al., 2009	Men and women with various cancers. Exercise history not reported.	138 total participants; 73 in the exercise group and 65 in control	In treatment	Brisk walk followed by slower walking (cool down), other aerobic activities such as cycling could substitute or supplement walking, biweekly telephone calls	The intervention was the mean length of cancer treatment (12.83 weeks). Follow-up was at the end of treatment.	Intensity was approximately 50%–70% of the maximum heart rate; duration was 25–35 minutes.	Individual format in the home with no professional supervision
Hacker et al., 2011	Men and women with hematologic cancer. Exercise history not reported.	22 total participants (three withdrew); 9 in the exercise group and 10 in control	In treatment	Progressive strength-training intervention, including a comprehensive program of progressive resistance to strengthen the upper body, lower body, and abdominal muscles using elastic resistance bands, if able, and body weight for resistance' preselected exercises with concentric and eccentric muscle contractions; and exercises that used body weight as resistance	The intervention lasted six weeks with follow-up at the end of the intervention.	Intensity corresponded with the Borg RPE scale 13; duration varied.	Individual format in the facility or home with professional supervision
Haddad et al., 2011	Women with breast cancer. Exercise history not reported.	163 total participants; 109 in the exercise group and 54 in control	In treatment	Yoga (exercise group 1) and stretching (exercise group 2) exercise intervention	The intervention lasted six weeks with follow-up at one, three, and six months.	Not reported	Not reported
Headley et al., 2004	Women with breast cancer. Exercise history not reported.	38 total participants	Scheduled	Exercise program in which participants sit in a straight backed chair while performing stretching and repeated flexion and extension of the arms, head, upper torso, and legs with the assistance of a video. The program includes warm up, repetitive motion exercises, and cool down.	The intervention lasted 12 weeks with follow-up at the end of the intervention.	Moderate intensity; duration was 30 minutes.	Individual format in the home with no professional supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)							
Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Hwang et al., 2008	Women with breast cancer. Exercise history not reported.	40 total participants; 17 in the exercise group and 20 in control	Scheduled	Exercise program, including stretching exercises focused on the shoulders, aerobic exercise such as treadmill walking and bicycling, and strengthening exercise	The intervention lasted five weeks with follow-up at the end of the intervention.	50%–70% of the age-adjusted maximum heart rate; duration was 50 minutes.	Not reported
Jarden et al., 2009	Men and women with hematologic cancer with a history of exercise	42 total participants; 21 in the exercise group and 21 in control	Scheduled	Multimodal exercise program, including stationary cycling, dynamic and stretching exercises, resistance training; progressive relaxation; and psychoeducation	The intervention lasted the length of hospitalization with follow-up six months postintervention.	Intensity did not exceed 75% of maximal heart rate; duration was one hour.	Individual format in a facility with professional supervision
Moadel et al., 2007	Women with breast cancer. Exercise history not reported.	164 total participants; 108 in the exercise group and 56 in control	In treatment and post-treatment	Yoga, with each session including physical stretches and poses, breathing exercises, and meditation	The intervention lasted 12 weeks with follow-up at one, three, and six months.	Mild intensity; duration was 90 minutes.	Group and Individual format in a facility or the home; supervision was not reported
Mock et al., 1994	Women with breast cancer. Exercise history not reported.	14 total participants; 9 in the exercise group and 5 in control	In treatment	Progressive, regular program composed of a brisk, incremental walk followed by slow walking (cool down); support group led by an oncology clinical nurse specialist	The intervention length was the same as chemotherapy treatment (4–6 months) with follow-up one month postintervention.	Intensity was not reported; duration was 10–45 minutes with a five-minute cool down.	Individual format in the home with no supervision
Mock et al., 1997	Women with breast cancer. Exercise history not reported.	50 total participants (four withdrew); 22 in the exercise group and 24 in control	In treatment	Self-paced progressive walking program	The intervention length was about 6 weeks with follow-up at the end of the intervention.	Intensity not reported; duration was 26–35 minutes.	Individual format in the home with no supervision
Mock et al., 2001	Women with breast cancer. Exercise history not reported.	52 total participants	In treatment	Walking program with contact from clinic staff	The intervention was the length of treatment (six weeks for radiation therapy and 4–6 months for chemotherapy); follow-up was at the end of the intervention.	Not reported	Individual format in the home with no supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)							
Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Mock et al., 2005	Women with breast cancer. Exercise history not reported.	119 total participants; 60 in the exercise group and 59 in control	In treatment	Progressive walking program	The intervention was the length of treatment (six weeks for radiation and 3–6 months for chemotherapy); follow-up was post-intervention.	Intensity was about 50%–70% of the maximum heart rate; duration was 45 minutes.	Individual format in the home with no supervision
Monga et al., 2007	Men with prostate cancer. Exercise history not reported.	30 total participants	In treatment	Exercise program including warm-up, walking on a treadmill, and cool down	The intervention lasted eight weeks with follow-up at the end of the intervention.	Participants were instructed to maintain heart rate; duration was 50 minutes.	Format was unclear; however, it was in a facility with professional supervision
Moros et al., 2010	Women with breast cancer. Exercise history not reported.	22 total participants; 11 in the exercise group and 11 in control	In treatment	Dynamic aerobic exercise (not specified)	The intervention was 18–22 weeks with follow-up at 10 or 15 days postintervention.	Intensity was 60%–70% of determined cardiac heart rate; duration was 60 minutes.	Individual format in a facility with professional supervision
Mustian et al., 2009	Men and women with prostate and breast cancer and with a history of exercise	40 total participants; 20 in the exercise group and 20 in control	In treatment	Walking program and resistance band exercise prescription included individually determined number of sets for each of the 11 exercises with instructions to increase resistance	The intervention lasted four weeks and follow-up was at three months.	Aerobic: 60%–70% of heart rate reserve, 3–5 exercise rating of perceived exertion on the AC SM revised rating scale; anaerobic: progressive resistance exercise (3–5 exercise rating of perceived exertion); duration was not reported.	Individual format in a facility or in the home with professional supervision
Mutrie et al., 2007	Women with breast cancer. Exercise history not reported.	203 total participants; 101 in the exercise group and 102 in control	In treatment	Program consisted of a warm-up, exercise, and cool-down and relaxation periods; usual care; support in form of group discussions following exercise session in which a specific theme was covered.	The intervention lasted 12 weeks with follow-up at six months.	Intensity was 50%–75% of age-adjusted maximum heart rate; duration was 45 minutes.	Group and individual format in a facility or in the home with professional support
Oh et al., 2008	Men and women with various cancers. Exercise history not reported.	30 total participants; 15 in the exercise group and 15 in control	In treatment and post-treatment	Medical qigong, with each session including general discussion, gentle stretching and body movement in standing postures, movement in seated posture, and breathing exercises	The intervention lasted eight weeks with follow-up at the end of the intervention.	Mild intensity; duration was 90 minutes in facility and 60 minutes at home.	Group and individual format in a facility or in the home with professional supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)							
Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Oh et al., 2010	Men and women with various cancers. Exercise history not reported.	162 total participants; 79 in the exercise group and 83 in control	In treatment and post-treatment	Medical qigong, with each session including general discussion, gentle stretching and body movement in standing postures, movement in seated posture, and breathing exercises	The intervention lasted 10 weeks with follow-up at the end of the intervention.	Mild intensity; duration was 90 minutes in facility and 30 minutes at home.	Group and individual format in a facility or in the home with professional supervision
Raghavendra et al., 2007	Women with breast cancer. Exercise history not reported.	98 total participants; 31 in the exercise group and 34 in control	In treatment	An integrated yoga program tailored to the participant's need during chemotherapy; the home sessions consisted of yoga postures, breathing exercises and pranayama, and yogic relaxation.	The intervention length varied, by number of adjuvant chemotherapy cycles; follow-up was at the end of the intervention.	Intensity was not reported; duration was 60 minutes.	Individual format in the facility or home with professional supervision
Rogers et al., 2009	Women with breast cancer. Exercise history not reported.	41 total participants; 21 in the exercise group and 20 in control	In treatment	Discussion group sessions with a clinical psychologist, exercise programs (walking), and individual update counseling sessions with an exercise specialist	The intervention lasted 12 weeks with follow-up at three months.	Transition from baseline to week 12 to 150 minutes of moderate-intensity activity	Group and individual format in the facility or home with professional supervision
Segal et al., 2001	Women with breast cancer with a history of exercise	123 total participants; 82 in the exercise group and 41 in control	In treatment	Both exercise groups received instructions for monitoring exercise intensity and completing an exercise diary, along with a standardized series of warm-up and cool-down exercises and a progressive walking program. Home based exercise group (exercise group 1) also received a home exercise prescription and contact by telephone during the training period. The supervised exercise group (exercise group 2) also received a supervised exercise program with warm up, walking at prescribed pace, and standard cool-down periods.	The intervention lasted 26 weeks with follow-up at the end of the intervention.	Intensity was 50%–60% of the predicted maximal oxygen uptake; duration was not reported.	Individual format in the facility and home with professional supervision
Segal et al., 2003	Men with prostate cancer with a history of exercise	155 total participants; 82 in the exercise group and 73 in control	Scheduled	Resistance exercise program (i.e., leg extension, calf raises, leg curl, chest press, latissimus pull-down, overhead press, triceps extension, biceps curls, and modified curl-ups), and warm-up and cool-down exercises	The intervention lasted 12 weeks with follow-up at the end of the intervention.	Intensity was 60%–70% of the one-repetition maximum, increasing resistance by 5 pounds when more than 12 repetitions were performed; duration was “as needed” to complete program.	Individual format in a facility with professional supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)

Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Segal et al., 2009	Men with prostate cancer. Exercise history not reported.	121 total participants; 80 in the exercise group and 41 in control	In treatment	The aerobic exercise intervention (exercise group 1) included exercise on a cycle ergometer, treadmill, or elliptical trainer; the resistance exercise intervention (exercise group 2) included leg extension, leg curl, seated chest fly, latissimus pull-down, overhead press, triceps extension, biceps curls, calf raises, low back extension, and modified curl-ups.	The intervention lasted 24 weeks with follow-up at the end of the intervention.	Aerobic intensity was 50%–60% of VO ₂ peak for weeks 1–4, 70%–75% for weeks 5–24; anaerobic: 60%–70% of estimated one-repetition maximum, increased by 5 pounds when more than 12 repetitions were performed; duration was 15 minutes, increasing by five minutes every three weeks for as many as 45 minutes.	Individual format in a facility with professional supervision
Tang et al., 2010	Men and women with various cancers. Exercise history not reported.	72 total participants; 37 in the exercise group and 35 in control	In treatment and post-treatment	Walking exercise intervention, including instructions to walk briskly (at a pace that was faster than normal), starting with a warm-up (walking slowly) and finishing with a cool-down after completing the walk; exercise booklet, written material for home use focusing on safety and proper technique	The intervention lasted eight weeks with follow-up at one and two months postintervention.	Rating of perceived exertion was between 11 and 13, with a rating of 6 indicating resting and 20 indicating very, very hard; duration was 30 minutes with an additional five minutes before and after for warm up and cool down, respectively.	Individual format in the home without professional supervision
Targ & Levine, 2002	Women with breast cancer with a history of exercise	181 total participants; 93 in the exercise group and 88 in control	In treatment and post-treatment	Intensive lifestyle change and group support program that included weekly health series discussion group, a dance/movement program, silent meditation, and guided imagery	The intervention lasted 12 weeks with follow-up at the end of the intervention.	Intensity was mild to moderate; duration was 90 minutes.	Group format in a facility with professional supervision
Vadiraja et al., 2009	Women with breast cancer with a history of exercise	88 total participants; 44 in the exercise group and 44 in control	In treatment	Yoga, including a set of asanas (postures done with awareness), breathing exercises, pranayama (voluntarily regulated nostril breathing), meditation, and yogic relaxation techniques with imagery (mind-sound resonance technique and cyclic meditation)	The intervention lasted six weeks with follow-up at the end of the intervention.	Intensity was not reported; duration was 60 minutes.	Individual format in a facility or the home with professional supervision
Wang, 2010	Women with breast cancer with a history of exercise	72 total participants; 35 in the exercise group and 37 in control	In treatment	Walking program and strategies to boost exercise self-efficacy; the exercise program included the use of a heart rate monitor, pedometer, phone call, exercise diary, meetings, a role model story to advance participants' exercise self-efficacy.	The intervention lasted six weeks with follow-up at the end of the intervention.	Intensity was 40%–60% of maximal heart rate or modified Borg scale between 0.5–2; duration was 30 minutes.	Individual format in the home without professional supervision

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Appendix A. Characteristics of Participants and Interventions in Reviewed Trials (Continued)							
Study	Sample	Size	Treatment Status	Exercise Program	Intervention and Follow-Up	Intensity and Duration	Format, Location, and Supervision
Windsor et al., 2004	Men with prostate cancer. Exercise history not reported.	66 total participants; 33 in the exercise group and 33 in control	Scheduled	Continuous walking program	The intervention lasted until the end of radiation therapy with follow-up at four weeks postintervention.	Intensity was 60%–70% of the calculated maximum heart rate; duration was 30 minutes.	Individual format in the home; whether or not there was professional supervision is unclear.
Wiskemann et al., 2011	Men and women with hematologic cancers with a history of exercise	112 total participants; 57 in the exercise group and 55 in control	In treatment	Aerobic: recommended (brisk) walking in the outpatient setting, bicycling and treadmill walking during hospitalization, Nordic walking, or jogging Anaerobic: strength training including exercises for the upper and lower extremities with and without stretch bands	The intervention lasted 7–12 weeks with follow-up at the end of the intervention.	Intensity was rated on the Borg scale with a score of 12–14 for aerobic and 14–16 for anaerobic resistance exercises; for duration, aerobic was 20–40 minutes and anaerobic was 8–20 repetitions, 2–3 sets.	Individual format in a facility or the home with professional supervision
Yang et al., 2011	Women with breast cancer. Exercise history not reported.	44 total participants (four withdrew); 19 in the exercise group and 21 in control	In treatment	Walking program, that included warm up, brisk walking, and cool down periods	The intervention lasted 12 weeks with follow-up at the end of the intervention.	Intensity was 60%–80% of the age-adjusted maximal heart rate; duration was about 40 minutes.	Individual format in the home without professional supervision