Riding the Crest of the Teachable Moment: Promoting Long-Term Health After the Diagnosis of Cancer

Wendy Demark-Wahnefried, Noreen M. Aziz, Julia H. Rowland, and Bernardine M. Pinto
From the Program of Cancer Prevention, Detection and Control Research, Duke Comprehensive Cancer Center, Durham, NC; Office of Cancer Survivorship, National Cancer Institute, Bethesda, MD; and The Miriam Hospital, Lifespan Academic Medical Center, Centers for Behavioral and Preventive Medicine, Brown University, Providence, RI.

Abstract

Purpose—Cancer survivors are at increased risk for several comorbid conditions, and many seek lifestyle change to reduce dysfunction and improve long-term health. To better understand the impact of cancer on adult survivors' health and health behaviors, a review was conducted to determine (1) prevalent physical health conditions, (2) persistent lifestyle changes, and (3) outcomes of previous lifestyle interventions aimed at improving health within this population.

Methods—Relevant studies from 1966 and beyond were identified through MEDLINE and PubMed searches.

Results—Cancer survivors are at increased risk for progressive disease but also for second primaries, osteoporosis, obesity, cardiovascular disease, diabetes, and functional decline. To improve overall health, survivors frequently initiate diet, exercise, and other lifestyle changes after diagnosis. However, those who are male, older, and less educated are less likely to adopt these changes. There also is selective uptake of messages, as evidenced by findings that only 25% to 42% of survivors consume adequate amounts of fruits and vegetables, and approximately 70% of breast and prostate cancer survivors are overweight or obese. Several behavioral interventions show promise for improving survivors' health-related outcomes. Oncologists can play a pivotal role in health promotion, yet only 20% provide such guidance.

Conclusion—With 64% of cancer patients surviving > 5 years beyond diagnosis, oncologists are challenged to expand their focus from acute care to managing the long-term health consequences of cancer. Although more research is needed, opportunities exist for oncologists to promote lifestyle changes that may improve the length and quality of life of their patients.

INTRODUCTION

Cancer survival has risen steadily over the past three decades for all cancers combined. Prevalence proportions estimated from cancer incidence and follow-up data from the Surveillance, Epidemiology, and End Results registry indicate that there currently are 9.8 million cancer survivors in the United States alone, representing between 3% and 4% of the...
entire US population.1-4 As advances in cancer detection, treatment, and care diffuse into clinical practice, the number of survivors is expected to increase. The aging of the population and a longer life expectancy in general will contribute further to this trend.

The proportion of long-term cancer survivors also continues to grow. Today, in the absence of other competing causes of death, an estimated 64% of those diagnosed with cancer can expect to be alive in 5 years, whereas in 1971 long-term survival was estimated at < 50%.4 As the number of survivors and their length of survival expand, long-term health issues specific to cancer survival are fast emerging as a public health concern. The purpose of this review is to (1) describe common medical sequelae occurring among adult cancer survivors, (2) summarize lifestyle changes that are pursued by this population after diagnosis, and (3) examine lifestyle interventions that may hold promise in reducing adverse treatment-related effects and comorbidity. Relevant observation and intervention studies were identified through MEDLINE and PubMed searches using the specific search term “cancer survivor,” as well as cross-referenced medical subject heading terms “neoplasms,” “survivors,” “diet,” “exercise,” “physical activity,” “smoking,” “intervention,” and “lifestyle.” Although all articles from 1966 and beyond were considered, for the sake of brevity the search was limited to articles in the English language that describe physical health outcomes and not inclusive of alternative or complementary medicine. Additionally, we incorporated summaries of recent reviews when they were available. Data suggest that although the cancer survivor is at risk for a host of conditions that range from cardiac compromise to secondary cancers, the oncologist may be optimally positioned to capitalize on the “teachable moment” created by the cancer diagnosis and play a pivotal role in guiding survivors toward behaviors that improve overall health and physical well-being.5-8

HEALTH ISSUES OF CANCER SURVIVORS

Cancer survivors are high healthcare utilizers who have several distinct healthcare issues.9 Data clearly show that cancer survivors are at greater risk for developing secondary cancers and other diseases; these risks may be brought on by cancer treatment, genetic predisposition, and/or common lifestyle factors.2,10-13 Although the threat of progressive or recurrent disease is at the forefront of health concerns for a cancer survivor, a comparison by Brown et al10 of > 1.2 million patient records obtained from the Surveillance, Epidemiology, and End Results database with those obtained from the National Center for Health Statistics shows that “the evidence that cancer patients die of noncancer causes at a higher rate than persons in the general population is overwhelming.” Increased morbidity and decreased functional status and disability that result from cancer, its treatment, or health-related sequelae also are significant concerns.

PROGRESSIVE/RECURRENT DISEASE AND SECOND PRIMARIES

Second cancers account for a large number of new cancers.1,2,11,13 A second primary may result from host susceptibility (genetic predisposition or immunodeficiency), a clustering of risk factors, common carcinogenic influences, treatment for the first tumor (eg, breast cancer after treatment for Hodgkin's disease), diagnostic surveillance, a chance event, or the interaction of these factors.1,2,13 Second cancers may occur in the same organ site (eg, breast or colorectal) and also at other sites, with leukemia and solid tumors of the breast, bone, thyroid, and bladder being reported most frequently. Thus, survivors can benefit from guidelines established for the primary prevention of these secondary cancers, as well as continued surveillance.1,14,15
METABOLIC SYNDROME–ASSOCIATED DISEASES: OBESITY, DIABETES, AND CARDIOVASCULAR DISEASE

Obesity is a well-established risk factor for cancers of the breast (postmenopausal), colon, kidney (renal cell), esophagus (adenocarcinoma), and endometrium; thus, a large proportion of cancer patients are overweight or obese at the time of diagnosis. Additional weight gain also can occur during or after active cancer treatment, an occurrence that has been documented frequently among individuals with breast cancer but recently was reported among testicular and gastrointestinal cancer patients, as well. Given data that obesity is associated with cancer recurrence in both breast and prostate cancer and reduced quality of life (QOL) among survivors, there is compelling evidence to support weight-control efforts in this population. Also, gradual weight loss has proven benefits in controlling hypertension, hyperinsulinemia, pain, dyslipidemia, and improving levels of physical functioning—conditions that reportedly are significant problems in the survivor population. Accordingly, the American Cancer Society Recommendations for Cancer Survivors list the “achievement of a healthy weight” as a primary goal.

Obesity represents one of several metabolic disorders that are frequently manifest among cancer survivors—disorders that are grouped under the umbrella of “the metabolic syndrome” and include diabetes and cardiovascular disease (CVD). Insulin resistance is the underlying event associated with the metabolic syndrome, and insulin resistance, co-occurring hyperinsulinemia, and/or diabetes have been reported as health concerns among cancer survivors. Diabetes may play a significant role in the increased number of non–cancer-related deaths among survivors; however, its role in progressive cancer is still speculative.

Although there is one study that suggests that older breast cancer patients derive a cardioprotective benefit from their diagnosis and/or associated treatments (most likely tamoxifen), most reports indicate that CVD is a major health issue among survivors, as evidenced by mortality data that show that half of non–cancer-related deaths are attributed to CVD. Risk is especially high among men with prostate cancer who receive hormone-ablation therapy, patients who receive adriamycin, and patients who receive radiation treatment to fields surrounding the heart. Although more research is needed to explore the potential benefits of lifestyle interventions specifically within survivor populations, the promotion of a healthy weight through a low-saturated-fat diet with ample amounts of fruits and vegetables and moderate levels of physical activity is recommended.

OSTEOPOROSIS

Osteoporosis and osteopenia are prevalent conditions in the general population, especially among women. Despite epidemiologic findings that increased bone density and low fracture risk are associated with increased risk for breast cancer, clinical studies suggest that osteoporosis is still a prevalent health problem among survivors. Data of Twiss et al indicate that 80% of older breast cancer patients have t scores less than −1 and thus have clinically confirmed osteopenia at the time of their initial appointment. Other cancer populations, such as premenopausal breast and prostate cancer patients, may possess good skeletal integrity at the onset of their disease but are at risk of developing osteopenia, which may ensue with treatment-induced ovarian failure or androgen ablation.

DECREASED FUNCTIONAL STATUS

Previous studies indicate that functional status is lowest immediately after treatment and tends to improve over time; however, the presence of pain and co-occurring diseases may affect this

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relationship.\textsuperscript{40} In the older cancer survivor, regardless of duration after diagnosis, the presence of comorbidity rather than the history of cancer per se correlates with impaired functional status.\textsuperscript{41} Cancer survivors have an almost two-fold increase in having at least one functional limitation; however, in the presence of another comorbid condition, the odds ratio increases to 5.06 (95\% CI, 4.47 to 5.72).\textsuperscript{42} These findings have been confirmed by other studies in diverse populations of cancer survivors.\textsuperscript{43-46} A cost analysis by Chirikos et al\textsuperscript{45} indicates that “the economic consequence of functional impairment exacts an enormous toll each year on cancer survivors, their families and the American economy at large.”

ESTABLISHING A HEALTHFUL LIFESTYLE: THE POTENTIAL BENEFIT FOR CANCER SURVIVORS

There are a variety of behavioral interventions that may mitigate elevated risk for the host of conditions for which the cancer survivor is especially vulnerable.\textsuperscript{1,2,47} However, because research on cancer survivorship is only just now receiving the attention it deserves, few studies have quantified longer-term physiologic outcomes of lifestyle change specifically within this population.\textsuperscript{48,49} According to the 2003 American Cancer Society Guide for Informed Choices, Nutrition and Physical Activity During and After Cancer Treatment, although no consensus exists to support “convincing evidence of benefit” as it relates to either disease-free or overall survival, current data do provide support for “probable” and “possible” benefit for several health behaviors, such as striving for a healthy weight, eating more fruits and vegetables and less saturated fat, and increasing physical activity.\textsuperscript{14} Although the focus of this article is on physical health, it is worth mentioning that some health behaviors, such as exercise are consistently associated with positive effects on psychological or emotional well-being (eg, mood states, self-esteem, and QOL) and reductions in fatigue.\textsuperscript{50-53} A recent study by Blanchard et al\textsuperscript{54} of 326 survivors of breast, prostate, and colorectal cancer suggests that survivors who exercise regularly, as well as those who practice more than one healthful behavior (ie, routine exercise, consumption of 5+ servings of fruits and vegetables per day, and tobacco abstinence), have significantly higher levels of health-related QOL than those who do not adhere to behavioral guidelines. Similarly, McBride et al\textsuperscript{55} found that psychological distress was lower among 988 breast and prostate cancer survivors who practiced healthful behaviors compared to those who did not.

LIFESTYLE PRACTICES AMONG SURVIVORS

A substantial number of reports suggest that cancer survivors spontaneously adopt lifestyle changes in hopes of achieving improved health. To date, published findings exist on \textgreater 20 studies that have explored persistent lifestyle practices among cancer survivors that extend beyond the year after diagnosis (Table 1).\textsuperscript{54,56-80} Although the preponderance of data suggest that the practice of healthful behaviors is notably higher among survivors, caution exists; given that such findings may be subject to bias (ie, survivors who do respond may be more likely to practice healthful behaviors).\textsuperscript{54} Findings of a recent prospective study by Satia et al\textsuperscript{81} on a population-based sample (N = 737), however, suggest that changes in lifestyle do accompany the cancer diagnosis; they observed significant increases in vegetable intake (\(P = .002\)) and physical activity (\(P < .001\)) among 278 colorectal cancer survivors from prediagnosis to 2-year follow-up, as compared with no change in age-, race-, and sex-matched controls.

TOBACCO AND ALCOHOL USE AMONG SURVIVORS

At the time of diagnosis, the incidence of smoking among cancer patients varies tremendously, with rates approaching 100\% among those with tobacco-related cancers of the lung or esophagus\textsuperscript{2,60,65,66,71} and rates of \(< 10\%\) among men and women diagnosed with non–tobacco-related cancers such as carcinoma of the prostate or breast.\textsuperscript{54,59} Quit rates vary

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Accordingly and range from 46% to 96% among smokers with lung, head, or neck cancers, as compared with only 4% noted among smokers with breast cancer.\textsuperscript{59,60,61,65,66,72} Data from the National Health Interview Survey suggest that approximately 20% of cancer survivors continue to smoke. Although smoking prevalence among survivors is lower than that for those without a cancer history (24%), it is not appreciably lower. Also worrisome is the observation that the highest rates are among the youngest group of survivors (ages 18-44), > 40% of whom report current smoking.\textsuperscript{2} Alcohol abstinence ranges from 47% to 59% in those with head and neck cancers (in which the association between drinking and cancer is strong) to between 8% and 16% in breast and lung cancer survivors (in which the strength of association is either weaker and/or newly established).\textsuperscript{61,63,70} Current studies on alcohol and tobacco use among survivors are limited by their relatively short-term follow-up, especially given the history of recidivism for these addictive behaviors. To date, only Gritz et al\textsuperscript{65} have reported data on longer-term follow-up (up to 4 years postdiagnosis), showing durable quit rates of approximately 40% among smokers diagnosed with lung cancer.

**DIETARY INTAKES OF CANCER SURVIVORS**

Dietary modification is another prevalent behavior change noted after diagnosis. Consumption of a “healthier diet” is reported by 30% to 60% of survivors, with a majority indicating reduced intakes of meat and increased consumption of fruits and vegetables, although not all of these studies used standardized, validated instruments or subscales to ascertain dietary data.\textsuperscript{58,59,64,68,69,70,73,74,76-78} A cross-sectional study by Tangney et al\textsuperscript{78} of 117 breast cancer survivors using a validated food-frequency questionnaire indicated mean Healthy Eating Index scores of 67.2 ± 13.2 within this population when compared with contemporaneous normative data existing on healthy women from the Continuing Survey of Food Intakes by Individuals (63.4 ± 13.3).\textsuperscript{82} The higher diet-quality scores described in this study were primarily a function of reported lower energy intakes (approximately 200 calories less per day) with concurrently higher fruit and lower meat consumption. Other studies suggest that 45% to 69% of survivors consume diets with < 30% of energy from fat and that 25% to 42% consume at least five servings of fruits and vegetables per day.\textsuperscript{54,59,74,77}

Recent findings of a longitudinal study of 260 breast cancer survivors tracked over the course of 2 years suggests that although initial dietary changes such as reduced fat and increased fruit and vegetable intakes may occur postdiagnosis, significant recidivism in fat intake occurs over time and fruit and vegetable intake, although increased, still remains suboptimal in a majority of survivors (75.8%).\textsuperscript{83} Furthermore, a large proportion of successfully treated cancer survivors are overweight or obese, \textsuperscript{11,14,15,18,20,22,48,74} with body weight increasing consistently and significantly over time,\textsuperscript{83} thus arguing for interventions aimed at energy restriction and/or increased physical activity.

**PHYSICAL ACTIVITY AMONG CANCER SURVIVORS**

Data regarding physical activity and cancer survivors are mixed, with some studies suggesting higher levels of physical activity,\textsuperscript{54,59,68,74,79} some suggesting no differences,\textsuperscript{57,67,75} and some suggesting less.\textsuperscript{58} Data from a study by Salminen et al\textsuperscript{76} indicate that 27% of survivors report more physical activity after diagnosis, whereas 10% report less after diagnosis. Interpretation of data is complicated further by recent shifts in guidelines. For example, a 2000 study by Demark-Wahnefried et al\textsuperscript{59} suggests that a majority of breast and prostate cancer survivors “routinely exercise.” However, this study was conducted at a time when the physical-activity guidelines were 20 minutes per day, 3 times per week, not the 30 minutes (American College of Sports Medicine) or the 60 minutes (Institute of Medicine) on most days per week currently recommended.\textsuperscript{84,85} Thus, it is doubtful whether a majority of survivors would be classified as “active” using these new criteria, although a recent study of breast, colon, and
prostate cancer survivors by Blanchard et al\textsuperscript{54} suggests that 70\% of survivors report exercising 30 minutes per day at least 5 days per week. As in the general population, cancer survivors frequently overestimate their level of physical activity; thus, these data are suspect.\textsuperscript{86,87} Regardless, it should be recognized that the impact of the media and the establishment of a role model may bring positive, sweeping change, as evidenced by the recent findings of Thorsen et al\textsuperscript{79} In this study of testicular cancer survivors, an increased odds ratio of 1.32 (95\% CI, 1.10 to 1.58) for physical activity was found, a result attributed to Lance Armstrong (testicular cancer survivor and seven-time winner of the Tour de France), because cycling accounted for much of the increased activity.

**FACTORS INFLUENCING LIFESTYLE CHANGE AMONG CANCER SURVIVORS**

Although a substantial proportion of cancer survivors spontaneously initiate positive behavioral changes, many do not. Males and those who are less educated, over the age of 65, or who live in urban areas are less likely to either undertake healthful changes in behavior\textsuperscript{54,59,64,73} or maintain them.\textsuperscript{55,65,88} Data originating from the area of mammography screening clearly show that physicians are among the most powerful catalysts for promoting behavior change\textsuperscript{89,90} and therefore may be optimally positioned to deliver guidance regarding health promotion. Indeed in a recent randomized controlled trial (\(N = 450\)) conducted by Jones et al,\textsuperscript{91} breast cancer patients randomly assigned to an arm receiving an oncologist’s recommendation to exercise reported a mean increase of 3.4 Metabolic Equivalents per week, compared with those not receiving a similar message (\(P = .011\)). Current reports, however, suggest that only approximately 20\% of oncology care physicians provide assistance in this area—an unmet need that may be driven by competing treatment or health concerns, time constraints, or an unsurety regarding the delivery of appropriate health-behavior messages and their potential impact on health outcomes.\textsuperscript{54,59,92,93} Abbreviated reviews in areas of smoking cessation, diet, and exercise follow in an effort to inform oncologists of lifestyle interventions that have been conducted to date and their associated outcomes.

**LIFESTYLE INTERVENTIONS AMONG SURVIVORS**

MacVicar and Winningham\textsuperscript{94} were the first to report results of a lifestyle intervention aimed at improving health among cancer survivors. Their study, which measured changes in functional capacity with an exercise program, was typical of many of the earlier behavioral studies that targeted cancer survivors (ie, studies on small samples, using quasi-experimental designs and using an amalgam of outcomes, including some that solely measured treatment-related issues such as nausea). During the ensuing years, the field has evolved, sample sizes of studies have increased, the rigor of experimental design has improved, and the breadth of studies has expanded. Although most of these behavioral interventions are focused on improving QOL and other psychosocial end points and are not included in this review, several are aimed specifically at improving physical health or functional outcomes. To date, published reports describe 20 exercise interventions,\textsuperscript{87,94-112} 11 diet-related interventions (not including those limited to dietary supplements or single nutrients),\textsuperscript{113-123} two diet and exercise interventions,\textsuperscript{124,125} six behavioral-based smoking-cessation interventions,\textsuperscript{126-131} and one sun-protection intervention.\textsuperscript{132} Brief summaries of studies that used a randomized design are listed in Table 2.

**SMOKING-CESSATION INTERVENTIONS AMONG CANCER SURVIVORS**

Smoking is well recognized for its causal association with lung and head and neck cancers, as well as CVD; however, less well known is its association with cancers of the cervix, bladder, and kidney.\textsuperscript{133} Thus, smoking cessation is of paramount importance for primary prevention.
and is essential also for preventing recurrence among those with tobacco-related carcinomas. Although one would expect that the cancer diagnosis may provide a “teachable moment,” Sanderson-Cox et al observed comparable uptake of a brief smoking-cessation intervention delivered by a nicotine-dependence counselor in both lung cancer and nonlung cancer patients (ie, 22% vs 14% abstinence rates, respectively; no significant difference in adjusted analyses). Similarly, no observed differences were seen between quit rates of head and neck cancer patients who received standardized advice to quit versus those who received more intensive counseling by their surgeons. Schnoll et al also observed no significant differences in quit rates when they compared cancer patients who received standard of care to those who received a brief (<5-minute) smoking-cessation intervention from their physician. Taken together, these findings suggest that proven smoking-cessation interventions may be appropriate for use among cancer survivors; however, more work is needed to develop effective interventions for use in these high-risk and resistant populations.

**DIETARY INTERVENTIONS AMONG CANCER SURVIVORS**

To date, there have been 11 reported dietary-intervention studies among cancer survivors. These have been divided equally across the following areas: (1) energy restriction; (2) fat restriction; and (3) a plant-based, low-fat diet. Dietary intake has been reported in seven of these studies, and findings suggest that interventions have been largely effective in promoting dietary change—a change that is confirmed in two of the three studies in which biomarkers of intake were collected (ie, serum carotenoids as a measure of fruit and vegetable intake). In eight studies, body weight was listed as an end point, and significant improvement in weight status was reported in all but one of these studies. Hormonal end points were measured in two of three studies that explored the effects of low-fat diet interventions, and findings suggest that estrogen profiles improved overall. Therefore, these dietary interventions seem successful, at least with respect to the end points considered. However, most dietary interventions to date have relied on intensive, in-person, individualized counseling sessions delivered by trained nutritionists and therefore are resource intensive. Kristal et al, Djuric et al, and Pierce et al have reported success in using less intensive interventions that are either delivered by trained volunteer staff, by commercial institutions (ie, Weight Watchers), or through telephone counseling, although trained nutritionists were still an important component of these interventions.

Combined approaches using individualized counseling, group classes, and telephone counseling have served as the delivery channels for two large, multisite, randomized controlled trials that should produce results regarding whether modifications in diet affect disease-free and/or overall survival. Published findings of the Women’s Intervention Nutrition Study (a trial that will test the effect of a low-fat diet [< 15% of total calories] in approximately 2,500 postmenopausal breast cancer patients) are anticipated soon. Results of the Women’s Healthy Eating and Living Study, a trial that will test the effect of more global dietary change (ie, daily intakes of five vegetable servings, 16 ounces of vegetable juice, three fruit servings, 15% to 20% energy from fat, and 30 g of dietary fiber) in 3,088 pre- and postmenopausal breast cancer patients are anticipated in 2006. Although preliminary findings suggest that these interventions have been effective in promoting biomarker-validated dietary change, the impact of dietary change on ultimate end points of disease progression and recurrence has yet to be determined. The results of both of these trials will be instrumental in filling the void that currently exists regarding the impact of dietary interventions on disease-free survival.

Although problems with anorexia and cachexia may continue among some groups of survivors such as those with head and neck cancers, for many survivors avoiding or controlling obesity is a far greater problem. Here, multiple behavior interventions that
use a comprehensive approach to energy balance and include both diet and exercise components may have the potential to be more effective than interventions relying on either component alone. In their evaluation of a diet and exercise intervention aimed at early-stage breast cancer patients, Goodwin et al found that aerobic exercise was the strongest predictor of weight loss. To date, findings of only two multiple behavior interventions among survivors have been reported, and both used quasi-experimental designs. There are, however, at least two studies that are currently in the field.

EXERCISE INTERVENTIONS AMONG CANCER SURVIVORS

Exercise-intervention trials have comprised the majority of the behavioral interventions conducted among cancer survivors to date. Many of these trials were undertaken to determine whether increased physical activity could relieve treatment-related nausea and fatigue or were aimed at improving QOL. Recent reviews by Courneya, Courneya and Friedenreich, Pinto and Maruyama, Schwartz, and the Agency for Healthcare Research and Quality find that exercise is consistently associated with improved QOL. The Agency for Healthcare Research and Quality review, as well as recent reviews by McTiernan and Galvao and Newton, suggest that exercise interventions have been effective also in improving physical functioning (ie, oxygen capacity, other fitness or strength measures, flexibility, and global health), anthropometric measures (ie, weight status, body fat, and waist and hip circumferences), and health-related biomarkers (ie, blood pressure, heart rate, hemoglobin concentration, and circulating hormonal levels). Increased engagement in social activities and less sleep disturbance have been reported also. A recent study by Fairey et al also suggests that exercise has a favorable effect on a subset of markers associated with metabolic syndrome such as insulin-like growth factor 1 and insulin-like growth factor-binding protein-3. Although it is clear that exercise is associated with many benefits for the cancer survivor, the impact of exercise on survival (whether overall or disease free) remains to be determined. Additionally, it is still unknown how soon after diagnosis exercise should be promoted. Although reviews suggest that early intervention has positive effects on QOL and several health outcomes, there is the potential, at least theoretically, for exercise to increase free-radical formation, reduce white blood cell counts, and interfere with treatment. Pre-existing conditions (eg, arthritis, chronic obstructive pulmonary disease) and adverse effects of treatment (eg, cardiac compromise secondary to anthracycline exposure) also may warrant caution in what types of exercise and how aggressively a survivor should pursue exercise after treatment. Thus, more research is necessary, as is prudent guidance for pursuing exercise in a moderate and stepped-dose approach, especially if undertaken during active treatment.

FUTURE DIRECTIONS: THE ONCOLOGIST’S ROLE IN PROMOTING HEALTH

As cancer joins the ranks of chronic disease, oncologists will increasingly find themselves at a juncture with their patients, as interests turn from acute care to managing long-term health. Cancer survivors thus present us with an exceptional opportunity to target primary, secondary, and tertiary prevention strategies capable of effecting beneficial outcomes at all three levels of prevention. A cancer survivor may simultaneously be a good candidate to receive (1) primary prevention messages such as reducing saturated fats in the diet and obesity management to prevent coronary heart disease and other potential comorbidities, (2) secondary prevention strategies such as screening for breast cancer in females previously treated for Hodgkin’s Disease or regular screening for other secondary malignant neoplasms among those diagnosed and treated for cancer, and (3) tertiary prevention methods such as the early detection and management of late effects of cancer treatment such as heart disease after adriamycin chemotherapy. Such strategies may overlap; for example, the use of DEXRA or Zinecard in relation to adriamycin-based chemotherapy may have implications in both primary and tertiary prevention. Messages and strategies also must be tempered and are affected by multiple

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mediating or moderating factors such as age (current and at diagnosis/treatment), genetic risk profile (family history), concurrent comorbidities, and so on. Figure 1 presents a model of some of the more salient and complex associations between prevention strategies, attendant targets, and potential moderators or mediators. A recent review by Kattlove and Wynn\textsuperscript{139} also can help guide oncologists in providing quality continuing care for their patients—care that spans a broad spectrum of medical areas ranging from surveillance to genetic susceptibility. As noted, cancer survivors increasingly are looking to their oncology care providers for counsel and guidance with respect to lifestyle change that will improve their prospects of a healthier life and possibly a longer one as well.\textsuperscript{95,139} Although complete data regarding lifestyle change among cancer survivors have yet to be determined and there remains an unmet need for behavioral interventions with proven efficacy in various cancer populations,\textsuperscript{140} the oncologist nonetheless can make use of extant data to inform practice and also should be attentive to new developments in the field. Physician-based strategies also can be adopted from those that currently exist in primary care.\textsuperscript{141-148} Additionally, the development of partnerships with behavioral researchers, as well as allied health personnel, may be helpful in overcoming barriers of limited time, resources, and expertise in delivering effective lifestyle interventions.\textsuperscript{149} A resource list of organizations that provide sound information regarding lifestyle behaviors also is provided in Table 3 to facilitate this exchange. For decades the cancer diagnosis has been acknowledged as a life-changing event. It is time for oncology care providers not only to lead their patients away from disease but also to capitalize on the teachable moment that cancer provides and guide their patients to better health.

REFERENCES


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123. Rose DP, Connolly JM, Chlebowski RT, et al. The effects of a low-fat dietary intervention and tamoxifen adjuvant therapy on the serum estrogen and sex hormone-binding globulin concentrations.


Fig 1.
Model for preventive health among cancer survivors.
Table 1
Post-Treatment Health-Behavior Practices Reported at Least 1 Year Beyond Diagnosis Among Adult Cancer Survivors

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample (size and key characteristics)</th>
<th>Key Findings</th>
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</thead>
<tbody>
<tr>
<td>Gritz et al⁶⁵</td>
<td>317 patients with resected stage I non–small-cell lung cancer who were current smokers at the time of diagnosis (up to 4 years postdiagnosis)</td>
<td>16.8% continued to smoke 53% quit smoking permanently (throughout period of observation) 30.2% quit smoking for some time period At 2 years, permanent cessation stabilized at &gt; 40%; however, the prevalence of continuing smoking decreased through all periods of follow-up; quitters were more likely to be female and healthier than continuous smokers</td>
</tr>
<tr>
<td>Ostroff et al⁷¹</td>
<td>74 patients with head and neck cancers who reported smoking within 1 year prior to diagnosis</td>
<td>65% quit smoking; of those that relapsed, 45% made two to five quit attempts, and 23% made more than five quit attempts</td>
</tr>
<tr>
<td>Dresler et al⁶⁰</td>
<td>362 lung cancer patients scheduled for a thoracotomy and followed an average of 17.5 months</td>
<td>The longer the patient is nonsmoking preoperatively, the more likely they are to remain nonsmoking postoperatively; 81% quit prior to surgery, 86% of whom remain nonsmokers postsurgery</td>
</tr>
<tr>
<td>Vander Ark et al⁸⁰</td>
<td>87 patients with squamous cell carcinoma of the head and neck</td>
<td>69% quit smoking, and 66% abstained from alcohol; smoking cessation was more likely among those who were older, who smoked &lt; 35 cigarettes per day, and who abstained from alcohol; pharmacologic aids alone were found to be of no value</td>
</tr>
<tr>
<td>Gritz et al⁶⁶</td>
<td>83 subjects from a previous smoking-cessation trial who completed 12 months of follow-up</td>
<td>25% quit successfully for at least 48 hours and then relapsed Relapse was significantly related to treatment (radiation therapy vs surgery), younger age of initiation, greater addiction (smoking ≤ 30 min after waking), and the use of gradual reduction “cold turkey” to quit</td>
</tr>
<tr>
<td>Demark-Wahnefried et al⁵⁹</td>
<td>978 survivors of locoregional breast or prostate cancer (1–6 years postdiagnosis)</td>
<td>58% routinely exercise 42% consumed five or more daily servings of fruits and vegetables 69% consumed a low-fat diet 8% smoked 80% were interested in health-promotion programs (54% interested in diet, 51% interested in exercise, and 60% of smokers interested in smoking cessation); preference for home-based formats (mailed materials followed by telephone counseling)</td>
</tr>
<tr>
<td>Ostroff et al⁷²</td>
<td>84 patients who were smokers at diagnosis and were receiving follow-up care for bladder cancer</td>
<td>Patients diagnosed at later stages were 2.80 times more likely to be continuous abstainers than those diagnosed sooner (95% CI, 1.08 to 7.25)</td>
</tr>
<tr>
<td>Allison⁵⁶</td>
<td>191 head and neck cancer patients</td>
<td>78.5% quit smoking 59.2% abstained from alcohol Higher education, living with one’s partner, later stage, laryngeal site, and having surgery or combined therapy were associated with higher quit rates; female sex, later stage, and less time elapsed since treatment were associated with alcohol abstinence</td>
</tr>
<tr>
<td>Hounshell et al⁶⁸</td>
<td>31 survivors of hairy cell leukemia</td>
<td>61.3% reported exercising more 51.6% reported a healthier diet</td>
</tr>
<tr>
<td>Maskarinec et al⁶⁹</td>
<td>143 survivors of various cancers in Hawaiian Cancer Registry diagnosed from 1995 to 1996</td>
<td>48% reportedly changed their diet postdiagnosis, with a majority indicating increased intakes of fruits and vegetables and decreased meat intake</td>
</tr>
<tr>
<td>Duffy et al⁶¹</td>
<td>81 head and neck cancer patients</td>
<td>65% quit smoking 54% abstained from alcohol Of those who continued to smoke or drink, 32% were interested in smoking-cessation services, and 9% were interested in alcohol abstinence</td>
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<td>Ganz et al⁶⁴</td>
<td>817 survivors of stage I or II breast cancer</td>
<td>48.4% reported a low-fat diet 20.4% reported a low-calorie diet 18.6% reported a low-salt diet 10% of women reported no “hard” activity</td>
</tr>
<tr>
<td>Gross et al⁶⁷</td>
<td>27 postmenopausal breast cancer survivors</td>
<td>52% reported no “very hard” activity</td>
</tr>
<tr>
<td>Maunsell et al⁷⁰</td>
<td>250 French Canadian women with nonmetastatic breast cancer (12 months postdiagnosis)</td>
<td>41% reported dietary changes at some time since diagnosis, with decreases in meat (77%) and increases in fruit and vegetable intake (72%) most common; women reporting changes were more likely to be younger, have positive nodes, be receiving adjuvant therapy, and be more distressed initially</td>
</tr>
<tr>
<td>Pinto et al⁷⁴</td>
<td>86 breast cancer survivors</td>
<td>54% were overweight or obese</td>
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</table>
### Study | Sample (size and key characteristics) | Key Findings
--- | --- | ---
Pinto et al\(^75\) | 69 stage 0-II breast cancer patients followed over the course of 1 year | 45% reported dietary fat intake of < 30% 72% exercised 39% reported both exercise and a low-fat diet Overweight and obese women had lower self-efficacy scores and were less likely to exercise or eat a low-fat diet than nonoverweight peers 13% exercised vigorously at time of diagnosis 29% exercised vigorously 12 months postdiagnosis 30% reported making dietary changes (more fruits and vegetables, less meat) 4% quit smoking 8% abstained from alcohol 27% reported increased physical activity (10% decreased physical activity)
Salminen et al\(^76\) | 139 Finnish breast cancer patients | 
Tangney et al\(^78\) | 117 Australian survivors of breast cancer (0.5-5 years postdiagnosis) | Survivors had lower energy intakes and higher Healthy Eating Indexes compared to normative data on a healthy population (Continuing Survey of Food Intakes by Individuals [CSFII])
Blanchard et al\(^57\) | 335 survivors of breast cancer compared to 6,880 noncancer controls | No differences between groups in levels of moderate and strong activity, although groups differed with regard to specific activity
Blanchard et al\(^58\) | 352 survivors of various cancers | 47% reported an improved diet 46% of smokers quit 30% reported exercising less
Earle et al\(^62\) | 5,965 elderly breast cancer survivors v age-, race-, and geographically matched controls 142 survivors of non–small-cell lung cancer (≥ 5 years postdiagnosis) | Survivors had higher rates of cervical and colorectal cancer screening 81% quit smoking 16.3% abstained from alcohol 51% were overweight 66.3% reported making lifestyle changes 40.4% reported making at least one dietary change 20.8% reported more physical activity Fewer changes were reported by males and individuals aged ≥ 65
Evangelista et al\(^63\) | 114 prostate, 126 breast, and 116 colorectal cancer survivors (total 357) | 
Patterson et al\(^73\) | 24 successfully treated patients with stage I or II oral cavity carcinoma | 25% consumed five or more servings of fruits and vegetables/day Low intakes of vitamins C and E; borderline intake of vitamin A 96% quit smoking 47% abstained from alcohol
Steward et al\(^77\) | 1,276 Norwegian testicular cancer survivors and 20,391 age-matched controls 117 prostate, 123 breast, and 86 colorectal cancer survivors (total 326) | Survivors had higher levels of physical activity (adjusted odds ratio, 1.32; 95% CI, 1.10 to 1.58) 70% exercise 30 minutes per day, 5 days per week 26% consumed five or more daily servings of fruits and vegetables 6% smoked
Thorsen et al\(^79\) | 278 colon cancer survivors and 459 age-, sex-, and race-matched controls followed from postdiagnosis to approximately 2 years postdiagnosis | Vegetable intake increased from 2.0 to 2.3 servings per day from pre- to postdiagnosis (\(P = .002\)); mean levels of physical activity increased from 179 to 228 Metabolic Equivalent Task h/wk (\(P = .0001\)) Survivors report approximately 0.5 servings per day increase in fruit and vegetable consumption and a reduction in fat intake postdiagnosis; fat intake increased from 34.5% to 35.5% (\(P = .01\)) over follow-up; fruit and vegetable increases were maintained but remained below recommended levels (ie, 4.2 servings per day)
Wayne et al\(^83\) | 260 breast cancer survivors followed from approximately 5 months postdiagnosis to approximately 2 years postdiagnosis |
<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects</th>
<th>End Points</th>
<th>Intervention</th>
<th>Findings</th>
<th>Comment</th>
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<tbody>
<tr>
<td>Smoking-cessation interventions</td>
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<tr>
<td>Gritz et al[^128]</td>
<td>186 individuals diagnosed with head and neck cancer</td>
<td>1, 6, and 12 months postintervention self-reported end points with cotinine confirmation: ever quit, point prevalence, and continuous abstinence</td>
<td>Control (N = 92): usual care, standardized advice to quit; intervention (N = 94): surgeon-delivered smoking-cessation counseling session postsurgery plus booster sessions at initial six monthly medical visits post-treatment</td>
<td>No significant differences between arms; 74% of intervention and 77% of controls reported continuous abstinence at 12-month follow-up</td>
<td>Attrition rate was 39%; inclusion of recent ex-smokers and delivery of minimal intervention among controls may have attenuated treatment effect</td>
</tr>
<tr>
<td>Stanislaw and Wewers[^131]</td>
<td>26 hospitalized surgical oncology patient smokers</td>
<td>Abstinence from smoking, as determined by saliva cotinine measured at first discharge visit</td>
<td>Control (N = 14): usual care; intervention (N = 12): structured smoking-cessation intervention during hospitalization followed by five weekly phone calls after discharge</td>
<td>At first postdischarge visit, 75% of experimental-group subjects were abstinent compared with 42.9% in the usual-care group</td>
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<tr>
<td>Griebel et al[^127]</td>
<td>28 hospitalized surgical oncology patient smokers</td>
<td>Self-reported smoking status at 6 weeks postdischarge with saliva cotinine validation</td>
<td>Control (N = 14): usual care; intervention (N = 14): one session, nurse-delivered minimal intervention</td>
<td>At 6 weeks, abstinence was noted in 21% of the intervention and 14% of the control arms</td>
<td>Among those who relapsed, smoking was resumed within 1 week of discharge</td>
</tr>
<tr>
<td>Schnoll et al[^130]</td>
<td>435 individuals with stage I-II cancer (of any type) or stage III-IV breast, prostate, or testicular cancer or lymphoma</td>
<td>Smoking abstinence: 7-day point prevalence, 30-day prolonged abstinence, and 6 months prolonged abstinence</td>
<td>Control (N = 218): usual care; intervention (N = 217): physician-delivered, brief (&lt; 5-minute) intervention regarding benefits of quitting, establishing quit date, discussion of nicotine-replacement therapy, provision of self-help materials and support services (1-800-4-CANCER telephone number and/or referral to a cessation program)</td>
<td>No significant difference in quit rates between the usual-care and intervention arms at 6 months (11.9% v 14.4%) and 12 months (13.6% v 13.3%), respectively</td>
<td>Higher quit rates in head, neck, or lung cancer patients who used self-help materials, attended group sessions, had a greater desire to quit, initiated smoking after age 16, and smoked &lt; 15 cigarettes per day</td>
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<tr>
<td>Dietary interventions</td>
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<tr>
<td>Nordevang et al[^120]</td>
<td>240 women with stage I-II breast cancer</td>
<td>Baseline and 1-and 2-years follow-up: dietary intake</td>
<td>Control (N = 119): usual care; intervention (N</td>
<td>Significant changes in intervention arm</td>
<td>Differential drop-out; at 2 years,</td>
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<tr>
<td>Study</td>
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<tr>
<td>Chlebowski et al&lt;sup&gt;114&lt;/sup&gt;</td>
<td>290 postmenopausal women with stage I-IIA breast cancer</td>
<td>Baseline, 3 months, 6 months, and every 6 months up to 2 years: dietary assessments; serum lipids; and height, weight, and waist circumference</td>
<td>Individualized dietary instruction by trained dietitians (behavioral theory not reported); control (N = 147): balanced diet; intervention (N = 143): low-fat diet (&lt; 20% total energy)</td>
<td>At 18 months, fat intake reduced significantly to 20.3 ± 2.4% in intervention arm v 31.5 ± 2.6% in control arm; significant weight loss of 1.46 ± 5.01 kg in intervention arm v weight gain of 1.8 ± 6.34 kg among controls</td>
<td>Disbelief that obesity is a problem for cancer patients was a barrier to recruitment</td>
</tr>
<tr>
<td>DeWaard et al&lt;sup&gt;115&lt;/sup&gt;</td>
<td>102 obese postmenopausal women with breast cancer (Netherlands and Poland)</td>
<td>Weight</td>
<td>Control (N = 43): usual care; intervention (N = 59): individualized dietary instruction by trained dietitians on energy-restricted (1,000-1,500 kcal/d) diet</td>
<td>At 1 year, median weight loss was 6 kg in intervention arm; weight loss was maintained in half the sample followed for another 2 years</td>
<td>50% attrition in both groups</td>
</tr>
<tr>
<td>Loprinzi et al&lt;sup&gt;119&lt;/sup&gt;</td>
<td>107 premenopausal women starting adjuvant chemotherapy for breast cancer</td>
<td>Weight, waist and hip circumference, and energy intake</td>
<td>Control (N = 53): physician and nurse informed subject of potential for weight gain and general ways to prevent it; intervention (N = 54): individual sessions with dietitian every 4-6 weeks on energy-restricted diet (behavioral theory not reported)</td>
<td>At 6 months, no significant differences between the two arms in outcome measures (mean weight gain was 3.5 kg in the control arm v 2 kg in the intervention arm)</td>
<td>Weight gain was significantly associated with higher body mass indexes at baseline (P = .01) and prior energy restriction (P = .02) within 6 months of participation</td>
</tr>
<tr>
<td>Kristal et al&lt;sup&gt;118&lt;/sup&gt;</td>
<td>144 postmenopausal women with stage I-II breast cancer, &lt; 18 months postdiagnosis, ≥ 110% of ideal weight</td>
<td>Baseline, and 3, 6, and 12 months: dietary intake and weight</td>
<td>Control: usual care; intervention: trained volunteer staff (40% were dietitians) administered individualized sessions and structured group sessions on a low-fat diet using the Transtheoretical Model</td>
<td>At 1 year, intervention arm significantly decreased their weight (3.5 ± 0.7 kg) and fat intake, compared with controls</td>
<td>Did not control for the effect of exercise on weight; at 1 year, attrition was 23% in the intervention arm and 25% in the control arm</td>
</tr>
<tr>
<td>Pierce et al&lt;sup&gt;121&lt;/sup&gt;</td>
<td>93 pre- and postmenopausal women with stage I-IIIA breast cancer within 4 years of diagnosis</td>
<td>Baseline and 6- and 12-month follow-up: dietary intake, serum lipids and carotenoids, and anthropometric data</td>
<td>Individualized dietary counseling delivered via telephone and using Social</td>
<td>Significant differences in change in intake between intervention v controls:</td>
<td>Attrition rate: 14% in intervention arm and 15% among controls</td>
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<thead>
<tr>
<th>Study</th>
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<tr>
<td>Hebert et al117</td>
<td>172 women diagnosed with stage I or II breast cancer within past 2 years</td>
<td>Baseline and 4-month and 1-year follow-up:</td>
<td>Cognitive Theory framework: control (N = 56); stress reduction (N = 51):</td>
<td>Subjects in the NEP had significant decreases in their fat intake (P &lt; 0.0002) and BMI (P = .003),</td>
<td>8% attrition</td>
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<td>energy intake, fat intake, complex carbohydrate intake, fiber intake, and body mass index</td>
<td>yoga and mindfulness; Nutrition Education Program (NEP) (N = 50);</td>
<td>changes that were evident at 4 months and largely maintained over the course of 1 year</td>
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<td>individualized and group Social Cognitive Theory-based; intervention: all programs were 15 weeks in duration</td>
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<tr>
<td>Djuric et al116</td>
<td>48 women with stage I-II breast cancer diagnosed within the past 4 years</td>
<td>Baseline and 12-month measures: weight and health status</td>
<td>Control (N = 16): received the National Cancer Institute’s “Action Guide to Healthy Eating” and the “Food Guide Pyramid” pamphlets, Weight Watchers (WW); intervention (N = 16); encouraged to attend WW meetings; individualized counseling intervention (N = 16); one-on-one counseling (Social Cognitive Theory), weekly contacts for first 3 months, biweekly for second 3 months, and monthly thereafter</td>
<td>Weight change at 12 months: control v WW, +0.85 ± 6.0 v −2.6 ± 5.9 kg, respectively; individualized counseling v combination, −8.0 ± 5.5 v −9.4 ± 8.6 kg, respectively (significant difference from control)</td>
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<tr>
<td>Pierce et al122</td>
<td>2,970 pre- and postmenopausal women with stage I-IIA breast cancer within 4 years of diagnosis and not on tamoxifen</td>
<td>Baseline and 12-month follow-up: dietary intake and plasma carotenoids</td>
<td>Individualized dietary counseling delivered via telephone and using Social Cognitive Theory framework:</td>
<td>Intervention arm experienced significant pre- and postintervention increases in vegetable, fruit, and fiber intakes (none in</td>
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<tr>
<td>Exercise interventions</td>
<td>MacVicar et al(^{106})</td>
<td>45 women with stage II breast cancer on chemotherapy</td>
<td>Pre- and postintervention: peak oxygen consumption and bike stress test</td>
<td>Standard control (N = 16): usual care; attention control (N = 11): thrice-weekly, 10-week program of stretching and flexibility exercises; intervention (N = 18): thrice-weekly, 10-week program of interval training cycle ergometry at 60-85% of MHR</td>
<td>Significant 40% increase in maximum oxygen uptake and performance on stress test in the intervention arm compared to both control arms</td>
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<tr>
<td></td>
<td>Wintingham et al(^{112})</td>
<td>24 women with stage II breast cancer on chemotherapy</td>
<td>Pre- and postintervention: bike stress test, weight, and skinfolds</td>
<td>Three-weekly, 10- to 12-week supervised program; control (N = 12): stretching and flexibility; intervention (N = 12): interval training cycle ergometry at 60-85% of MHR</td>
<td>Intervention arm had significant decreases in subcutaneous fat and % body fat compared to controls</td>
</tr>
<tr>
<td>Berglund et al(^{96})</td>
<td>199 individuals with cancer (majority were diagnosed with breast cancer)</td>
<td>Baseline and 3-, 6-, and 12-month follow-up: physical and social activities and physical strength and activities</td>
<td>Control (N = 101): usual care; intervention (N = 98): oncology nurse-facilitated 7-week (1- to 2-h) program that provided general information, physical skills, coping skills, and relaxation training</td>
<td>At 12 months, the intervention arm had significant improvements in physical status, strength, and sleep than controls; both arms had decreases in fatigue and health problems and increases in employment</td>
<td>Self-reported physical strength and no adherence data; multicomponent program</td>
</tr>
<tr>
<td>Dimeo et al(^{101})</td>
<td>70 individuals with various solid tumors post high-dose chemotherapy and bone marrow transplant</td>
<td>Prehospitalization and at discharge: treadmill stress test, hemoglobin concentration, and serum chemistry</td>
<td>Control (N = 37): usual care; supervised (N = 33): daily interval training with bed ergometer at ≤50% MHR</td>
<td>Intervention arm exercised on 82% of hospitalized days and had significantly greater maximum performance on the stress test after discharge than control arm</td>
<td>Dose of exercise was difficult to quantify because days to hospital discharge varied</td>
</tr>
<tr>
<td>Segal et al(^{110})</td>
<td>123 women with stage I-II breast cancer within 2 weeks of initiating adjuvant chemotherapy</td>
<td>Physical function, aerobic capacity, and weight</td>
<td>Control (N = 41): usual care; self-directed intervention (N = 40): individualized guidance via one</td>
<td>At 26 weeks, there were significant (P = .04) differences between groups regarding physical function</td>
<td>19.6% drop-out rate</td>
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<tbody>
<tr>
<td>[97] Burnham and Wilcox</td>
<td>[87] 18 breast or colorectal cancer survivors</td>
<td>Aerobic capacity, lower body flexibility, and body fat</td>
<td>in-person visit with exercise specialist and bimonthly telephone calls regarding warm-up, cool-down, and progressive-walking (5 d/wk) program at 50-60% VO2 maximum (concepts of Social Cognitive Theory [ie, self-monitoring and problem solving] were used); supervised intervention (N = 42); thrice-weekly exercise program with supervised warm-ups, cool-downs, and self-paced walking and structured exercise (expected to exercise at home twice weekly) Control (N = 7); usual care; low-intensity intervention (N = 7); exercise (25-35% MHR); moderate-intensity intervention (N = 7); exercise (40-50% MHR)</td>
<td>function: control: −4.1 patients; self-directed: +5.7 patients; supervised: +2.2</td>
<td>14% attrition</td>
</tr>
<tr>
<td>[107] McKenzie and Kalda</td>
<td>[88] 14 breast cancer survivors with unilateral upper extremity lymphedema</td>
<td>Arm volume, arm circumference, and Short Form-36</td>
<td>Control (N = 7); usual care; intervention (N = 7); 8-week upper body resistance training and aerobic arm ergometer training</td>
<td>After 10 weeks, no difference between exercise arms but a significant difference between exercise and control arms in aerobic capacity (P &lt; .001), lower body flexibility (P = .027), and body fat (P &lt; .001)</td>
<td>No differences in arm measures between groups but the intervention group had higher physical function (P = .05), general health (P = .048), and vitality (P = .023)</td>
</tr>
<tr>
<td>[88] Pinto et al</td>
<td>[88] 24 sedentary women with stage 0-II breast cancer</td>
<td>Blood pressure, heart rate, and weight</td>
<td>Control (N = 12); wait list; moderate aerobic exercise (N = 12): 12-week, thrice-weekly, 60-70% MHR clinic-based mixed regimen with encouragement to exercise at home at least once per week</td>
<td>Pre-post decreases in the intervention arm: systolic blood pressure: −13.5 (P &lt; .05); diastolic blood pressure: −8.9 (P &lt; .05); heart rate: −1.56 (NS); weight: −2.8 kg (NS)</td>
<td>25% attrition and 88% adherence in intervention arm</td>
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<tr>
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<tr>
<td>Segal et al111</td>
<td>155 men with prostate cancer scheduled for androgen deprivation</td>
<td>Weight, waist circumference, skinfolds, fatigue, and upper and lower body fitness</td>
<td>Control (N = 73) usual care; intervention (N = 82); thrice-weekly resistance training</td>
<td>Intervention group had improved upper (P = .009) and lower (P &lt; .001) body fitness and less fatigue (P = .002)</td>
<td>No difference in body composition, weight, and anthropometric measures</td>
</tr>
<tr>
<td>Courneya et al98</td>
<td>108 individuals with a variety of cancers, most of whom were diagnosed within 1 year</td>
<td>Sit-and-reach test, skinfolds, and fatigue</td>
<td>Attention control (N = 48); 11 group psychotherapy sessions over 10 weeks; intervention (N = 60); psychotherapy + exercise: 11 group psychotherapy sessions and encouragement to exercise on own three to five times per week at moderate intensity (Theory of Planned Behavior)</td>
<td>Exercise arm demonstrated significantly better functional well-being, decreased skinfold measures, and less fatigue at follow-up</td>
<td>11% attrition and 84% adherence; 22% of control arm regularly exercised</td>
</tr>
<tr>
<td>Courneya et al99</td>
<td>53 postmenopausal women with breast cancer who completed treatment</td>
<td>Peak oxygen consumption and peak power output</td>
<td>Control (N = 28): usual care; intervention (N = 25); moderate-level thrice-weekly cycle ergometer sessions for 15 weeks (Theory of Planned Behavior)</td>
<td>Intervention group had significantly higher peak oxygen consumption and power output</td>
<td>2% attrition</td>
</tr>
<tr>
<td>Fairey et al104</td>
<td>53 postmenopausal women with breast cancer who completed initial treatment</td>
<td>Insulin resistance and IGF-1,2/IGFBP3</td>
<td>Control (N = 28): wait list; intervention (N = 25): thrice-weekly (15 weeks) cycle ergometer training</td>
<td>Significant differences in intervention v control change scores for IGF-1 (~4.9 ± 10.7 v 2.5 ± 14.8 ng/mL) and IGFBP-3 (103.4 ± 224.7 v −77.1 ± 313.5 ng/mL)</td>
<td>4% attrition in intervention arm/0% in control arm; 98% adherence in intervention arm</td>
</tr>
<tr>
<td>Jones et al91</td>
<td>450 breast cancer survivors</td>
<td>Frequency of exercise</td>
<td>Usual-care control (N = 150); physician recommendation to exercise (N = 150); physician recommendation to exercise + referral for exercise consult (N = 150)</td>
<td>At 5-weeks postconsult, significant differences (P = .011) were observed between arms, with the usual-care, recommendation-only, and recommendation + referral reporting 6.7 ± 8.9, 10.1 ± 10.7, and 8.2 ± 9.5 Metabolic Equivalent Task h/wk of total exercise, respectively</td>
<td>34.5% overall attrition; attrition was significantly higher in the control arm (42%) compared with the other two groups (29-33%)</td>
</tr>
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</table>
Note: Does not include studies using quasi-experimental designs or those aimed primarily at alleviating acute, short-term, treatment-related adverse effects or those aimed solely at improving psychosocial quality of life.

Abbreviations: MHR, maximum heart rate; NS, not significant; IGF-1, insulin-like growth factor 1; IGFBP-3, insulin-like growth factor-binding protein-3.
# Table 3
Selected Listing of Resources to Inform Healthful Lifestyle Change

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Organization</th>
<th>Contact</th>
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<tr>
<td><strong>Smoking cessation</strong></td>
<td>American Cancer Society</td>
<td>(800) ACS-2345; <a href="http://www.cancer.org/docroot/PED/ped_10.asp">http://www.cancer.org/docroot/PED/ped_10.asp</a></td>
</tr>
<tr>
<td></td>
<td>Centers for Disease Control</td>
<td>(770) 488-5820; <a href="http://www.cdc.gov/tobacco/how2quit.htm">http://www.cdc.gov/tobacco/how2quit.htm</a></td>
</tr>
<tr>
<td></td>
<td>National Cancer Institute Quit-Line</td>
<td>(877) 44U-QUIT; <a href="http://www.smokefree.gov/guide">http://www.smokefree.gov/guide</a></td>
</tr>
<tr>
<td></td>
<td>National Network of Quitlines</td>
<td>(800) QUIT-NOW</td>
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<tr>
<td></td>
<td>American Heart Association</td>
<td>(800) 242-8721; <a href="http://www.americanheart.org/presenter.jhtml?identifier=1200013">http://www.americanheart.org/presenter.jhtml?identifier=1200013</a></td>
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<tr>
<td></td>
<td>Centers for Disease Control</td>
<td>(770) 488-5820; <a href="http://www.cdc.gov/nccdphp/dnpa/physical/index.htm">http://www.cdc.gov/nccdphp/dnpa/physical/index.htm</a></td>
</tr>
<tr>
<td><strong>Diet (general)</strong></td>
<td>American Cancer Society</td>
<td>(800) ACS-2345; <a href="http://www.cancer.org/docroot/MH/MH_1.asp?sitearea=MHandlevel=1">http://www.cancer.org/docroot/MH/MH_1.asp?sitearea=MHandlevel=1</a></td>
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<tr>
<td></td>
<td>American Dietetic Association</td>
<td>(800) 877-1600; <a href="http://www.eatright.org">http://www.eatright.org</a></td>
</tr>
<tr>
<td></td>
<td>American Heart Association</td>
<td>(800) 242-8721; <a href="http://www.americanheart.org/presenter.jhtml?identifier=1200010">http://www.americanheart.org/presenter.jhtml?identifier=1200010</a></td>
</tr>
<tr>
<td></td>
<td>American Institute for Cancer Research</td>
<td>(800) 843-8114; <a href="http://www.aicr.org/index.lasso">http://www.aicr.org/index.lasso</a></td>
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<td></td>
<td>Department of Health and Human Services</td>
<td><a href="http://www.healthierus.gov/dietaryguidelines">http://www.healthierus.gov/dietaryguidelines</a></td>
</tr>
<tr>
<td><strong>Diet (fruits and vegetables)</strong></td>
<td>Centers for Disease Control</td>
<td>(800) 311-3435; <a href="http://www.cdc.gov/nccdphp/dnpa/5aday">http://www.cdc.gov/nccdphp/dnpa/5aday</a></td>
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<td></td>
<td>National Cancer Institute</td>
<td>(800) 422-6237; <a href="http://www.5aday.gov/homepage/index_content.html">http://www.5aday.gov/homepage/index_content.html</a></td>
</tr>
<tr>
<td><strong>Diet (weight control)</strong></td>
<td>American Diabetes Association</td>
<td>(800) 342-2383; <a href="http://www.diabetes.org/weightloss-and-exercise/weightloss/portioncontrol.jsp">http://www.diabetes.org/weightloss-and-exercise/weightloss/portioncontrol.jsp</a></td>
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<td>Centers for Disease Control</td>
<td>(800) 311-3435; <a href="http://www.cdc.gov/nccdphp/dnpa/obesity/index.htm">http://www.cdc.gov/nccdphp/dnpa/obesity/index.htm</a></td>
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<tr>
<td><strong>Sunscreen use</strong></td>
<td>American Academy of Dermatology</td>
<td>(888) 462-DERM; <a href="http://www.aad.org/public/Publications/pamphlets/SkinCancer.htm">http://www.aad.org/public/Publications/pamphlets/SkinCancer.htm</a></td>
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<td></td>
<td>National Cancer Institute</td>
<td>(800) 4-CANCER; <a href="http://www.meb.uni-bonn.de/cancernet/504733.html">http://www.meb.uni-bonn.de/cancernet/504733.html</a></td>
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<td>Skin Cancer Foundation</td>
<td>(800) SKIN-490; <a href="http://www.skincancer.org/prevention/index.php">http://www.skincancer.org/prevention/index.php</a></td>
</tr>
<tr>
<td><strong>General wellness</strong></td>
<td>Agency for Healthcare Research and Quality</td>
<td>(301) 427-1364; <a href="http://www.ahrq.gov/consumer/index.html#prevention">http://www.ahrq.gov/consumer/index.html#prevention</a></td>
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