

CONTINUING EDUCATION

The Effects of Exercise on Body Weight and Composition in Breast Cancer Survivors: An Integrative Systematic Review

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Purpose/Objectives: To examine the research literature regarding the effects of exercise on body weight and composition in breast cancer survivors.

Data Sources: Primary studies in English published from 1989–2004, located through electronic databases, hand searches, and personal contacts.

Data Synthesis: Of 1,314 studies screened, 14 met all inclusion criteria. Body weight and composition generally were secondary endpoints. Effects on weight were less common than reduction in percentage of body fat.

Conclusions: The evidence regarding exercise as a strategy for body weight and composition management in breast cancer is sparse. Research that considers these outcomes as primary endpoints is needed. Numerous measurement issues need to be addressed in future studies.

Implications for Nursing: Exercise may help to control adverse body weight and composition changes among breast cancer survivors. Improved research that assigns these outcomes primary importance will greatly enhance clinicians' ability to assist women in body weight and composition management.

Key Points . . .

- Adverse body weight and composition changes occur during breast cancer and its treatment, and physical activity is known to decrease during treatment; however, few studies of breast cancer and exercise have focused on the outcomes of body weight and composition.
- Most studies of exercise among breast cancer survivors have involved aerobic programs or a combination of aerobic and resistance approaches that were done in a fitness facility among women who were not undergoing active treatment.
- Body weight has been less responsive to the effects of exercise than body composition in existing studies.
- To establish a sound basis for clinical practice, body weight and composition should be primary endpoints in future research that examines a variety of exercise approaches, makes an effort to adopt and describe more precise and accurate measurement techniques, assembles samples of adequate size, is of sufficient duration, carefully examines related variables such as other exercise and dietary intake, and assesses lymphedema in the context of overall body weight and composition change.

Goal for CE Enrollees

To enhance nurses' knowledge about research regarding body weight and composition among breast cancer survivors.

Objectives for CE Enrollees

1. Discuss factors known to contribute to weight gain in women who are breast cancer survivors.
2. Describe weaknesses associated with the control of variables in the studies reviewed.
3. Discuss future directions for research in body weight and composition that may yield more reliable results.

Exercise has been studied extensively and has demonstrated many benefits for cancer survivors (Baldwin & Courneya, 1997; Blanchard, Courneya, & Laing, 2001; Courneya & Friedenreich, 1997; Courneya, Friedenreich, et al., 2003; Courneya, Keats, & Turner, 2000; Courneya, Mackey, et al., 2003; Gaskin, LoBuglio, Kelly, Doss,

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& Pizitz, 1989; Mock et al., 1994, 1997, 2001; Nieman et al., 1995; Schwartz, 2000; Segar et al., 1998; Young-McCaughan et al., 2003; Young-McCaughan & Sexton, 1991); however, the effects of exercise on body weight and composition among breast cancer survivors have not been systematically assessed.

The purpose of this integrative, systematic review was to answer the following questions: (a) What is known about the influence of exercise on body weight and composition among breast cancer survivors? and (b) What is the quality of the research regarding the relationship between exercise and body weight and composition among breast cancer survivors? In this context, survivor indicates any woman who has been diagnosed with breast cancer; weight refers to total body weight expressed as pounds, kilograms, or body mass index (BMI); and body composition refers to all constituents of body composition. Although body composition usually is thought of and expressed as a percentage of body fat (Brodie, 1988; Dwyer, 1994), it includes two chemically distinct compartments, fat mass and fat-free mass (Lukaski, 1987). Fat-free mass may be subdivided further into lean body mass, including bone mineral and protein, and total body water (Lukaski).

Related Literature

Changes in Weight

Treatment-associated weight gain among women with early-stage breast cancer has long been acknowledged as a common problem, particularly for women who receive adjuvant chemotherapy (Bonadonna et al., 1985; Camoriano et al., 1990; DeConti, 1982; Goodwin, Panzarella, & Boyd, 1988; Heasman, Sutherland, Campbell, Elhakim, & Boyd, 1985; Knobf, 1986; Knobf, Mullen, Xistris, & Moritz, 1983; Subramanian, Raich, & Walker, 1981). Treatment-associated weight gain poses significant health risks, including increased risk of cancer recurrence (Camoriano et al.; Goodwin et al., 1988), lymphedema (Petrek, Senie, Peters, & Rosen, 2001), symptom distress (Knobf; McInnes & Knobf, 2001), and multiple chronic diseases. Although the problem of chemotherapy-associated weight gain appears to be decreasing with newer, shorter treatment regimens, weight gain ($\bar{X} \cong 2.4$ kg) continues to be reported during the first one to four years postdiagnosis (Demark-Wahnefried et al., 2001; Goodwin et al., 1999; McInnes & Knobf; Rock et al., 1999). Studies that are confined to the immediate treatment period seldom report weight gains; however, marked weight gains have been noted in the year following treatment (Aslani, Smith, Allen, Pavlakis, & Levi, 1999; Campbell, 2001; Demark-Wahnefried et al., 1997; Kutynec, McCargar, Barr, & Hislop, 1999).

Changes in Body Composition

Increased fat mass and decreased fat-free mass are frequent during adjuvant chemotherapy, even when overall weight gain is negligible (Campbell, 2001; Demark-Wahnefried et al., 2001; Freedman et al., 2004; Goodwin et al., 1999; Ingram & Brown, 2004; Kutynec et al., 1999). Increases in women's percentage of body fat ($\bar{X} \cong 2.7\%$) have been reported, with the greatest fat-free mass losses in the lower limbs and the greatest fat mass increases in the torso (Campbell; Demark-Wahnefried et al., 2001; Kutynec et al.).

Decreased bone mineral density (Freedman et al.; Headley, Theriault, LeBlanc, Vassilopoulou-Sellin, & Hortobagyi, 1998) and increased body water (Aslani et al., 1999; Ingram & Brown) also have been noted. Peripheral lymphedema is an abnormal accumulation of fluid, fat, protein and cellular debris in the interstitial space of an affected limb that results from an imbalance between capillary filtration and lymphatic drainage (International Society of Lymphology, 2003). Increased arm volumes of 30%–40% in comparison to the unaffected arm have been reported among breast cancer survivors (Williams, Vadgama, Franks, & Mortimer, 2002), and the increased arm weight and subjective heaviness of lymphedema lead to many lifestyle issues, including impaired arm and hand function (Muscari, 2004; Ridner, 2002; Williams et al.). Lymphedema, therefore, was included among the weight and body composition outcomes for this review.

Predictors of Changes in Weight and Body Composition

The predictors of treatment-associated body weight and composition changes among breast cancer survivors remain unclear despite extensive study. One consistent finding is that the frequency and degree of weight gain is related to the length of treatment (Bonadonna et al., 1985; Demark-Wahnefried et al., 2001; Goodwin et al., 1999; Ingram & Brown, 2004). Beyond this, speculation often has targeted overeating during treatment as a risk factor, but no empirical evidence supports the assumption (DeGeorge, Gray, Fetting, & Rolls, 1990; Demark-Wahnefried et al., 1997, 2001; Goodwin et al., 1999; Grindel, Cahill, & Walker, 1989; Ingram, 2001; Kutynec et al., 1999). Nor do any findings support a relationship between changes in resting energy expenditure and body weight or composition (Campbell, 2001; Demark-Wahnefried et al., 1997, 2001; Goodwin et al., 1999; Ingram; Irwin et al., 2003; Kutynec et al.; Rock et al., 1999). However, research has verified significant physical activity reductions during cancer treatment, particularly during adjuvant chemotherapy ($\bar{X} \cong 18\%$) (Courneya & Friedenreich, 1997; Demark-Wahnefried et al., 1997; Goodwin et al., 1999; Ingram; Irwin et al.; Kutynec et al.; Rock et al.). The findings suggest that exercise might play a role in body weight and composition management during adjuvant treatment. The predictors of lymphedema are better understood than those for overall body weight and composition changes and include axillary lymph node dissection, radiation therapy, scarring from postoperative infection, and weight gain (Muscari, 2004; Petrek et al., 2001; Ridner, 2002).

To date, cancer and exercise studies often have focused on emotional outcomes such as anxiety, depression, and self-esteem, all of which have improved with exercise (Baldwin & Courneya, 1997; Blanchard et al., 2001; Courneya, Friedenreich, et al., 2003; Mock et al., 1994, 1997, 2001; Segar et al., 1998). Exercise programs also have improved physical functioning (Courneya, Mackey, et al., 2003; Gaskin et al., 1989; Mock et al., 1994, 1997, 2001; Nieman et al., 1995; Schwartz, 2000), quality of life (Courneya et al., 2000; Courneya & Friedenreich, 1997; Courneya, Friedenreich, et al.; Courneya, Mackey, et al.; Mock et al., 2001; Young-McCaughan et al., 2003; Young-McCaughan & Sexton, 1991), energy levels (Young-McCaughan et al.), and fatigue

(Courneya, Friedenreich, et al.; Mock et al., 1997, 2001; Schwartz, 2000).

Summary

The phenomenon of weight gain among breast cancer survivors during adjuvant and postadjuvant chemotherapy has been well documented and is accompanied by adverse changes in body composition. Overeating and decreased resting energy expenditure have not been linked convincingly to the issue of weight gain. The evidence suggests that physical activity decreases significantly during adjuvant chemotherapy. Although breast cancer survivors can benefit from exercise in many ways, a gap exists in the literature regarding the effects of exercise on body weight and composition. The purpose of this integrative systematic review was to examine the research literature regarding the effects of exercise on body weight and composition in women with breast cancer.

Data Sources and Review Methods

The methodology outlined in the *Cochrane Handbook for Systematic Reviews version 4.2.2* (2004) was adopted for the current study. Adaptations were made to allow for the inclusion of nonrandomized trials because the body of evidence in the study area is small. The initial search was conducted in August 2003 and involved the following electronic databases: Medline and Premedline, CancerLit, CINAHL®, Cochrane CENTRAL, EMBASE, PsychINFO, PEDro, and SPORTDiscus. Search terms pertaining to breast cancer, exercise interventions, and body weight or composition outcomes were combined. Because body weight and composition are often secondary outcomes in breast cancer and exercise studies, the search strategy for outcomes was defined quite broadly (see Figure 1).

The literature search was restricted to human studies written in English that were published through August 2003 and was updated in 2005. Reference lists of key articles were hand searched, and key investigators were contacted to request unpublished papers, subanalyses, and information regarding works in progress. The review group consisted of three paid research assistants, two undergraduate nursing student assistants, and the principal investigator. To determine the items for full-text retrieval, each title and abstract

was reviewed independently by two of the five review group members using specific inclusion and exclusion criteria (see Figure 2).

Following title and abstract screening, the full text of each item retrieved was reviewed independently for relevance to the review by two of the five review group members using a tool adapted from the Effective Public Health Practice Project ([EPHPP], 2003) of the city of Hamilton, Ontario. Items meeting all four review criteria (i.e., study type, population, intervention, and outcome) were included in the review. The inter-rater agreement for screening activities ranged from 82%–100%; discrepancies were discussed within the review group and resolved by consensus. The final set of studies was reviewed independently by two review group members for data extraction and assessment of methodologic quality using criteria adapted from EPHPP (see Figure 3).

Data extraction and quality assessment were performed only with regard to body weight and composition outcomes. Discrepancies were discussed and resolved by consensus. Quality was rated as strong, moderate, or weak according to EPHPP scoring guidelines, and an overall score was assigned to each study as follows: a strong overall score required at least four strong ratings with no weak ratings on any of the quality criteria, a moderate score allowed only one weak rating, and a weak overall score was assigned if a study received more than one weak rating.

Data Synthesis

The initial database search generated 1,314 titles and abstracts. Of 184 potentially relevant items that remained after title and abstract screening, 181 were found. Twelve published articles ultimately met the inclusion criteria for the review, and unpublished subanalyses from two studies that included participants with a variety of cancers also were obtained (see Table 1). Thus, 14 studies were included in the review.

Characteristics of Study Samples

The range of women's mean ages in the studies reviewed was 45.6–59 years. Their breast cancer staging ranged from ductal cancer in situ to stage IV but was most commonly stage I, II, or IIIA. Nine studies enrolled women who were not receiving adjuvant therapy at the time they exercised (Bendz & Fagevik Olsen, 2002; Burnham & Wilcox, 2002; Cheema, 2002; Courneya, Friedenreich, et al., 2003; Courneya, Mackey, et al., 2003; Galantino et al., 2003; Harris & Niesen-Vertommen, 2000; McKenzie & Kalda, 2003; Pinto, Clark, Maruyama, & Feder, 2003); however, based on standard treatment for the disease stages included in the studies, some women may not have reported hormonal therapy that they received. Six studies enrolled women who were receiving adjuvant chemotherapy or radiation therapy (Courneya, Friedenreich, et al.; Kolden et al., 2002; Schwartz, 1999, 2000; Segal et al., 2001; Winningham, MacVicar, Bondoc, Anderson, & Minton, 1989). In cases in which women were not receiving adjuvant therapy, their post-treatment intervals ranged from two months (Burnham & Wilcox) to 17 years (Harris & Niesen-Vertommen).

Interventions

Seven studies examined aerobic exercise involving a cycle ergometer (Courneya, Mackey, et al., 2003; Winningham et

Breast cancer: breast neoplasms, breast cancer, cancer of the breast, breast cancer survivors

Exercise: exercise therapy, exertion, rehabilitation, exercise therapy, exercise training, exercise intervention, exercise intensity, exercise program, fitness, muscle strengthening, physical activity, physical fitness, physical therapy, resistance exercise, sports, physical education and training, therapeutic exercise, weight training, specific types of exercise (e.g., cycle ergometer, walking, tai chi)

Body weight and composition: body composition, body weight, body mass index, adipose tissue, obesity, percent body fat, subcutaneous skinfold measures, subcutaneous fat, lean body mass, bone density, body water, edema, lymphedema, energy metabolism, exercise tolerance, functional ability, functional assessment, functional capacity, physical function, muscular strength

Figure 1. Sample Search Terms for Breast Cancer, Exercise, and Weight and Body Composition Changes

Title and Abstract Screening for Full-Text Retrieval

Inclusion

- Articles published in English through 2005
- Review articles or primary studies published in journals, abstracts, proceedings, dissertations, books, or book chapters
- Exercise took place after participants were diagnosed with breast cancer.
- Inclusion (or probable inclusion) of one or more body weight or composition outcomes (i.e., fat mass, lean body mass, body water, or a combination)

Exclusion

- Fitness testing
- Editorials, news items, case reports, reviews, or letters
- Exercise as a risk factor for breast cancer development
- Exercise with a nominal effect on body weight and composition (e.g., movement therapy, stretching, passive range of motion)
- Exercise was part of a multicomponent intervention, and no separate analysis of exercise effects was done.

Full-Text Screening for Inclusion in the Review

- **Type of study:** primary
- **Population:** breast cancer survivors or a mixed sample of cancer survivors if breast cancer data were analyzed separately
- **Intervention:** exercise intervention that took place during or after cancer treatments or a multifaceted intervention if the exercise data were analyzed separately
- **Outcome:** included at least one outcome related to body weight or composition

Figure 2. Criteria Used in Screening for the Systematic Review on Breast Cancer, Exercise, and Body Weight and Composition Changes

al., 1989), walking (Segal et al., 2001), self-selected exercise (Courneya, Friedenreich, et al., 2003; Schwartz, 1999, 2000), or multiple methods (i.e., stair climber, treadmill, and stationary bicycle) (Burnham & Wilcox, 2002). Five programs tested a combination of aerobic and resistance training (Cheema, 2002; Harris & Niesen-Vertommen, 2000; Kolden et al., 2002; McKenzie & Kalda, 2003; Pinto et al., 2003), and one compared walking and tai chi (Galantino et al., 2003). One study focused on timing rather than type of exercise by examining preoperative versus postoperative exercises to prevent lymphedema and shoulder dysfunction (Bendz & Fagevik Olsen, 2002). Three studies involved exercise classes or groups (Kolden et al.; Pinto et al.; Segal et al.), six involved individually performed exercises (Bendz & Fagevik Olsen; Cheema; Courneya, Friedenreich, et al., 2003; Galantino et al.; Schwartz, 1999, 2000), and the remaining five did not clarify whether exercise was done in groups. Only five studies (Bendz & Fagevik Olsen; Courneya, Friedenreich, et al.; Galantino et al.; Schwartz, 1999, 2000) took place in an unsupervised setting (i.e., home-based setting outside of a fitness facility or laboratory), although an additional study compared supervised and self-directed walking programs (Segal et al.). None of the home-based studies involved resistance training. Prescriptions for fitness testing, duration, and frequency closely followed the guidelines of the American College of Sports Medicine ([ACSM], 1995). All but one study (Bendz & Fagevik Olsen) specified an exercise frequency of three to five times per week. The duration of exercise in 10 studies ranged from 15–20 minutes per session at baseline, with gradual progression to 20–35 minutes. McKenzie and Kalda added aerobic arm exercises using an arm ergometer in the

last six weeks of their program, which progressed from five to 20 minutes per session. The remaining studies did not specify the duration of participants' aerobic exercise sessions. Participants in Bendz and Fagevik Olsen's study performed five repetitions of prescribed arm and shoulder exercises three times daily.

The most varied components in the studies reviewed were program length, aerobic intensity, and approach to resistance. One intervention lasted six weeks (Galantino et al., 2003), whereas five lasted eight weeks (Cheema, 2002; Harris & Niesen-Vertommen, 2000; McKenzie & Kalda, 2003; Schwartz, 1999, 2000), four lasted 10–12 weeks (Burnham & Wilcox, 2002; Courneya, Friedenreich, et al., 2003; Pinto et al., 2003; Winningham et al., 1989), two lasted 15–16 weeks (Courneya, Mackey, et al., 2003; Kolden et al., 2002),

Data Extraction Criteria

- Study design
- Theoretical framework, if any
- Dates of data collection
- Study location (country)
- Sample size
- Sociodemographic and clinical data
- Baseline body weight and composition data
- Exercise intervention (e.g., type, duration, frequency, intensity, control condition, location, training or supervision, adjuncts)
- Length of follow-up
- Dropout rates
- Co-interventions
- Primary and secondary outcomes (e.g., outcomes measured, measurements used, reliability and validity of measurements, results)
- Statistical analysis methods

Quality Assessment Criteria

- **Selection bias:** Are the participants in the study likely to represent the target population? What percentage of selected individuals agreed to participate?
- **Allocation bias:** Did the study use a randomized design? Is the method of random allocation stated? Is it appropriate? Was the random allocation concealed?
- **Confounders:** Were between-group differences present at baseline for important confounders, and were they reported in the article? If important differences were present, were they managed adequately in the analysis? Were important confounders not reported?
- **Blinding:** Were outcome assessors blinded?
- **Data collection methods:** Were data collection tools shown to be or are they known to be valid? Were data collection tools shown to be or are they known to be reliable?
- **Percentage of withdrawals and dropouts:** What percentage of participants completed the study? (If the percentage differs by groups, record the lowest.)
- **Analysis methods:** Does the study include a sample size calculation or power calculation? Did the study show a statistically significant difference between groups? Are the statistical methods appropriate? Is the analysis performed by intervention allocation status (i.e., intention to treat) rather than the actual intervention received?
- **Intervention integrity:** What percentage of participants received the allocated intervention or exposure of interest? Was the consistency of the intervention measured?

Figure 3. Categories of Data Extraction and Quality Assessment for the Systematic Review on Breast Cancer, Exercise, and Body Weight and Composition Changes

Note. Based on information from Effective Public Health Practice Project, 2003.

Table 1. Effects of Exercise on Body Weight and Composition in Breast Cancer Survivors

Reference	Sample	Design	Intervention	Measurements of Body Weight and Composition	Outcomes
Winningham et al., 1989	N = 24, stage II, on chemotherapy for one to six months	RCT	No-exercise CG versus supervised EG; participants used a cycle ergometer for 20–30 minutes three times per week for 10–12 weeks at 60%–85% of their maximum heart rate.	Weight by platform balance beam scale; percentage of BF by SO3S; FFM by subtraction of fat mass from total weight	EG had less weight ↑ than CG (NS); FFM ↑ in EG and ↓ CG (NS); percentage of BF ↓ in EG and ↑ in CG ($p = 0.008$); initial fat losses were greater in the upper body; gains were greater in the hips.
Schwartz, 1999	N = 27, stages I–IV, all postoperative and on current chemotherapy	Nonrandomized (pre- and post-test)	Home-based, participant-selected aerobic exercise for 15–30 minutes at low to moderate intensity three to four times per week for eight weeks; weekly phone calls were made to encourage adherence.	Weight (no method reported)	Exercisers maintained or ↓ weight and non-exercisers ↑ weight ($t = 2.53$, $p = 0.03$); no weights were reported.
Harris & Niesen-Vertommen, 2000	N = 20, Dragon Boat racers post-breast cancer and in training; all had axillary node dissection plus RT and were 1–17 years postdiagnosis.	Nonrandomized (case series)	Supervised aerobic exercise (jogging, brisk walking, bicycling, or swimming) for 20–30 minutes at moderate intensity and six upper-body resistance exercises three times per week for eight weeks; all participants used a compression sleeve.	Arm volume by arm circumference at four sites	No change for 99% of data points; no difference between arms; strenuous exercise in women with axillary dissection with or without RT does not increase rates of lymphedema.
Schwartz, 2000	N = 78, stages I–IV, all within 21 days after surgery	Nonrandomized (pre- and post-test)	Home-based aerobic exercise for 15–30 minutes four times per week for four chemotherapy cycles; weekly phone calls were made to encourage adherence, goal updates, and personalized feedback and information.	Weight by standing balance beam scale	Exercisers ↓ 0.1 kg and non-exercisers ↑ 3.3 kg ($p < 0.05$); weight differences were significant at cycles 3 and 4, but not 2.
Segal et al., 2001	N = 123, stages I–II, 67% on chemotherapy	RCT	Usual care versus aerobic exercise five times per week for 26 weeks at 50%–60% of predicted $VO_{2\max}$; compared a supervised (three times per week supervised, two times per week home-based) and a fully home-based program; semi-weekly phone calls were made to encourage participants.	Weight (no method reported)	Weight ↓ in supervised EG (NS); among the nonchemotherapy subjects, supervised EG weight versus CG weight difference equalled 4.8 kg ($p = 0.01$); a longer exercise program demonstrated more beneficial effects than shorter ones.
Bendz & Fagevik Olsen, 2002	N = 230, preoperative	RCT	Usual care versus home-based shoulder and arm and grip strength exercises initiated on the first postoperative day; follow-up was done by a physiotherapist at 1, 6, and 24 months postoperatively.	Arm volume by water volume displacement	EG had ↓ arm volumes at 1, 6, and 24 months; NS compared to CG; early versus delayed initiation of arm exercise does not influence rate of lymphedema.
Burnham & Wilcox, 2002 ^a	N = 15, breast cancer in a group of 18 survivors of different cancers; $\bar{X} = 10$ months post-treatment; EG and CG matched on aerobic capacity.	RCT	No exercise versus supervised low- or moderate-intensity treadmill, bike, and stair-climber (equal time on each) for 14–32 minutes three times per week for 10 weeks; EGs were combined for analysis.	Weight (no method reported); BF percentage by SO3S	Slight weight ↓ in both groups (NS); BF percentage ↓ in EG (2.61%) and ↑ in CG (0.22%) ($p = 0.018$); pre- to post-EG change ($p = 0.003$)

(Continued on next page)^a Unpublished secondary analyses^b Physical fitness including body compositionBF—body fat; BMI—body mass index; CG—control group; EG—exercise group; FFM—fat-free mass; GP—group psychotherapy; HT—hormonal treatment; NS—nonsignificant; RCT—randomized controlled trial; RT—radiation therapy; SO3S—sum of three skinfolds; SO5S—sum of five skinfolds; $VO_{2\max}$ —maximal oxygen uptake

Table 1. Effects of Exercise on Body Weight and Composition in Breast Cancer Survivors (Continued)

Reference	Sample	Design	Intervention	Measures of Body Weight and Composition	Outcomes
Cheema, 2002	N = 27, Island Breast-Strokers, a post-breast cancer Dragon Boat team, $\bar{X}$ = 5.2 years after treatment	Nonrandomized (pre- and post-test)	Supervised resistance sessions of nine exercises plus abdominal curls two times per week plus three supervised or unsupervised aerobic sessions three times per week, all for eight weeks	Body composition by SO5S; also waist girth (cm) and hip girth (cm)	SO5S ↓ 11.7% (p = 0.00); waist ↓ 3.2% (p = 0.00); hip ↓ 2.3% (p = 0.00)
Kolden et al., 2002	N = 40, stages I–III, all after surgery, most one year or less after diagnosis; mixed postadjuvant or active chemotherapy, RT, and HT	Nonrandomized (pre- and post-test)	Supervised group aerobic (walk, cycle, step, dance) and resistance exercise (bands, free weights, machines) for 60 minutes total three times per week for 16 weeks; aerobic exercise gradually increased from 40% to 60%–70% $VO_{2\max}$	Weight (no method reported); BF percentage by SO3S with Lange calipers (Beta Technology, Santa Cruz, CA)	Weight ↓ (NS); BF percentage ↓ (NS); maintenance of weight and % BF is notable, given the trend to gain weight following adjuvant therapy.
Courneya, Friedenreich, et al., 2003 ^a	N = 39, breast cancer in a group of 96 survivors of different cancers attending GP	RCT (randomized by groups)	GP versus GP plus home-based walking three to five times per week for 20–30 minutes, progressive to 65%–75% of maximum heart rate	Body composition by SO5S	Mean SO5S ↓ in EG (–8.3 mm), ↑ in CG (12.3 mm) (p = 0.013) survivors; cancer site by group interaction; exercise had a greater effect on body composition in breast versus non-breast cancer.
Courneya, Mackey, et al., 2003	N = 53, stages I–III, postchemotherapy and RT, 46% current HT, $\bar{X}$ = 14 months after treatment	RCT	No training versus supervised cycle ergometer for 15–35 minutes at 70%–75% $VO_{2\max}$ three times per week for 15 weeks	BMI calculated on weight (Tanita 2100 electronic scale [Tanita Corporation of America, Arlington Heights, IL]) and standard height without footwear; BF percentage by SO5S with Fowler-John Bull calipers (Fred V. Fowler, Inc., Newton, MA)	BMI ↑ in both groups (NS); BF percentage ↓ in EG and ↑ in CG (NS); lymphedema rates were slightly higher in EG; lymphedema should be monitored closely in exercise studies.
Galantino et al., 2003	N = 11, stages II–IV, within one year post-chemotherapy or RT; regular exercisers were excluded.	RCT	Home-based walking versus group-based Yang family tai chi three times per week for six weeks; weekly phone calls were made to both groups.	BMI (no method reported); % BF by SO3S and estimation equations	BMI ↑ in walkers and ↓ in tai chi (NS); BF percentage ↓ in walkers and ↑ in tai chi (NS).
McKenzie & Kalda, 2003	N = 14, stages I–II, after treatment for at least six months	RCT	No-exercise CG versus EG with supervised aerobic exercise (cycling or walking) and upper body resistance exercise three times per week for eight weeks; all used compression sleeves.	Arm volume by arm circumference every 3 cm at 15 sites and volume displacement	No changes in arm volume by either method; progressive upper body exercise does not appear to affect arm volume in women with lymphedema.
Pinto et al., 2003	N = 24, stages I–II, mixed current and past treatment diagnosed within the past three years; all were sedentary.	RCT	No-exercise CG versus EG with supervised aerobic exercise (arm ergometer, stationary cycling, treadmill, or rowing) for 30 minutes three times per week for 12 weeks, progressing to 60%–70% of maximum heart rate; home-based exercise once a week during the last month	Weight (no method reported)	Slight ↓ in weight in EG (NS); on-site exercise may not be attractive to cancer survivors; research is needed on type, amount, and frequency of exercise for particular outcomes.

^a Unpublished secondary analyses

^b Physical fitness, including body composition

BF—body fat; BMI—body mass index; CG—control group; EG—exercise group; FFM—fat-free mass; GP—group psychotherapy; HT—hormonal treatment; NS—nonsignificant; RCT—randomized controlled trial; RT—radiation therapy; SO3S—sum of three skinfolds; SO5S—sum of five skinfolds; $VO_{2\max}$ —maximal oxygen uptake

one lasted 26 weeks (Segal et al., 2001), and one did not report length (Bendz & Fagevik Olsen, 2002). In general, exercise prescriptions were derived from baseline fitness testing, and intensity was progressed as tolerance increased. Variations in prescribed aerobic intensity targets arose from use of different criteria. Four studies used 60%–75% of maximum heart rate (Cheema; Courneya, Friedenreich, et al.; Pinto et al.; Winningham et al.), three prescribed exercises to maintain 40%–75% of participants' maximum oxygen consumption (Courneya, Mackey, et al.; Kolden et al.; Segal et al.), three set a low to moderate intensity (Harris & Niesen-Vertommen; Schwartz, 1999, 2000), and others varied or did not include information about intensity. Burnham and Wilcox compared participants who exercised at low and moderate intensities. Resistance prescription in the resistance exercise studies was discussed only once (Cheema). In general, resistance exercises were carried out two to three times per week for six to nine muscle groups. Three studies used free weights (Cheema; Kolden et al.; Pinto et al.), whereas a combination of resistance methods was reported in two other studies (Harris & Niesen-Vertommen; McKenzie & Kalda). Two of the resistance studies also included abdominal crunches or curls (Cheema; Pinto et al.).

Adjuncts to the exercise programs included personal feedback in all supervised programs (i.e., verbal encouragement and instruction by study personnel), frequent phone calls or checkups (Courneya, Friedenreich, et al., 2003; Galantino et al., 2003; Schwartz, 1999, 2000; Segal et al., 2001), instruction manuals or videotapes (Cheema, 2002; Courneya, Friedenreich, et al.; Galantino et al.), weekly group meetings (Galantino et al.), and compression sleeves to prevent lymphedema (Harris & Niesen-Vertommen, 2000; McKenzie & Kalda, 2003).

Outcomes

The most common primary outcomes in the studies reviewed were physical function or fitness, fatigue, and mood. Body weight or composition was identified as a primary outcome in only two studies (Schwartz, 2000; Winningham et al., 1989), and in both studies, body weight and composition were studied in secondary analyses from larger studies with other primary endpoints. Because four additional studies included a measure of lymphedema, they were considered by the review group in the current analysis to target a primary body composition outcome (Bendz & Fagevik Olsen, 2002; Cheema, 2002; Harris & Niesen-Vertommen, 2000; McKenzie & Kalda, 2003), bringing the total number of studies with primary body weight and composition outcomes to six.

Only 3 of 10 studies that assessed body weight or BMI reported significant between-group differences. Of these, two nonrandomized trials found that exercising participants maintained body weight whereas nonexercisers gained weight (Schwartz, 1999, 2000) ($p = 0.03$ [Schwartz, 1999]; $p < 0.05$ [Schwartz, 2000]), and an additional study found differences only in a subgroup of participants not on active treatment (Segal et al., 2001). More often, exercise had beneficial effects on body composition rather than weight. Of six studies that assessed changes in body composition, four noted significant differences between exercisers and nonexercisers (Burnham & Wilcox, 2002; Cheema, 2002; Courneya, Friedenreich, et al., 2003; Winningham et al., 1989). The four studies reported decreases of 2.6% ($p = 0.003$) to 11.7% ($p = 0.00$) in exercisers'

percentage of body fat compared to increases in body fat percentages among the controls. None of the studies that evaluated lymphedema noted significant increases with exercise (Bendz & Fagevik Olsen, 2002; Cheema; Harris & Niesen-Vertommen, 2000; McKenzie & Kalda, 2003).

Quality of Studies

Qualitative assessments of the reviewed studies are summarized in Table 2. Sample sizes in the studies reviewed ranged from 11 (Galantino et al., 2003) to 230 (Bendz & Fagevik Olsen, 2002), with a mean of 55. Only three studies enrolled samples of 75 or more participants (Bendz & Fagevik Olsen; Schwartz, 2000; Segal et al., 2001), whereas six enrolled 24 or fewer (Burnham & Wilcox, 2002; Galantino et al.; Harris & Niesen-Vertommen, 2000; McKenzie & Kalda, 2003; Pinto et al., 2003; Winningham et al., 1989).

For the first quality rating criterion, selection bias, the most common problem was accrual. Three studies accrued less than 60% of eligible subjects (Courneya, Mackey, et al., 2003; Pinto et al., 2003; Segal et al., 2001), and only one other study reported accrual data (Courneya, Friedenreich, et al., 2003). The Courneya, Friedenreich, et al. study was rated as very likely to have assembled a representative sample, whereas two others were assessed as somewhat likely (Schwartz, 1999, 2000). Other studies were rated as weak for a variety of reasons (e.g., volunteers, special interest groups, poor accrual).

Randomized participant allocation (i.e., randomized = strong; nonrandomized = weak) was the focus of design evaluation. For randomized controlled trials (RCTs), the use of no-treatment control groups and the methods of randomization, concealment, and blinding also were considered. Seven RCTs had usual care control groups (Burnham & Wilcox, 2002; Courneya, Friedenreich, et al., 2003; Courneya, Mackey, et al., 2003; McKenzie & Kalda, 2003; Pinto et al., 2003; Segal et al., 2001; Winningham et al., 1989), and two compared two interventions (Bendz & Fagevik Olsen, 2002; Galantino et al., 2003). All uncontrolled trials, including four pretest/post-test designs (Cheema, 2002; Kolden et al., 2002; Schwartz, 1999, 2000) and one case series (Harris & Niesen-Vertommen, 2000) were rated as weak on the participant allocation criterion. Of the nine randomized studies, the two that lacked a no-treatment control group were rated as moderate. Although several RCTs reported randomization procedures, only two that used fitness assessors who were blinded to participants' group assignments reported blinding procedures and were rated as strong on blinding (Courneya, Friedenreich, et al.; Courneya, Mackey, et al.).

Control of external variables and potential sources of contamination were assessed with confounders, as was control of important baseline differences between groups. Two variables with a strong potential to influence body composition in exercise trials are dietary intake and exercise other than the intervention. Although some studies controlled for other exercise, none monitored or controlled for dietary intake. Of the studies that examined overall body composition, only one controlled for lymphedema (Cheema, 2002). Thus, no studies were rated as strong on this criterion. Those that controlled for baseline differences or other exercise were rated as moderate.

Although measures of the major endpoints generally were well-described in the studies reviewed, body weight and composition measures were not. The data collection quality rating criterion was marked strong if a measure was described and was well known or shown to be reliable and valid, moderate

Table 2. Quality Ratings of Included Studies

Study	Likelihood of Selection Bias	Study Design	Control of Important Confounders	Blinding	Data Collection Methods	Withdrawals and Dropouts	Integrity and Consistency	Overall Rating
Winningham et al., 1989	Weak	Strong	Moderate	Weak	Strong	Strong	Strong	Weak
Schwartz, 1999	Moderate	Weak	Weak	Weak	Weak	Strong	Moderate	Weak
Harris & Niesen-Vertommen, 2000	Weak	Weak	Weak	Weak	Moderate	Strong	Weak	Weak
Schwartz, 2000	Moderate	Weak	Weak	Weak	Moderate	Strong	Moderate	Weak
Segal et al., 2001	Weak	Strong	Moderate	Weak	Weak	Strong	Moderate	Weak
Bendz & Fagevik Olsen, 2002	Weak	Moderate	Moderate	Weak	Moderate	Strong	Weak	Weak
Burnham & Wilcox, 2002	Weak	Strong	Moderate	Weak	Moderate	Strong	Strong	Weak
Cheema, 2002	Weak	Weak	Weak	Weak	Moderate	Strong	Strong	Weak
Kolden et al., 2002	Weak	Weak	Weak	Weak	Weak	Moderate	Strong	Weak
Courneya, Friedenreich, et al., 2003	Strong	Strong	Weak	Strong	Moderate	Strong	Strong	Moderate
Courneya, Mackey, et al., 2003	Weak	Strong	Moderate	Strong	Moderate	Strong	Strong	Moderate
Galantino et al., 2003	Weak	Moderate	Weak	Weak	Weak	Weak	Weak	Weak
McKenzie & Kalda, 2003	Weak	Strong	Moderate	Weak	Moderate	Strong	Weak	Weak
Pinto et al., 2003	Weak	Strong	Moderate	Weak	Moderate	Strong	Strong	Weak

if one of these elements was missing, and weak if both were missing. In the nine studies that reported weights, only three discussed weighing procedures (Courneya, Mackey, et al., 2003; Schwartz, 2000; Winningham et al., 1989). Of the five studies that measured body composition, all used and described methods of obtaining skinfold measures, but only two discussed reliability (Courneya, Friedenreich, et al., 2003; Winningham et al.). Of the four studies that measured lymphedema, all described data collection procedures, but one did not use water displacement, which is considered to be the most acceptable method of clinical lymphedema assessment (Harris & Niesen-Vertommen, 2000).

Assessment of withdrawals, dropouts, and intervention integrity (i.e., dose of the intervention) was the most strongly rated criterion among the studies reviewed. Retention of participants ranged from 78%–100% in 13 of 14 studies, with only one study not reporting the data (Galantino et al., 2003). Mean exercise adherence ranged from 60%–98% in 10 studies, whereas four did not report the data (Bendz & Fagevik Olsen, 2002; Galantino et al.; Harris & Niesen-Vertommen, 2000; McKenzie & Kalda, 2003).

Conclusions

Substantive Findings

Exercise increasingly has proven to be a safe and beneficial intervention for breast cancer survivors. Despite recognition that adverse body weight and composition changes occur during breast cancer and its treatment and that physical activity decreases during treatment, few studies have focused on the outcomes of body weight and composition. Because the outcomes have been of secondary importance, their investigation has not been conducted or described adequately.

The majority of women in the studies reviewed were involved in aerobic exercise and were not on active treatment. Exercise research only recently has explored the effects of

resistance alone, combined aerobic and resistance training, and compared aerobic training with other forms of exercise among participants on active cancer treatment. The comparison of aerobic and resistance training and the combination of the methods is particularly important for breast cancer survivors with weight issues because the women seem prone to developing sarcopenic obesity. Sarcopenic obesity refers to weight gain that involves no increase in or a loss of lean tissue (Demark-Wahnefried et al., 2001). Some also have noted that women are metabolically more resistant than men to weight and fat loss with exercise but may experience increased lean tissue mass (Winningham et al., 1989). Resistance training increases muscle mass, thereby increasing metabolism and promoting consumption of calories.

A study's length should be suited to its primary endpoint (Oldervoll, Kaasa, Hjermstad, Lund, & Loge, 2004), and insufficient duration to induce changes in body weight and composition is a common problem in exercise studies. The studies in this review ranged from 6–26 weeks in length, with only three exceeding 12 weeks' duration. Although exercise may affect outcomes such as fatigue and mood fairly quickly, body weight and composition take longer. The nonsignificant findings related to body weight and composition in the studies reviewed may have been the result, in part, of the short duration of the interventions.

In the 14 studies reviewed, body composition improved more consistently than weight. Several factors may account for the less favorable weight outcomes, including measurement error and women's previously noted metabolic resistance to weight loss with exercise. Increases in muscle mass also may have offset reductions in body fat. No relationship between the degree of weight change and the type or length of intervention was apparent. Furthermore, no differences were apparent in exercise type or duration, study design, baseline fitness levels, or treatment status that explain the differences between studies that did and did not report significant differences.

Qualitative Findings

None of the studies in the current review were designed or sufficiently powered to examine body weight and composition. None specifically recruited overweight breast cancer survivors, used gold standard measures of body weight and composition, controlled for dietary intake or body size, or employed the type of exercise known to strongly influence body weight and composition. Although methods of body weight and composition measurement sometimes were described, the descriptions were limited, methods were selected for convenience, and reliability and validity rarely were discussed. The major strengths of the studies were the many RCTs, the few withdrawals and dropouts, and the excellent adherence.

The problems of recruiting participants for exercise studies are legion (Oldervoll et al., 2004; Schwartz, 1999). For cancer survivors to exercise, they must have the motivation and ability to exercise and persevere, a rare level of commitment even in healthy individuals (Oldervoll et al.). A further problem is reluctance to be randomized to a control group when a socially desirable treatment is tested (Schwartz, 1999). The prevalence of small sample sizes in this review is partially a reflection of low accrual, and low accrual with high retention rates suggests that participants were a select and highly motivated group, which is especially likely because most studies required participants to attend supervised exercise facilities several times per week.

A number of the reviewed studies tested or controlled for baseline differences that could affect outcomes. Also, some effort was made to control for other exercise. However, no studies examined the effect of dietary intake, which has a strong potential to affect body weight and composition and to be altered during the course of chemotherapy as well as an exercise program. Women on adjuvant chemotherapy often report unusual dietary cravings that mimic those of pregnancy or find that increasing the frequency of meals and snacks relieves nausea (Heasman et al., 1985; Knobf, 1986).

Although lymphedema has the potential to alter body weight and composition significantly (Williams et al., 2002) and is more likely in the presence of weight gain (Petrek et al., 2001), it has been studied in isolation and not in the context of overall body weight and composition change. Only one study monitored participants for lymphedema in studying the outcomes of body weight and composition change (Cheema, 2002). However, none of the studies that measured lymphedema noted significant increases in relation to exercise, and the growing conviction that exercise may actually prevent or reduce lymphedema requires further study.

Implications for Nursing

Despite conjecture that exercise may be effective in controlling adverse body weight and composition changes among breast cancer survivors, the evidence is still sketchy. Future exercise research should assign body weight and composition primary importance. Refocusing on body weight and composition would, of necessity, change study designs and measures. In the studies under review, body weight and composition measures usually were chosen for convenience, and their reliability and validity rarely were mentioned. If studies are to make body weight and composition primary outcomes, an effort to adopt and describe more precise and accurate gold standard measurement techniques is required. More careful

examination of related variables such as other exercise and dietary intake also is warranted.

An important direction for further research is to expand the study of exercise among breast cancer survivors who still are undergoing active treatment and to investigate the interaction of different forms of exercise with different types of medical treatment. Furthermore, because premenopausal women are at greater risk for body weight and composition changes during adjuvant chemotherapy (Bonadonna et al., 1985; Camoriano et al., 1990; Demark-Wahnefried et al., 1997; Foltz, 1985; Goodwin et al., 1999; Huntington, 1985; Loprinzi et al., 1996), controlling for baseline menopausal status is important. Efforts to recruit large, unbiased samples also are required.

To date, interventions have focused on aerobic exercise, presumably because it was the best match for the outcomes of primary interest. That is, aerobic exercise is known to have a positive influence on treatment-related symptoms such as fatigue, mood disturbances, and physical fitness and functioning (Blanchard et al., 2001; Courneya et al., 2000; Courneya & Friedenreich, 1997; Courneya, Friedenreich, et al., 2003; Courneya, Mackey, et al., 2003; Gaskin et al., 1989; Mock et al., 1994, 1997, 2001; Nieman et al., 1995; Young-McCaughan & Sexton, 1991). However, to be effective in maintaining or increasing fat-free mass and constraining increases in adiposity, resistance training also is required (Al Majid & McCarthy, 2001; King & Tribble, 1991). Further research focused on resistance training—the optimal resistance, frequency, method, setting, and duration—is needed. Moreover, most studies in the current review are first generation, in that they are uncontrolled trials or compare a single exercise program with usual care (Courneya, 2001). Second-generation studies that compare two or more interventions will be the best approach to determining the most effective exercise for specific types of breast cancer survivors (Courneya). Another concern is that most of the studies were conducted under supervised conditions in a fitness facility. For women receiving cancer treatment, traveling to a fitness facility may be a significant barrier, which may account for some of the accrual problems in the studies reviewed. Sustaining an exercise program requires motivation and perseverance, is a problem even among healthy participants, and can present special challenges for cancer survivors (Oldervoll et al., 2004). Comparing the outcomes of supervised and home-based, self-directed programs is particularly important, in addition to better understanding which adjunctive measures (e.g., phone calls, training materials) might help to achieve comparability between settings.

Because authors rarely have studied body weight and composition as primary outcomes of interest, the existing literature is prone to methodologic drawbacks. However, beginning evidence supports exercise as a beneficial intervention that may help to control adverse body weight and composition changes among breast cancer survivors. Enhanced research efforts should assign primary importance to these outcomes, assemble unbiased samples of appropriate sizes, and attend to existing measurement issues. With these improvements, knowledge of the effects of exercise on body weight and composition and clinicians' ability to assist women in effectively managing their body weight and composition issues will be greatly enhanced.

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