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Physical Activity

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Abstract

Objective—To provide a summary of the research on the effects of exercise on cancer survivors during and following cancer treatment.

Data Sources—Electronic data bases, published studies and review articles.

Conclusions—While there is a growing body of research on the effects of exercise on cancer survivors, evidence is growing to support exercise interventions to improve quality of life, physiologic and psychological outcomes during and following treatment.

Implications for Nursing Practice—Nurses should provide encouragement and information to exercise to cancer survivors.

Today in the United States there are approximately 9.8 million cancer survivors who are alive, and the population of long-term cancer survivors continues to grow (1). Cancer treatments are increasingly efficacious and, for more than 20-years, survival rates for cancer have been improving (2). Because our understanding of cancer pathophysiology continues to improve, it appears this trend is likely to continue. Improved cancer survival rates do not tell of the numerous toxic sequelae that cause significant short and long-term physiologic and psychologic morbidity including pain, fatigue, reduced quality of life, and reduced cardiorespiratory capacity as well as increased risk for other common chronic diseases such as cardiovascular disease and diabetes (3). Exercise and physical activity interventions appear to be particularly appropriate for cancer patients and survivors because they have the potential to improve both physical and psychological health in the short- and long-term.

The purpose of this article is to review the research on exercise intervention in cancer survivors, the published research on exercise during and following cancer treatment, means of promoting exercise, the challenges of two recently completed trials, and suggest directions for future research. Because there have been several detailed reviews and meta-analyses of the effects of exercise during and following cancer treatment, a summary of the literature and review of recently completed trials is the primary focus of this article. Cancer survivors will be defined according to the National Coalition for Cancer Survivorship as

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“any individual that has been diagnosed with cancer, from the time of discovery and for the balance of life.” (4)

A computer-assisted search of Medline, CINAHL, Cochrane Library and Cancer Lit were performed to identify studies of exercise interventions during and following cancer treatment. The review was undertaken to systematically evaluate and summarize the results of exercise interventions for cancer survivors with any type or stage of cancer. With the exception of one study, all studies reported on patients with stage I-III cancer (5).

Effects of Exercise During Treatment

Over thirty-five studies were identified that examined the effects of exercise during cancer treatment. The exercise interventions included home-based and supervised exercise programs, aerobic and resistance exercise and ranged from 2- to 52-weeks; however, the dose of exercise was not specified in many of the studies.

The literature consistently demonstrates that exercise during cancer treatment is associated with an improved quality of life, oxygen capacity, cardiorespiratory fitness, muscle strength, flexibility, fatigue, anxiety, depression, pain, and anthropometric measures of body weight, body fat, waist and hip circumferences and other health related biomarkers including blood pressure, heart rate and circulating hormonal levels (6 – 17). Exercise is an evidence-based intervention to reduce cancer-related fatigue during treatment (18).

Effects of Exercise Following Treatment

Thirty eight studies examined exercise following the completion of cancer treatment. The majority used supervised exercise interventions; only 4 reported using home-based exercise. The interventions consisted of aerobic, resistance, and combined aerobic and resistance exercises. Presentation of the exercise dose (frequency, intensity and duration) was not clearly articulated in most of the studies.

The post-treatment benefits of exercise were strong for cardiorespiratory fitness, muscle strength, hemoglobin concentration, fatigue, depression, anxiety, vigor and vitality, body image, confusion, body size, mental health and quality of life (19 – 36). The effect of exercise following treatment does not appear to be as strong as during treatment. However many of the post-treatment studies have not been as methodologically rigorous as studies conducted during treatment.

Exercise, Recurrence and Overall Survival

Only three studies have examined the association between exercise, cancer recurrence, and overall survival. The results of these studies, in breast and colon cancer, suggest survivors who routinely exercise have significantly lower risk of developing disease or dying compared to their sedentary counterparts. Patients in these studies had been diagnosed with early stage breast cancer and early to advanced stage colon cancer. The breast cancer study followed over 1200 women following treatment (38), (NEED TO CITE REF. 37 BEFORE 38) while one of the colon cancer studies followed 573 people from the Nurses' Health

Study who were diagnosed with early to advance colon cancer (39), and the other followed 832 people with stage III colon cancer who had completed surgery and chemotherapy (40). These studies are the first to examine the role of regular exercise on preventing recurrence and improving survival. These findings strengthen the importance of exercise as an integral part of a cancer survivor's plan of care.

Meta-analyses

Several meta-analyses and critical reviews have examined the evidence that physical activity interventions were effective during and following cancer treatment on physical and emotional outcomes (41-46). A total of 1844 patients were included in the studies (1164 actively receiving treatment and 680 patients who had completed treatment). These studies demonstrated beneficial effects of exercise interventions on physical activity behavior, cardiorespiratory fitness, and side effects during cancer treatment. Following the completion of treatment, exercise demonstrated a positive effect on cardiorespiratory fitness and vitality/vigor. Definitive conclusions cannot be drawn from the meta-analyses because there are still too few studies. Intervention dose, study procedures, and lack of standardization also limit the scope of the meta-analyses.

Recommending Exercise

Studies describe different recommendations and guidelines for exercise based on various medical parameters, and individual investigator's experience. To date, however, there are no evidence-based cancer-specific guidelines for exercise or a position statement by American College of Sports Medicine, American Society for Clinical Oncology, Oncology Nursing Society or other authority. Until there are guidelines, clinicians, who may be hesitant to prescribe exercise for their patients, need to consider the potential harm from inactivity compared to the short- and long-term benefits on health. The efficacy of and tolerance for exercise by cancer patients has been demonstrated in many studies (10 – 37). It is clearly documented that inactivity during and following cancer treatment leads to decreased cardiorespiratory fitness, bone loss, muscle atrophy, declines in glucose metabolism, insulin sensitivity digestive function, immune function and increased cardiovascular risk (47). The documented benefits of a well designed exercise program, whether home-based or directly supervised, clearly outweigh the risks of rest and inactivity. Given the current interest in cancer and exercise, there is an urgent need to establish evidence-based cancer-specific exercise guidelines.

Until such guidelines are created, clinicians should tell their patients to exercise at least every other day at a moderate intensity that is symptom-limited. Patients should be told to start exercising slowly, well below their perceived ability, and progress in a slow, step-by-step fashion with the goal of increasing their exercise to at least 30 minutes. If exercising more than a few minutes at one time is too challenging for a patient, the individual should be instructed to break the exercise into short bouts with periods of rest in between exercise. While the ideal exercise recommendation is undoubtedly a combination of aerobic and resistance exercise, if a patient is only inclined to do one type of exercise, s/he should be encouraged to begin an aerobic exercise program that will have the benefits of increasing

cardiovascular fitness, strength, balance, and helping to maintain body weight and physical independence. Table 1 provides basic guidelines for exercise prescription.

Injuries and Adverse Events

The majority of studies that have reported on adverse events (N=14) have observed that physical activity during and following treatment is safe. Only two adverse events were reported in these studies: one reported nausea during an exercise session in a patient who was nearing the completion of radiation therapy (25), and another study(26) suggested that lymphedema was “borderline significantly higher” in the physically active group where three subjects experienced lymphedema. The authors noted that 2 of the 3 subjects had received axillary radiation, putting them at strong risk for lymphedema (26). A pilot study of upper body exercise for breast cancer survivors with lymphedema noted no increases in arm volume in the exercise group (27). Although many studies do not specifically report on injuries and adverse events, it could be assumed that these studies did not have injuries and adverse events related to the exercise. Given the number of survivors (during and following treatment) who have participated in a diversity of exercise intervention studies, it appears that well designed exercise programs are safe and pose a minimal risk to cancer survivors.

Promoting Exercise and Physical Activity

While many of the adverse acute and chronic effects associated with “efficacious” cancer treatment may be inevitable, it is likely that much of the co-morbidity and declines in functional ability of cancer patients and survivors may be ameliorated with exercise (38 – 40, 48 – 50). Cancer survivors are at an increased risk for co-morbid conditions such as cardiovascular disease, diabetes, osteoporosis, hypertension, overweight, and obesity, which may be directly attributed to cancer treatment, their personal genetic predisposition, and lifestyle practices. Some of these risk factors can be reduced by physical activity interventions that are introduced and reinforced by the oncology health care team and other health care providers (49). It is well recognized that a physician's recommendation for behavior change is a powerful means for patients and survivors to increase physical activity (51, 52). A randomized clinical trial observing the effect of physician recommendation to exercise on women with breast cancer observed an increase in 3.4 metabolic equivalent task (MET) hours per week of physical activity among women who received an oncologist's recommendation to exercise compared to those who did not receive the same message (53). Researchers converted the reports of physical activity (ranging from jogging to flights of stairs climbed) to metabolic equivalent task (MET) hours. For example, walking at a moderate pace for an hour is equivalent to three MET hours. While physician recommendations may increase patients beliefs that they can become more physically active, this motivational effect is largely untapped, given that fewer than 20% of oncologists encourage their patients to exercise (55, 54). Nurses are ideally positioned to provide physical activity recommendations and counseling (48 – 50). Cancer survivors are likely to face many of the barriers and challenges to exercise that are common to other individuals with chronic disease. Some of these barriers include being embarrassed to exercise with other people, fear of side effects, not knowing how to accommodate exercise to physical limitations, and the barriers that everyone faces such as being too busy, and not wanting to

feel uncomfortable. This makes the role of the nurse important in delivering motivational messages to exercise. These messages can be as simple as regularly talking to the patient about exercise, asking how they are doing with it, how they fit it into their day, how they are managing their symptoms so they can exercise and what makes it hard to exercise. Often a simple question asked in a chemotherapy room will start a whole conversation with other patients who are interested in what they can do for themselves to feel better during treatment.

There are a few contraindications to exercise that nurses should be aware of. These include febrile neutropenia, platelet counts below 50,000/mm³, hemoglobin below 10g/dl, and uncontrolled nausea, vomiting or pain. When platelet counts are low, exercise is feasible, but precautions need to be taken to reduce the risk of bleeding and head injury. Patients need to learn how to exercise within their ability and around any physical limitations they may have. Patients with peripheral neuropathy need to be warned to be aware of an increased risk of falling, however exercise can increase their balance and muscular strength ultimately reducing their risks of falling. Exercise should be considered part of standard care to maintain and improve a patient's physical and emotional function and an opportunity for patients to begin living a healthier lifestyle so they can live life to its fullest.

Recently Completed Trials and Their Challenges

Contamination in a Randomized Trial: Aerobic versus Resistance Exercise in Cancer Patients Receiving Catabolic Steroids

This 12-month randomized clinical trial compared the effects of aerobic exercise to resistance exercise and usual care control on newly diagnosed cancer patients beginning chemotherapy that included a catabolic steroid (e.g. decadron). One hundred one subjects were enrolled: Aerobic exercise (AE, N=34), resistance exercise (RE, N=32), Control (N=33). The exercise groups were instructed to follow the home-based exercise prescription 4 days a week for the 12-months of the study. The control group was instructed to continue doing their usual activities, because this study was a full year in length we felt that it was unethical to specifically tell subjects not to exercise. All subjects maintained an activity log. Outcomes were assessed at baseline, 6- and 12-months. Physiologic changes were assessed by 12-minute walk (functional ability), 1-repetition maximum test (muscle strength), balance beam scale (body weight) and bone density (bone densitometry). Fatigue was assessed with the Schwartz Cancer Fatigue Scale, and quality of life was assessed Sickness Impact Profile.

Eighty-eight per cent (N=89) of the subjects completed the trial. Adherence to the interventions declined over time: at 6-months there was 86% adherence to the AE group, 70% adherence to the RE group, and unfortunately 43% of the control group reported regular exercise. By 12-months, adherence to the interventions had declined to 66% adherence to AE, 31% adherence to RE and even more control subjects (54%) had started to exercise. The intent to treat analysis demonstrated a trend toward improved outcomes for the exercise groups for measures of functional ability, muscle strength, fatigue, social function, ability to work, and small, but significant differences in weight maintenance and bone density between the aerobic exercise and control groups. These differences were stronger at

6-months than 12-months, and greater in the aerobic exercise group. While many of the changes were not statistically significant, declines in fatigue were sufficient to indicate a clinically important difference (56). This trial was the first to follow cancer survivors for 12-months from the beginning of treatment and, despite the significant problems with exercise adherence and contamination, suggests the benefit of exercise during and following treatment on improving physical function and quality of life.

Challenges to Recruitment & Intervention Fidelity: The Breast Cancer Survivors: Raloxifene & Exercise (REX) trial

The REX trial was a four-arm double-blind placebo controlled longitudinal trial (12-months) designed to determine the effects of aerobic and resistance exercise training and raloxifene on bone health and multidimensional quality of life (physical and emotional function) in breast cancer survivors who had completed treatment. Women were enrolled (N=118) from two cancer centers and randomized to Usual care + placebo (N=29), Usual care + raloxifene (N=31), Exercise + placebo (N=30) or Exercise + raloxifene (N=28). Exercise subjects followed a supervised program for the first 3 months and were then transitioned to a home-based program. Outcomes were assessed at baseline, 6- and 12-months on the following measures: dual energy absorptiometry (DXA), bone-specific alkaline phosphatase, N-telopeptide to assess bone health, and Schwartz Cancer Fatigue Scale, 12-minute walk, 1-repetition maximum, cholesterol, Side Effect Check List, Positive & Negative Affect Scale, and Trail Maker to assess overall quality of life.

Adherence to this supervised and home-based exercise program was 86%, however 69% of the women in the control group also began to exercise at various times during the study. While there were problems with contamination, greater hurdles were encountered in the drug arm of this trial. The addition of a medication posed a challenge to recruitment (women did not want to take another medication, even if it might help reduce risks of a known side effect of treatment), and during the trial, women did not want to continue taking the medication. Other challenges that influenced the study included new research about female hormones and health added another impediment to women's willingness to participate and take a medication. Direct competition for subject recruitment with the Study of Tamoxifen and Raloxifene (STAR) trial was another challenge. Had this trial been an exercise only study, enrollment would have been much easier.

In spite of the many barriers, the intent to treat analysis demonstrated that bone health was improved among women who took raloxifene regardless of whether they exercised or not, but that women who exercised and took raloxifene had the most significant improvements. Overall quality of life was unchanged except that positive affect, aerobic capacity and muscle strength were improved for exercisers, regardless of drug assignment. This was the first longitudinal exercise trial designed to minimize some of the long-term side effects of cancer treatment and suggests that exercise has a bone preservation effect that is improved with the addition of raloxifene.

Limitations to the Research

While exercise and cancer survivorship is a rapidly emerging area of research, the quality and rigor of the studies is not uniform. Some limitations to the studies that make comparisons difficult include: (1) small sample sizes, (2) the poorly described methods, (3) inadequately articulated interventions including exercise dose, (4) interventions or study periods that did not coincide with the entire course of treatment, and (5) differences in measures and measurement times. As exercise and physical activity research in oncology develops, it will be increasingly important for researchers to use designs of the highest rigor, and report on details such as adverse events, completion, and adherence rates. Studies that do not provide a clear description of the exercise intervention are limited in their clinical applicability. Research reports should include information on exercise dose, withdrawal, drop-out, injuries/adverse events, and should clarify if the analysis is intention-to-treat. An intent-to-treat analysis is stronger than an actual treated analysis, but can be adversely affected by contamination which may weaken or leave no visible effect of the intervention, which is why researchers often report only the results of actual treated analysis.

Future Research Directions

Exercise has been embraced by survivors as a means to help themselves during and following treatment. While it is exciting to see this interest by survivors, for researchers this enthusiastic response to exercise poses challenges to designing and conducting rigorous trials. Home-based programs, such as the one described above, should build in motivators or goals to keep subjects exercising over the course of the study. The issue of contamination will continue to be a serious challenge that may be best addressed by using wait-list control groups, which may prevent the resentful demoralization and contempt that some subjects feel which prompts them to start their own exercise program. The wait-list control subjects feel like they will get their fair chance if they wait, so they are not as inclined to start their own programs.

Exercise interventions have proven benefit in reducing the functional ability declines associated with cancer and its treatment and also play an important role in preventing comorbidities, and in reducing risk of death from causes other than cancer (49, 58). There are still many unanswered questions about exercise effects on cancer survivors. Some questions for future research are: What or which types of exercise confer the greatest benefit to survivors? What is the optimal time to offer exercise interventions (at diagnosis before treatment starts, during treatment, after treatment)? What is the effect of sustained exercise on survival? Future studies should focus on clearly describing the intervention, and examining the data from a dose-response perspective so that specific prescriptive guidelines for exercise can be developed. Large, randomized clinical trials are needed to further examine the impact of exercise on recurrence and overall survival. Finally, developing a consensus on assessing key outcomes will allow for pooling of data and better comparison across studies.

For now, nurses should focus on talking to all of their patients about exercise, how to get started, and inquire about how they are doing with their exercise program on a regular basis.

Patients with physical challenges should be referred to physical therapy or other exercise professional if necessary to learn to exercise within their ability. *Cancer Fitness: Exercise programs for patients and survivors* (2004, Simon & Schuster) may be a helpful resource book for nurses to share with patients who are interested in starting an exercise program. The book provides a step-by-step approach to exercise during and following treatment and offers helpful information on symptom management and tested exercise programs.

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References

1. Jemal A, Murray T, Samuels A, Chafoor A, Ward E, Tun M. Cancer statistics 2003. *CA Cancer J Clin.* 2002; 53:5–26. [PubMed: 12568441]
2. Coleman MP, Rachet B, Woods LM, et al. Trends and socioeconomic inequities in cancer survival in England and Wales up to 2001. *Br. J. Cancer.* 2004; 90:1367–1373. [PubMed: 15054456]
3. Courneya KS, Friedeneich CM. Framework PEACE: An organizational model for examining physical exercise across the cancer experience. *Ann Behav Med.* 2001; 23:262–72.
4. National Coalition for Cancer Survivorship (home page on the Internet). Glossary. Available from: <http://canceradvocacy.org/resources/glossary.aspx>.
5. Porock DL, Kritjansson LJ, Tinnelly T, Duke T, Blight J. An exercise intervention for advanced cancer patients experiencing fatigue: a pilot study. *J. Palliat. Care.* 2000; 16:30–36. [PubMed: 11019505]
6. Adamsen L, Midtgaard J, Rorth M, Borregaard N, Andersen C, Quist M, Meller T, Zacho M, Madsen JK, Knutsen L. Feasibility, physical capacity and multidimensional exercise program for cancer patients undergoing chemotherapy. *Support Care Cancer.* 2003; 11:707–716. [PubMed: 12898370]
7. Schwartz AL. Fatigue mediates the effects of exercise on quality of life in women with breast cancer. *Quality of Life Research.* 1999; 8:529–538. [PubMed: 10548868]
8. Young-McCaughan S, Sexton DL. A retrospective investigation of the relationship between aerobic exercise and quality of life in women with breast cancer. *Oncol Nurs Forum.* 1991; 18:751–757. [PubMed: 2067964]
9. Segal RJ, Reid RD, Courneya K. Resistance exerciser in men receiving androgen therapy for prostate cancer. *J. Clin Oncol.* 2003; 21:1653–1659. [PubMed: 12721238]
10. Segar ML, Katch VL, Roth RS, et al. The effect of aerobic exercise on self esteem and depressive and anxiety symptoms among breast cancer survivors. *Oncol Nurs Forum.* 1998; 25(1):107–113. [PubMed: 9460778]
11. Mutrie N, Campbell AM, Whyte F, McConnachie A, Emslie C, Lee L, Kearney N, Walkter A, Ritchie D. Benefits of supervised group exercise programme for women being treated for early stage breast cancer: programmatic randomized controlled trial. *BMJ.* doi:10.1136/bmj.39094.AE (published February 2007).
12. Agency for Healthcare Research and Quality. Effectiveness of Behavioral Interventions to Modify Physical Activity Behaviors in General Populations and Cancer Patients and Survivors. US Department of Health and Human Services; Rockville, MS: 2004. p. 107-111. ASRQ publication 04-E027-2
13. Courneya K. Exercise in cancer survivors: An overview of research. *Med Sci Sports Exerc.* 2003; 35:1846–1852. [PubMed: 14600549]
14. Courneya K, Friedenreich C. Physical exercise and quality of life following cancer diagnosis A literature review. *Ann Behav Med.* 2005; 21:171–179. [PubMed: 10499138]
15. Pinto BM, Maruyama NC. Exercise in the rehabilitation of breast cancer survivors. *Psychooncology.* 1999; 8:191–206. [PubMed: 10390732]

16. Schwartz AL. Physical activity after a cancer diagnosis: Psychosocial outcomes. *Cancer Invest.* 2004; 22:82–92. [PubMed: 15069765]
17. Schwartz AL, Winters K, Gallucci B. Exercise effects on bone mineral density in premenopausal and postmenopausal women with breast cancer receiving adjuvant chemotherapy. *Oncol Nurs Forum.* 2007; 34:627–642. [PubMed: 17573321]
18. Mock V, Atkinson A, Barsevick A, Blackwell S, Cella D, Cianfrocca ME, et al. NCCN (v.1.2003). Cancer-related fatigue clinical practice guidelines in oncology. *J. Natl Comp Cancer Network.* 2003; 1:308–331.
19. Jones LW, Demark-Wahnefried W. Diet, exercise and complementary therapies after primary treatment for cancer. *Lancet.* 2006; 7:1017–1026. [PubMed: 17138223]
20. McTiernan A. Physical activity after cancer: Physiologic outcomes. *Cancer Invest.* 2004; 22:68–81. [PubMed: 15069764]
21. Dimeo FCHM, Tilmann H, BERTZ L, Kanz R, Mertelsmann, and J Keul Aerobic exercise in the rehabilitation of cancer patients after high dose chemotherapy and autologous peripheral stem cell transplantation. *Cancer.* 1997; 79:717–1722. [PubMed: 9024709]
22. Durak EP, Lilliy PC. The application of an exercise and wellness program for cancer patients: a preliminary outcomes report. *J. Strength Cond Res.* 1998; 12:3–6.
23. Keats MR, Courneya KS, Danileson S, Whitsett SF. Leisure time physical activity and psychosocial well-being in adolescents after cancer diagnosis. *J. Pediatr Oncol. Nurs.* 1999; 16:180–188. [PubMed: 10565106]
24. Winters, K.; Schwartz, AL. Quality of Life and Fatigue in Breast Cancer.. In: McTiernan, A., editor. *Physical Activity, Energy Balance, and Cancer: Etiology and Prognosis.* Marcel Dekker Publishing; 2006.
25. Mc Neely ML, Parliament M, Courneya KS, et al. A pilot study of a randomized controlled trial to evaluate the effects of progressive resistance exercise training on shoulder dysfunction caused by spinal accessory neurectomy in head and neck cancer survivors. *Head Neck.* 2004; 26:518–30. [PubMed: 15162353]
26. Courneya KS, Mackey JR, Bell GJ, Jones LW, Field CJ, Fairey AS. Randomized controlled trial of exercise training in postmenopausal breast cancer survivors: cardiopulmonary and quality of life outcomes. *J Clin Oncol.* 2003; 21:1660–1668. [PubMed: 12721239]
27. McKenzie DC, Kalda AL. Effects of upper extremity exercise on secondary lymphedema in breast cancer patients: a pilot study. *J. Clin Oncol.* 2003; 21:721–727.
28. Young-McCaughan S, Mays MZ, Arzola SM, Yoder LH, Dramiga SA, Leclerc KM, Caton JR, Sheffler RL, Nowlin MU. Change in exercise tolerance, activity and sleep patterns and quality of life in patients with cancer participating in a structured exercise program. *Oncol Nurs Forum.* 2003; 30:441–453. [PubMed: 12719744]
29. Ohira T, Schmitz KH, Ahmed RL, Lee D. Effects of weight training on quality of life in recent breast cancer survivors. *Cancer.* 2006; 106:2076–2083. [PubMed: 16568409]
30. Thorsen L, Skovlund E, Stomme SB, Hornslien K, Dahl A, Fossa SD. Effectiveness of physical activity on cardiorespiratory fitness and health-related quality of life in young and middle-aged cancer patients shortly after chemotherapy. *J Clinical Oncol.* 2005; 23:2378–2388. [PubMed: 15800330]
31. Mitchell TL, Yakiwchuk CV, Griffin KL, Gray RE, Fitch MI. Survivor dragon boarding: A vehicle to reclaim and enhance life after treatment for breast cancer. *Health Care for Women International.* 2007; 2:122–140. [PubMed: 17364976]
32. Milne HM, Wallman KE, Gordon S, Courneya KS. Effects of a combined aerobic and resistance exercise program in breast cancer survivors: a randomized controlled trial. *Breast Cancer Res Treat.* 2007; 105:49–007.
33. Korstjens I, Mesters, Ilse M, vanDer Peet E, Gijesen B, van den Borne B. Quality of life of cancer survivors after physical and psychosocial rehabilitation. *European J. Cancer Prev.* 2006; 15:541–547. [PubMed: 17106335]
34. Kendall AR, Mahue-Giangreco M, Carpenter CL, Ganz PA, Leslie B. Influence of exercise activity on quality of life in long-term breast cancer survivors. *Qual Life Res.* 2005; 14:361–71. [PubMed: 15892425]

35. Hong S, Bardwell WA, Natarajan L, Flatt SW, Rock CL, Newman V,A, Madlensky L, Mills PJ, Misdale JE, Thomson CA, Hajek RA, Chilton JA, Pierce JP. Correlates of physical activity level in breast cancer survivors participating in the Women's Health Eating and Living (WHEL) Study. *Breast Cancer Res Treat.* 2007; 101:225–232. [PubMed: 17028988]
36. Damush TM, Perkins A, Miller K. The implementation of an oncologist referred, exercise self-management program for older breast cancer survivors. *Psycho-oncology.* 2006; 15:884–890. [PubMed: 16378317]
37. Burnham TR, Wilcox A. Effects of exercise on physiological and psychological variables in cancer survivors. *Med Sci Sport Exerc.* 2002; 34:1863–1867.
38. Holmes MD, Chen WY, Feskanich D, et al. Physical activity and survival after breast cancer diagnosis. *JAMA.* 2005; 293:2479–86. [PubMed: 15914748]
39. Meyerhardt JA, Giovannucci EL, Holmes MD, et al. Physical activity and survival after colorectal cancer diagnosis. *J. Clin Oncol.* 2006; 24:3527–34. [PubMed: 16822844]
40. Meyerhardt JA, Heseltine D, Niedzwiecki D, et al. Impact of physical activity on cancer recurrence and survival in patients with stage III colon cancer: findings from CALGB 89803. *J Clin Oncol.* 2006; 24:3535–41. [PubMed: 16822843]
41. Schmitz KS, Holtzman J, Courneya KS, et al. Controlled physical activity trials in cancer survivors: Systematic review and meta-analysis. *Cancer Epidemiol Biomarkers Prev.* 2005; 14:1588–595. [PubMed: 16030088]
42. McKelly M, Campbell Kristin L, Rowe BH, Klassen TP, Mackey JR, Courneya KS. Effects of exercise on breast cancer survivors: a systematic review and meta-analysis. *CMAJ.* 2006; 175:34–41. [PubMed: 16818906]
43. Humpel N, Iverson DC. Review and critique of the quality of exercise recommendations for cancer patients and survivors. *Supportive Care Cancer.* 2005; 23:493–502.
44. Brockow, MM. Exercise for women receiving adjuvant therapy for breast cancer (Review). The Cochrane Collaboration. Published by John Wiley & Sons, LTD; 2007.
45. Knols R, Aaronson NK, Uebelhart D, Fransen J, Aufdemkampe G. Physical exercise in cancer patients during and after medical treatment: A systematic review of randomized and controlled clinical trials. *J. Clin Oncol.* 2005; 23:38303842.
46. Galvao DA, Newton RU. Review of exercise intervention studies in cancer patients. *J. Clin Oncol.* 2005; 23:899–909. [PubMed: 15681536]
47. U.S. Department of Health and Human Services. Physical activity and health: a report of the surgeon general. National Cancer for Chronic Disease Prevention and Health Promotion; Washington DC: 1996.
48. Doyle C, Kushi LH, Byers T, Courneya KS, Demark-Wahnefried W, Grant B, et al. Nutrition and physical activity during and after cancer treatment: An American Cancer Society Guide for Informed Choices. 2006; 56:323–353.
49. Brown JK, Byers T, Doyle W, et al. Nutrition and Physical activity during and after cancer treatment: An American Cancer Society guide for informed choices. *CA Cancer J Clin.* 2003; 53:268–291. [PubMed: 14570227]
50. Schwartz, AL.; Winters, K. Promoting Physical Activity in Cancer Survivors.. In: McTiernan, A., editor. *Physical Activity, Energy Balance, and Cancer: Etiology and Prognosis.* Marcel Dekker Publishing; 2006. NEED PAGE NUMBERS
51. Rauscher GH, Hawley ST, Earp JA. Baseline predictors of initiation vs maintenance of regular mammography use among rural women. *Prev Med.* 2005; 40:822–830. [PubMed: 15850884]
52. Demark-Wahnefried W, Pinto B, M. Gritz ER. Promoting health and physical function among cancer survivors: Potential for prevention and questions that remain. *J Clin Oncol.* 2006; 24:5125–5131. [PubMed: 17093274]
53. Jones LS, Courneya KS, Fairey AS, et al. Effects of an oncologist's recommendation to exercise on self-reported exercise behavior in newly diagnosed breast cancer survivors: A single-blind randomized controlled trial. *Ann Behav Med.* 2004; 28:105–113. [PubMed: 15454357]
54. Blanchard CM, Stein KD, Baker F, et al. Association between current lifestyle behaviors and health-related quality of life in breast, colorectal and prostate cancer survivors. *Psychol. Health.* 2004; 19:1–13.

55. Demark-Wahnefried W, Peterson B, McBride C, et al. Current health behaviors and readiness to pursue life-style changes among men and women diagnosed with early stage prostate and breast carcinomas. *Cancer*. 2000; 88:674–684. [PubMed: 10649263]
56. Schwartz AL, Meek PM, Nail LM, Fargo J, Lundquist M, Donofrio M, Grainger M, Throckmorton T, Mateo M. Measurement of fatigue. Determining minimally important clinical differences. *J Clin Epidemiol*. 2002; 55:239–244. [PubMed: 11864794]
57. Vallance JKH, Courneya KS, Jones LW, Reiman T. Differences in quality of life between non-Hodgkin's lymphoma survivors meeting and not meeting public health exercise guidelines. *Psycho-oncology*. 2005; 14:979–991. [PubMed: 15744764]

Table 1

Recommended aerobic and resistance exercise doses.

	Aerobic Exercise	Resistance Exercise
Frequency	At least every other day	Two to three days a week
Intensity	Moderate intensity: 50-75% predicted maximum heart rate or 10-14 on the Borg Rating of Perceived Exertion Scale	50% of maximum to begin
Duration	Work up to at least 30 minutes	2-3 sets of 10-12 repetitions