PHYSICAL EXERCISE AND QUALITY OF LIFE FOLLOWING CANCER DIAGNOSIS: A LITERATURE REVIEW

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ABSTRACT

With almost 8 million Americans alive today who have been through the cancer experience, it is important to develop interventions to maintain quality of life (QOL) following cancer diagnosis. Physical exercise is an intervention that may address the broad range of QOL issues following cancer diagnosis including physical, functional, psychological, emotional, and social well-being. The purpose of the present article was to provide a comprehensive and critical review of the topic and to offer suggestions for future research. The review located 24 empirical studies published between 1980 and 1997. Eighteen of the studies were interventions (i.e. quasi-experimental or experimental) but most of these were preliminary efficacy studies that suffered from the common limitations of such designs. Overall, however, the studies have consistently demonstrated that physical exercise has a positive effect on QOL following cancer diagnosis, including physical and functional well-being (e.g. functional capacity, muscular strength, body composition, nausea, fatigue) and psychological and emotional well-being (e.g. personality functioning, mood states, self-esteem, and QOL). Besides overcoming the limitations of past research, recommendations for future research included: (a) extending the research beyond breast and early-stage cancers; (b) comparing and integrating physical exercise with other QOL interventions; (c) examining resistance exercises, the timing of the intervention, and contextual factors; (d) expanding the breadth of the QOL indicators examined; and (e) investigating the rates and determinants of recruitment and adherence to an exercise program following cancer diagnosis.

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INTRODUCTION

Approximately 1.2 million Americans will be diagnosed with some form of cancer other than nonmelanoma skin cancer in 1998 (1). Over their lifetime, Americans have about a 41% probability of developing cancer (1). Early detection and improved treatments for cancer have resulted in increased survival rates over the last few decades. The most recent estimate of the 5-year relative survival rate for all cancers is 58% (1). Increased incidence rates combined with improved survival rates have resulted in nearly 8 million Americans being alive today with a history of cancer (1). This reality has placed an increased emphasis on addressing the quality of life (QOL) issues of concern to cancer patients and survivors (2).

Cancer diagnosis and its treatments (e.g. surgery, chemotherapy, radiotherapy) are often associated with negative side effects that diminish QOL. Some of the more common psychological and emotional sequelae of the cancer experience include depression, anxiety, stress, decreased self-esteem, loss of sense of control, and diminished psychological and emotional well-being (3–7). The physical and functional effects of cancer and its treatments include diminished cardiovascular function, reduced pulmonary function, decreased strength, deterioration of lean body tissue, weight change, difficulty sleeping, fatigue, nausea and vomiting, and pain (8–16). This research suggests that cancer patients are likely to experience a lower level of physical and psychologic functioning that may persist even after treatment is terminated. A strong need exists, therefore, for intervention strategies that will help mitigate the effects of cancer treatment on QOL and/or hasten recovery following treatment.

Currently, there are a number of QOL interventions that may help individuals cope with the cancer experience including cognitive–behavioural therapies (e.g. relaxation training, meditation), informational and educational strategies (e.g. procedural, medical), individual counselling or psychotherapy (e.g. existential, professional support), social support (e.g. by nonprofessionals such as family or other patients), and other alternative treatments (e.g. music therapy) (2,17). The effectiveness of these treatment therapies has been assessed in a recent meta-analysis that reported significant but small effects for the QOL outcomes of emotional adjustment, functional adjustment, treatment- and disease-related symptoms, and compound and global measures (17). No significant differences emerged among the treatment categories, indicating that all were equally effective (17). The uniform and modest success of current QOL interventions in cancer patients indicates the need to develop additional intervention strategies that may complement current approaches.

One common feature among the current QOL interventions is that they are largely psychologic in nature and are less likely to address adequately the physical and functional problems encountered by cancer patients (e.g. reduced cardiovascular and pulmonary function, loss of muscle strength, fatigue). This thesis finds some support in the Meyer and Mark (17) meta-analysis, since the weakest effect of the current QOL interventions was for functional QOL. Physical and functional well-being are considered by most QOL experts to be essential dimensions of overall QOL (18). In fact, recent research conducted with breast and colorectal cancer survivors has found that functional QOL was the least possessed but most important QOL dimension underlying overall satisfaction with life (19,20).

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An intervention therapy that may address the broad range of QOL issues following cancer diagnosis is physical exercise. The rationale for the use of physical exercise as a QOL intervention for cancer patients is very strong (21). Physical exercise is associated with numerous physiologic and psychologic health benefits in nondiseased populations that are typically diminished in cancer patients including cardiovascular fitness (22), pulmonary function (23), anxiety (24), depression (25), and self-esteem (26). Moreover, physical exercise has already been shown to be beneficial for the rehabilitation of patients with other chronic diseases including cardiovascular disease (27), essential hypertension (28), rheumatic disease (29), diabetes mellitus (30), pulmonary disease (31), and end-stage renal disease (32). Finally, anecdotal reports from clinicians, physical therapists, nurses, and cancer patients themselves regarding the benefits of physical exercise following cancer diagnosis are pervasive (33–36).

Based on this rationale, research has begun to emerge on the effectiveness of physical exercise specifically for cancer patients and survivors. Although some preliminary reviews of this literature exist (37–41), they have not been comprehensive or critical. The purpose of the present article was to provide a systematic, comprehensive, and critical review of the extant literature on physical exercise and QOL following cancer diagnosis with a view toward directions for future research.

LITERATURE REVIEW

A literature search of studies up to and including 1997 was conducted using the CD-ROM data bases of CancerLit, CINAHL, Heracles, MedLine, PsychINFO, and SPORT Discus. Key terms that related to cancer (i.e. cancer, oncology, tumor, neoplasm, carcinoma), rehabilitation (i.e. rehabilitation, therapy, treatment, intervention), and physical exercise (i.e. exercise, physical activity, physical therapy, sport) were combined and searched. Relevant articles were then hand-searched for further pertinent references. To be included in the review, studies had to examine physical exercise designed to improve cardiovascular and/or muscular fitness. Studies restricted solely to movement therapy and/or stretching/flexibility exercises for rehabilitation of range of motion were excluded. Studies were also excluded if they were inaccessible or presented in a form that did not provide sufficient detail to allow for critical review. This criterion resulted in the exclusion of four published abstracts (42–45), two conference proceedings (46,47), and one doctoral dissertation (48).

A total of 24 empirical studies were found that met the inclusion criteria (19,20,49–70). The studies were published between 1980 and 1997 and consisted of 20 journal articles (19,20,51–56,58–60,62–70), three doctoral dissertations (50,57,61), and one master's thesis (49). The authors, sample, design, exercise intervention/measurement, outcome variables/measures, and results for each study are presented chronologically in Table 1 separated by study design (i.e. descriptive versus intervention studies). An overview and summary of these parameters is provided in the following sections.

SAMPLES AND DESIGNS

Fourteen of the 24 studies examined breast cancer patients or survivors who were predominantly at Stage I and II of the disease (20,50,52,53,55,56,59–61,63,64,66,67,69). Four studies examined leukemia patients following bone marrow transplantation (51,54,57,65); two studies examined solid tumor patients following autologous peripheral blood stem cell transplants (58,68); and single studies were found for head and neck cancer survivors (62), colorectal cancer survivors (19), childhood cancer survivors (70), and one unspecified cancer site (49). The study designs consisted of 6 descriptive (19,20,59,60,66,67) and 18 intervention studies which could be further divided into 10 quasi-experimental (49,50,52,54,57,61,62,65,68,70) and 8 experimental (51,53,55, 56,58,63,64,69). The 18 intervention studies had sample sizes that ranged from 8 (50) to 70 (58) with a mean of 25. The descriptive studies had sample sizes that ranged from 54 (59) to 167 (20) with a mean of 93.

PHYSICAL EXERCISE INTERVENTION/MEASUREMENT

Of the 18 intervention studies, the exercise program in 7 studies was initiated during adjuvant therapy treatment (50,52, 53,55,56,63,69), whereas in 11 studies it was initiated posttreatment (49,51,54,57,58,61,62,64,65,68,70). Almost all intervention studies met the American College of Sport Medicine's (71) guidelines for the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory fitness, which is any aerobic activity that uses large muscle groups and is performed 3–5 days per week, for 20–60 continuous minutes, at 60% to 90% of maximum heart rate (71). The primary exercise mode in 8 of the intervention studies was a cycle ergometer (50,52,53,55–57,61), whereas 6 studies used walking either alone or combined with some other mode of exercise (62–65,68,69). One study employed resistance training (51), and 3 did not specify the type of exercise (49,54,70). The length of the intervention was 12 weeks or less in 14 studies (49–53,55–58,64,65,68–70), between 4 and 6 months in 3 studies (54,61,63), and 1 year in 1 study (62). Supervised exercise programs were reported by 13 studies (50–53,55–58,61,62,64,65,68), whereas 3 studies reported unsupervised, home-based exercise programs (54,63,69) and 2 studies reported a partially supervised exercise program (49,70).

The descriptive studies all employed self-report questionnaires to measure physical activity/exercise (19,20,59,60,66,67). Three studies used the Godin Leisure Time Exercise Questionnaire (19,20,66) and one study each used the Health Promoting Lifestyle Profile (59), a researcher-developed questionnaire (60), and an unreported measurement instrument (67). Two studies each obtained reports of current exercise from survivors (59,67); current exercise from a mixed sample of patients and survivors (60,66); and exercise prediagnosis, during treatment, and posttreatment as recalled by survivors (19,20).

OUTCOME VARIABLES/MEASURES

Objective indicators of physical and functional well-being were reported in all 18 intervention studies. More specifically, functional capacity was assessed in 15 studies by various methods, including symptom-limited graded exercise tests on cycle ergometers (50,52–55,57) and treadmills (49,58,64,65,68,70) and field tests such as the 6-minute (64) and 12-minute (63,69) walk tests. Body composition was assessed in five studies (49–51,56,70), usually by skinfold calipers. Muscular endurance/strength was assessed in four studies using either the Hand Dynamometer for grip strength (49) or tests of leg strength (57,62,64). Two studies each assessed flexibility using the Sit-and-Reach Test (49,62), natural killer cell activity (61,64), and hematological indices (58,68). Eleven studies, including descriptive studies (19,20,52,53,57,58,60,62,63,68,69), assessed physical and functional well-being by means of self-report using either general measures of QOL such as the Functional Assessment of Cancer Therapy (FACT) Scale (19,20) or specific measures of symptoms

TABLE 1
Empirical Studies of Physical Exercise and Quality of Life Following Cancer Diagnosis

Authors	Sample	Design	Exercise Intervention/ Measurement/Timing	Outcome Variables/ Measurement	Results
Descriptive Studies					
Nelson (59)	54 Stage I breast cancer survivors from state cancer registry and 54 controls from the community.	Cross-sectional	Self-reported posttreatment exercise using Health Promoting Lifestyle Profile.	Rosenberg Self-Esteem Scale and one item perceived health scale.	Among survivors, health-promoting behaviors (e.g. exercise) correlated positively with self-esteem.
Young-McCaughan and Sexton (60)	71 breast cancer survivors and patients from 2 university hospitals; 87% Stage I and II.	Retrospective	Self-reported exercise during or posttreatment using researcher-developed instrument.	Quality of Life Index for Patients With Cancer.	Regular exercisers reported a higher QOL than nonexercisers.
Baldwin and Courneya (66)	64 breast cancer survivors and patients from 4 support groups; 64% Stages I and II.	Cross-sectional	Self-reported mild, moderate, and strenuous exercise during or posttreatment using Godin Leisure Time Exercise Questionnaire.	Self-esteem (Rosenberg Self-Esteem Scale), physical acceptance (Body Image Visual Analogue Scale), physical competence (Physical Self-Efficacy Scale).	Strenuous exercise correlated positively with self-esteem and physical competence.
Bremer et al. (67)	90 breast cancer survivors of mixed ethnicity from South Africa.	Cross-sectional	Self-reported posttreatment exercise. Instrument not reported.	Psychological adjustment (Affect Balance Scale and Index of Well-Being), health locus of control (Multidimensional Health Locus of Control Scale).	No differences between survivors who did and did not report a regular exercise program.
Courneya and Friedenreich (19)	110 colorectal cancer survivors from provincial cancer registry; 86% Stages II and III.	Retrospective	Self-reported mild, moderate, and strenuous exercise prediagnosis, during treatment, and posttreatment using Godin Leisure Time Exercise Questionnaire.	Quality of life (Functional Assessment of Cancer Therapy and Satisfaction With Life Scale).	Survivors who permanently relapsed from pretreatment to posttreatment reported lowest QOL.
Courneya and Friedenreich (20)	167 breast cancer survivors from provincial cancer registry; 87% Stages I and II.	Retrospective	Self-reported mild, moderate, and strenuous exercise prediagnosis, during treatment, and posttreatment using Godin Leisure Time Exercise Questionnaire.	Quality of life (Functional Assessment of Cancer Therapy and Satisfaction With Life Scale).	Survivors who maintained exercise from pretreatment to posttreatment reported highest QOL.
Intervention Studies					
Buettner (49)	17 cancer survivors selected from 2 cities through American Cancer Society.	Quasi-experimental	1 supervised and 2 unsupervised exercise sessions/ week for 8 weeks consisting of cardiovascular, strength, and flexibility exercises during posttreatment.	Physical fitness (Balke Treadmill), grip strength (Hand Dynamometer), flexibility (Sit and Reach), body fat (skinfold caliper), personality (Cattell's 16PF Questionnaire).	Experimental group had ↑ weight loss, grip strength, flexibility, functional capacity, and personality changes than control.
Winningham (50)	8 Stage II breast cancer patients and 4 healthy controls from 3 medical centers.	Quasi-experimental	Supervised exercise on a cycle ergometer for 10–12 weeks, 3/week, 20–30 minutes, 60%–85% HRmax during chemotherapy.	Functional capacity (graded exercise test), body composition (skinfold calipers), locus of control (Multidimensional Health Locus of Control).	Experimental group ↑ functional capacity as much as healthy controls, whereas patient controls showed minimal change. Experimental group reported ↑ internal locus of control.
Cunningham et al. (51)	26 leukemia patients who underwent bone marrow transplants.	Experimental	Supervised exercise for either 3 or 5 days/week for 5 weeks for 30 minutes following BMT. Exercise consisted of resistive exercise (e.g. bench press).	Body composition (arm muscle circumference, biochemical parameters, skinfold).	Experimental groups maintained creatine excretion level whereas control group ↓.
MacVicar and Winningham (52)	10 Stage II breast cancer patients and 6 healthy controls.	Quasi-experimental	Supervised exercise on a cycle ergometer for 10 weeks, 3/week, 60%–85% HRmax during chemotherapy.	Functional capacity (graded exercise test) and mood disturbance (Profile of Mood States).	Experimental group ↑ functional capacity and mood equal to healthy controls; patient controls showed reverse effects.
Winningham and MacVicar (53)	42 breast cancer patients from university, medical, and private clinics, 83% Stage II.	Experimental	Supervised exercise on a cycle ergometer for 10 weeks, 3/week, 60%–85% HRmax during chemotherapy.	Nausea (Derogatis Symptom Checklist-90-Revised).	Experimental group showed larger ↓ in nausea than placebo and control groups.

TABLE 1
Continued

Authors	Sample	Design	Exercise Intervention/ Measurement/Timing	Outcome Variables/ Measurement	Results
Decker et al. (54)	12 patients with acute leukemia who underwent bone marrow transplants.	Quasi-experimental	Home-based exercise program for 30 minutes, 3/week at 85% HRmax starting 1 week before BMT and lasting 4 months. Exercise adherence was not reported.	Functional capacity (graded exercise test) and depression (Beck Depression Inventory).	Decreased maximal aerobic capacity and 20 lb. weight loss from pretransplant to 4-month posttransplant. Patients felt exercise program worthwhile.
MacVicar et al. (55)	45 Stage II breast cancer patients.	Experimental	Supervised exercise on a cycle ergometer for 10 weeks, 3/week, 60%–85% HRmax during chemotherapy.	Functional capacity (graded exercise test).	Experimental group showed ↑ functional capacity; control and placebo showed no change.
Winningham et al. (56)	24 Stage II breast cancer patients from outpatient chemotherapy clinic.	Experimental	Supervised exercise on cycle ergometer for 10–12 weeks, 3/week, 20–30 minutes, 60%–85% HRmax during chemotherapy.	Body weight and composition (skinfold calipers).	Experimental group showed ↓ in % body fat and ↑ in lean body mass; opposite for control group.
Pfalzer (57)	16 bone marrow transplant patients with various leukemias.	Quasi-experimental	Supervised exercise on a cycle ergometer for 3 days/week following BMT.	Physical fitness (peak VO2, peak torque) and symptoms (self-report).	Early and late intervention groups showed ↑ VO2 and torque, and ↓ depression and fatigue. Only early group showed ↓ HR and BP.
Peters (61)	13 Stage I and II breast cancer patients.	Quasi-experimental	Supervised cycle ergometer program for 5 weeks, 2–3/ week, 60%–86% HRmax posttreatment. Then self-reported exercise for 6 months, 2–3/week, moderate intensity.	Immune functioning (blood tests) and psychological functioning (Freiburg Personality Inventory).	Exercise resulted in ↑ natural killer cell activity and psychological well-being.
Seifert et al. (62)	44 head and neck cancer survivors in Germany who had undergone surgery and radiation.	Quasi-experimental	Supervised group exercise program for 1 year, 1/week, for 60 minutes (walking, stretching, and sport) posttreatment.	Physical capacity, flexibility, muscle endurance, and QOL (own instrument).	Trends in favor of experimental group but no significant differences due to small *n*.
Sharkey et al. (70)	10 childhood mixed cancer survivors who completed at least 1 year chemotherapy and received >100 mg/m^2 anthracyclines.	Quasi-experimental	Supervised exercise program for 12 weeks, 2/week, 60%–80% HRmax, 30 minutes posttreatment. Home-based exercise 1/week added for last 6 weeks.	Physical functioning (treadmill test), body fat, and pulmonary function (spirometry).	Exercise resulted in ↑ exercise time and trend towards ↑ peak oxygen uptake and ventilatory anaerobic threshold.
Mock et al. (63)	14 Stage I and II breast cancer patients from 2 medical centers.	Experimental	Combined walking/support program. Walking was home-based, self-paced for 10–45 minutes, 4–5/week during 4–6 months chemotherapy. Exercise self-reported.	Physical functioning (12-minute walk test), psychosocial adjustment (Psychosocial Adjustment to Illness Scale, Brief Symptom Inventory), Tennessee Self-Concept Scale, and Symptom Assessment Scales.	Experimental group showed ↑ physical functioning, psychosocial adjustment, and fewer symptoms than control at program midpoint and end.
Nieman et al. (64)	12 breast cancer survivors.	Experimental	Supervised walking and weight training program for 60 minutes, 3/week at 75% HRmax for 8 weeks during posttreatment.	Physical functioning (treadmill test, 6-minute walk test, leg strength) and natural killer cell activity.	Experimental group showed ↑ 6-minute walk test and strength test and ↓ in HR during testing than control. No differences in NKCA.
Dimeo et al. (65)	14 allogenic bone marrow transplant patients with hematological malignancies.	Quasi-experimental	Supervised treadmill walking program for 6 weeks, 5/week, 30 minutes, at 80% HRmax, started 18–42 days post-BMT.	Physical performance (training speed, distance walked, maximum performance, heart rate, lactate level).	Pre–post tests showed ↑ in all physical performance parameters.
Dimeo et al. (68)	32 autologous peripheral blood stem cell transplant patients with solid tumors or non-Hodgkins lymphoma.	Quasi-experimental	Supervised treadmill walking program for 6 weeks, 5/week, 30 minutes, at 80% HRmax, started at discharge.	Physical performance (speed, hemoglobin, HRmax, % HRmax) and fatigue (interview).	Experimental group showed ↑ maximum performance and hemoglobin levels and ↓ fatigue than control at posttest.

TABLE 1
Continued

Authors	Sample	Design	Exercise Intervention/ Measurement/Timing	Outcome Variables/ Measurement	Results
Dimeo et al. (58)	70 autologous peripheral blood stem cell transplant patients with solid tumors.	Experimental	Supervised "biking" using a bed ergometer 7/week for 30 minutes at 70% intensity from time of HDC until discharge.	Physical performance (treadmill speed), hematological indexes (hemoglobin, hematocrit, platelets, neutrophils), symptoms (pain, diarrhea, mucositis) and length of hospital stay.	Experimental group showed ↑ functional capacity at program end; ↓ neutropenia, thrombopenia; platelet transfusions; severity of pain and diarrhea; and hospital stay.
Mock et al. (69)	46 Stage I and II breast cancer patients from 2 university hospitals.	Experimental	Home-based, self-paced walking program for 20–30 minutes, 4–5/week during 6 weeks radiation. Exercise was self-reported.	Physical functioning (12-minute walk test), emotional distress (Symptom Assessment Scales), Piper Fatigue Scale.	Experimental group showed ↑ functional capacity and ↓ fatigue, anxiety, and sleep problems than control at program end.

such as nausea (53), fatigue (52,57,68,69), and diarrhea and pain (58).

Psychological and emotional well-being was assessed in 14 of the 24 studies (19,20,49,50,52,54,59,60–63,66,67,69). Four studies focussed on personality functioning using instruments such as Cattell's 16 Personality Factor Questionnaire (49), the Freiburg Personality Inventory (61), and the Health Locus of Control Scale (50,67). Four studies examined mood states (52,54,67,69) using instruments such as the Profile of Mood States (52), the Beck Depression Inventory (54), and the Affect Balance Scale (67). Four studies assessed general QOL (19,20,60,62) with instruments such as the FACT (19,20), the QOL Index for Patients With Cancer (60), and the Satisfaction With Life Scale (19,20). Finally, three studies examined self-esteem using either Rosenberg's Self-Esteem Scale (59,66) or the Tennessee Self-Concept Scale (63).

EMPIRICAL RESULTS

Overall, the studies have consistently demonstrated that physical exercise following cancer diagnosis has a positive effect on QOL including physical, functional, psychological, and emotional well-being (see Table 1). Specifically, 16 out of 18 (89%) intervention studies and 5 out of 6 (83%) descriptive studies reported statistically significant results for multiple QOL outcomes. The physical and functional benefits that have been demonstrated include improvements in functional capacity (49,50,52,55,57,58,63–65,68–70), muscular strength (49,57,64), flexibility (49), body composition (49,56), hematological indices (58,68), natural killer cell activity (61), nausea (53), fatigue (57,68,69), pain (58), and diarrhea (58). The psychological and emotional benefits that have been demonstrated include positive changes in personality functioning (49,61), locus of control (50), mood states including anxiety and depression (52,57,63,69), perceived physical competence (66), self-esteem (59,66), general QOL (19,20,60), and satisfaction with life (20). Although effect sizes could not be summarized across studies due to the diversity of outcomes with small numbers of effect sizes, the effects are clearly robust and clinically significant. The preponderance of statistically significant results for the intervention studies (89%) occurred despite the fact that these studies had, on average, only 25 participants per study.

LIMITATIONS OF PAST RESEARCH AND RECOMMENDATIONS FOR FUTURE RESEARCH

Although the literature reviewed is suggestive of a link between physical exercise and QOL following cancer diagnosis, there are a number of limitations that should be considered when interpreting the results and planning future research. Moreover, there are important unexplored issues that deserve research attention. The limitations of past research and directions for future research can be divided into the main categories used to organize Table 1. An additional issue of recruitment and adherence to physical exercise programs following cancer diagnosis will also be discussed.

Sample Limitations and Future Directions

One major sample limitation, the use of convenience sampling, is characteristic of almost all of the intervention studies. This method of sampling is problematic because there is no defined population from which the sample is drawn. With no defined population, the generalizability of the findings is in question because it is difficult to estimate the amount and nature of selection bias that may exist in the sample. A second limitation is the small sample sizes used in the intervention studies. An average of 25 total participants per study means that, on average, only about 12 or 13 participants were in the experimental condition. Small samples reduce the power of a study and also preclude the use of multivariate statistical techniques. The fact that almost all studies reported statistically significant results, however, makes this limitation less disconcerting. Nevertheless, future research on exercise following cancer diagnosis should attempt to recruit larger, random samples from a defined population such has been done in some of the descriptive studies (19,20) and one experimental study (58).

An important sampling issue for future research is to examine cancer patients at later stages of the disease. This research would help determine if exercise can play a role in the palliative care of cancer patients. Physical exercise for palliative purposes would be an attempt to maintain functional independence and quality of life for as long as possible. The only evidence that could be found in this regard was a case study reported by Winningham (41).

A second future direction is to extend the sample to a broader range of cancer sites. The unique demographics, pathology, surgical procedures, and treatment protocols associated with each type of cancer make it unwise to generalize the results from one cancer site to another. The majority of studies have examined breast cancer patients and survivors, and a significant minority have examined leukemia patients following bone marrow transplantation. Only single studies were found for colorectal cancer, head and neck cancer, mixed cancers, and childhood cancers. No published research is available for common cancers such as

prostate, lung, kidney, bladder, and uterine. Any cancer that is associated with QOL difficulties from the disease itself or its treatment (e.g. chemotherapy, radiotherapy) could potentially benefit from regular physical exercise following diagnosis.

Design Limitations and Future Directions

The main design limitation of descriptive studies is that they have been exclusively retrospective or cross-sectional which raises concerns of poor memory and recall bias. The descriptive design can be improved by employing a prospective approach. With respect to intervention studies, there is a need for more randomized experimental designs as opposed to quasi-experimental designs. The quasi-experimental designs suffer from numerous problems including nonequivalent control groups, participant self-selection into the experimental condition, the use of no-treatment control groups, or no control group at all. An appropriate control group would be equivalent on all relevant criteria receiving treatment identical to that of the experimental condition. Such a control group is necessary to control for the potential placebo effects due to expectation, attention, and involvement that are likely to result in an exercise study.

The issue of controlling for past exercise levels is of paramount importance to intervention studies. It seems reasonable to suggest that previously active people may benefit from maintaining exercise during cancer treatment; however, it is less intuitive to suggest that previously sedentary people will benefit from initiating exercise during cancer treatment. Thus, future intervention studies need to document the activity level of participants before their cancer diagnosis to determine any differential effects of exercise during cancer treatment based on previous exercise. It may even be desirable to stratify the sample based on this important baseline difference (72).

There is also the need to use repeated assessments of the main outcomes of interest to understand the timing of QOL changes that occur with physical exercise. Only one study to date has obtained more than preintervention and postintervention assessments (63). The most relevant time points for assessment would surround the adjuvant therapy and/or physical exercise programs. At the very least, the timing of assessments should include prior to program initiation, at program midpoint, at program end, and postprogram follow-up.

Perhaps the most interesting and rigorous evaluation of physical exercise interventions would be in comparisons and integrations with other currently accepted QOL interventions. To date, however, interventions have only demonstrated that exercise is better than nothing at all. Future research should compare physical exercise to the best available QOL interventions for cancer patients to determine the relative merits of each intervention for a given outcome. As an example, physical exercise could be compared to psychological counseling, informational and educational sessions, cognitive–behavioral strategies (e.g. progressive muscle relaxation, hypnosis, guided imagery), or social support interventions. Ideally, exercise will be shown to complement the best interventions rather than to simply be an alternative method to achieve the same outcome. Future research should attempt to determine if exercise can improve QOL in cancer patients beyond that realized by the currently most validated QOL interventions. For example, are there greater or broader QOL improvements in a combined psychological counseling and physical exercise intervention than with either intervention alone?

Exercise Intervention/Measurement Limitations and Future Directions

The descriptive studies and some intervention studies have relied on self-report measurements of physical exercise, sometimes with no known psychometric properties. The use of unvalidated or researcher-developed self-report instruments is unnecessary given the existence of reliable and validated instruments that can assess different kinds and time periods of physical exercise (73). Even validated self-report measures, however, are inferior to objective indicators of physical exercise such as activity monitors or attendance at fitness programs. Future descriptive and field-based intervention studies should attempt to obtain objective indicators of physical exercise.

A limitation of the intervention studies has been the length of the physical exercise intervention with the majority of interventions lasting for 12 weeks or less. This limitation may be problematic despite the fact that such short interventions have been consistently shown to improve fitness in cancer patients. The American College of Sports Medicine (ACSM) (71) has recommended a minimum of 15–20 weeks of physical exercise for the improvement of cardiovascular fitness but obviously the longer the intervention, the more definitive the test. Future research should continue to follow the ACSM guidelines for the frequency, intensity, and duration of physical exercise but should increase the length of the intervention.

One issue for future research is the type of physical exercise that is prescribed. All but one of the intervention studies examined aerobic or cardiovascular endurance exercise, whereas only four studies have included strength training exercises. A complete physical exercise program includes muscular strength and endurance exercises. Moreover, cancer patients report losses in physical strength and, therefore, such exercises should be included in interventions designed to improve QOL following cancer diagnosis.

A second issue for future research is the timing of the physical exercise intervention. Previous descriptive research has raised the question of whether interventions should begin during treatment or immediately posttreatment (19,20). The timing of the interventions has not been precisely documented in previous research. Seven of the 18 intervention studies initiated the exercise program during treatment but varied on whether it was initiated just prior to treatment, at the beginning of treatment, or 1 to 2 months into treatment. Of the 11 studies that initiated exercise posttreatment, only the bone marrow/stem cell transplant studies cited specific times for when the program was initiated (e.g. 58,65,68). The remaining intervention studies were often years after the treatment had ended and had large variations in time since treatment among participants. Future research should attempt to document the optimal time course of exercise interventions following cancer diagnosis. Descriptive studies should make it clear if they are describing exercise during treatment or posttreatment and not combine samples as has been done in some previous research.

It will also be useful to compare physical exercise programs on a variety of structural and contextual factors such as supervised versus unsupervised, institution-based versus home-based, and group versus individual. These parameters may be linked to QOL changes and/or exercise motivation and adherence.

Outcome Variable/Measurement Limitations and Future Directions

The most fundamental limitation in the selection of outcome variables has been the failure to follow a broad QOL framework. Most studies have included a collection of variables rather than a

systematic set of variables based on a QOL framework. Such frameworks will likely include various aspects of physical, functional, cognitive, emotional, spiritual, and social well-being. Theoretical models within a QOL framework might also be applied. For example, Baldwin and Courneya (66) examined a hierarchical self-esteem model that depicts a relationship between physical exercise and self-esteem mediated by self-efficacy, physical competence, physical acceptance, and physical self-worth.

A related limitation is that previous intervention research has focussed almost exclusively on either objective physiologic outcomes (e.g. functional capacity, body composition) and/or narrow psychologic outcomes (e.g. depression, locus of control, body image). This approach provides important information on intermediate outcomes of interest, but it is not consistent with a recent emphasis on global health indicators of QOL which are the ultimate outcomes of interest. The main point of using global QOL measures is that the more narrowly defined objective (e.g. cardiovascular endurance) or subjective changes (e.g. anxiety) in functioning that may result from exercise following cancer diagnosis need ultimately to be reflected in the broad dimensions of QOL or they may not have the practical benefit that is assumed. For this reason, it is important to understand if physical exercise can have an effect on overall QOL following cancer diagnosis and what specific dimensions are likely to be affected.

Concerning the breadth of QOL assessment, the most researched dimensions in the exercise and cancer domain have been physical, functional, and emotional well-being, whereas the least researched have been cognitive, spiritual, and social well-being. Future research on exercise and cancer should apply a broader QOL framework that includes all aspects of QOL. Moreover, some important specific indicators of QOL have been understudied. More studies need to include assessments of the common symptoms of cancer patients such as fatigue and pain.

Recruitment and Adherence to Physical Exercise Programs

The effectiveness of physical exercise as a QOL intervention following cancer diagnosis will depend to a large extent on the recruitment and adherence of participants to such a program. The reliance of previous research on convenience sampling has prevented the generation of any data on these issues. If few individuals can be recruited to an exercise intervention following cancer diagnosis, the results from such a study or intervention will be limited. Previous QOL intervention studies using psychosocial therapies (e.g. social support, psychotherapy) have typically attained an 80% recruitment rate (74). The physically demanding nature of exercise, however, makes it unlikely that such rates can be generalized to estimate recruitment rates to an exercise program. It is also likely that the determinants of exercise recruitment are different from those of other QOL interventions, most notably by including physical determinants such as body weight, body composition, fitness level, and previous exercise. Understanding the determinants of recruitment to an exercise program following cancer diagnosis is an important area of inquiry for future research.

The reliance on efficacy studies has also meant that the exercise interventions were, for the most part, completely monitored. They have usually consisted of individually supervised sessions on a cycle ergometer or treadmill in a research laboratory. Efficacy studies effectively eliminate the exercise adherence problem but raise questions about what the adherence rate would be once the intervention is implemented outside the laboratory. Self-initiated and self-maintained exercise will be necessary for any large-scale implementation of an exercise program following cancer diagnosis. It is not clear, however, that the majority of individuals who are receiving adjuvant therapy are able or willing to participate in a program of regular exercise. Previous exercise adherence research on a variety of populations has estimated a 50% dropout rate over the first 6 months (75,76). The unique surgical and treatment therapies that follow cancer diagnosis make it likely that even lower adherence rates would result. Once again, different determinants are likely to emerge in this population based on unique medical (e.g. stage, therapy type) and treatment (e.g. fatigue, nausea, pain) issues. Preliminary correlational research into the determinants of physical exercise following cancer diagnosis has been conducted but is limited at this time (59,60,72,77). Such information will be of great value for understanding and promoting exercise following cancer diagnosis should exercise interventions be warranted.

SUMMARY/CONCLUSION

A strong rationale exists for examining the effects of physical exercise on QOL following cancer diagnosis. Currently, there are 24 studies that have addressed this issue using both descriptive and intervention designs. The results of these studies suggest that physical exercise may improve QOL following cancer diagnosis, but there are limitations that must be considered when interpreting the findings. The most common limitations found in the present review were: (a) small convenience samples, (b) lack of appropriate control groups, and (c) relatively short interventions. The research is sufficiently strong, however, to warrant further investigations and a number of suggestions were made. The most important recommendations for future research were: (a) to extend the research beyond breast and early-stage cancers; (b) to compare and integrate physical exercise with other QOL interventions; (c) to examine resistance exercises, the timing of the intervention, and contextual and structural aspects of the exercise program; (d) to include a broader range of QOL indicators; and (e) to investigate the rates and determinants of recruitment and adherence to an exercise program following cancer diagnosis.

Finally, although physical exercise may be an effective QOL intervention for many cancer patients, it is important to recognize that there may be mitigating factors that make it unwise or even dangerous for some cancer patients to exercise. Some potentially mitigating factors include preexisting health conditions (e.g. cardiovascular disease) and cancer-related conditions such as cachexia, anemia, neutropenia, thrombocytopenia, and metastatic bone disease. This cautionary note is not meant to imply that cancer patients with such conditions could not benefit from an appropriately designed and supervised exercise program, only that the potential for adverse reactions may be high and continuous medical supervision may be required. Researchers interested in conducting studies involving physical exercise following cancer diagnosis should consult the guidelines on precautions and contraindications that have been outlined in the literature (21,38,41,78).

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