

# CA

A Cancer Journal for Clinicians

## **Nutrition and Physical Activity During and After Cancer Treatment: An American Cancer Society Guide for Informed Choices**

Colleen Doyle, Lawrence H. Kushi, Tim Byers, Kerry S. Courneya, Wendy Demark-Wahnefried, Barbara Grant, Anne McTiernan, Cheryl L. Rock, Cyndi Thompson, Ted Gansler, Kimberly S. Andrews and for the 2006 Nutrition, Physical Activity and Cancer Survivorship Advisory Committee  
*CA Cancer J Clin* 2006;56;323-353  
DOI: 10.3322/canjclin.56.6.323

**This information is current as of August 5, 2009**

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://caonline.amcancersoc.org/cgi/content/full/56/6/323>

**To subscribe to the print issue of *CA: A Cancer Journal for Clinicians*, go to (US individuals only): <http://caonline.amcancersoc.org/subscriptions/>**

*CA: A Cancer Journal for Clinicians* is published six times per year for the American Cancer Society by Wiley-Blackwell. A bimonthly publication, it has been published continuously since November 1950. *CA* is owned, published, and trademarked by the American Cancer Society, 250 Williams Street NW, Atlanta GA 30303. (©American Cancer Society, Inc.) All rights reserved. Print ISSN: 0007-9235. Online ISSN: 1542-4863.



# Nutrition and Physical Activity During and After Cancer Treatment: An American Cancer Society Guide for Informed Choices

Colleen Doyle, MS, RD; Lawrence H. Kushi, ScD; Tim Byers, MD, MPH;  
Kerry S. Courneya, PhD; Wendy Demark-Wahnefried, PhD, RD, LDN; Barbara Grant, MS,  
RD; Anne McTiernan, MD, PhD; Cheryl L. Rock, PhD, RD; Cyndi Thompson, PhD;  
Ted Gansler, MD, MBA; Kimberly S. Andrews; for The 2006 Nutrition, Physical Activity  
and Cancer Survivorship Advisory Committee

**ABSTRACT** Cancer survivors are often highly motivated to seek information about food choices, physical activity, and dietary supplement use to improve their treatment outcomes, quality of life, and survival. To address these concerns, the American Cancer Society (ACS) convened a group of experts in nutrition, physical activity, and cancer to evaluate the scientific evidence and best clinical practices related to optimal nutrition and physical activity after the diagnosis of cancer. This report summarizes their findings and is intended to present health care providers with the best possible information from which to help cancer survivors and their families make informed choices related to nutrition and physical activity. The report discusses nutrition and physical activity issues during the phases of cancer treatment and recovery, living after recovery from treatment, and living with advanced cancer; select nutrition and physical activity issues such as body weight, food choices, and food safety; issues related to select cancer sites; and common questions about diet, physical activity, and cancer survivorship. (*CA Cancer J Clin* 2006;56:323-353.) © American Cancer Society, Inc., 2006.

## INTRODUCTION

Over 10 million persons in the United States are cancer survivors.<sup>1</sup> Anyone who has been diagnosed with cancer, from the time of diagnosis through the rest of life, is considered a cancer survivor. Many cancer survivors are highly motivated to seek information about food choices, physical activity, dietary supplement use, and complementary nutritional therapies to improve their response to treatment, speed recovery, reduce risk of recurrence, and improve their quality of life.<sup>2</sup>

Nutritional needs change for most persons during the phases of cancer survivorship. Although many cancer survivors live with active or advanced disease, a large and growing number live extended, cancer-free lives. Sixty-five percent of Americans diagnosed with cancer now live more than 5 years.<sup>1</sup> The need for informed lifestyle choices for cancer survivors becomes particularly important as they look forward to successful completion of therapy and search for the best strategies to recover from treatment and improve their long-term outcomes. For long-term cancer survivors, an appropriate weight, a healthful diet, and a physically active lifestyle aimed at preventing recurrence, second primary cancers, and other chronic diseases should be a priority. For some, managing nutritional needs while living with advanced cancer becomes a particular challenge.

**Ms. Doyle** is Director, Nutrition and Physical Activity, American Cancer Society, Atlanta, GA.

**Dr. Kushi** is Associate Director for Etiology and Prevention Research, Kaiser Permanente, Oakland, CA.

**Dr. Byers** is Professor, Department of Preventive Medicine and Biometrics; and Deputy Director, University of Colorado Cancer Center, Aurora, CO.

**Dr. Courneya** is Professor and Canada Research Chair in Physical Activity and Cancer, Faculty of Physical Education, University of Alberta, Edmonton, Alberta.

**Dr. Demark-Wahnefried** is Professor, School of Nursing and Department of Surgery, Duke University Medical Center, Durham, NC.

**Ms. Grant** is Oncology Nutritionist, Saint Alphonsus Regional Medical Center, Cancer Care Center, Boise, ID.

**Dr. McTiernan** is Full Member, Fred Hutchinson Cancer Research Center, Cancer Prevention Research Program, Seattle, WA.

**Dr. Rock** is Professor, Department of Family and Preventive Medicine, School of Medicine, University of California, San Diego, La Jolla, CA.

**Dr. Thompson** is Assistant Professor, University of Arizona Department of Nutritional Sciences, Tucson, AZ.

**Dr. Gansler** is Director of Medical Content, Health Promotions, American Cancer Society, Atlanta, GA.

**Ms. Andrews** is Research Associate, Cancer Control Science, American Cancer Society, Atlanta, GA.

This article is available online at <http://CAonline.AmCancerSoc.org>

After receiving a diagnosis of cancer, survivors soon find there are few clear answers to even the simplest questions, such as *Should I change what I eat? Should I exercise more? Should I lose weight? Should I take dietary supplements?* Cancer survivors receive a wide range of advice from many sources about foods they should eat, foods they should avoid, how they should exercise, and what types of supplements or herbal remedies they should take. Unfortunately, this advice is often conflicting.

---

#### OVERVIEW OF THE REPORT

To synthesize evidence-based research, the American Cancer Society (ACS) convened a group of experts in nutrition, physical activity, and cancer to evaluate the scientific evidence and best clinical practices related to nutrition and physical activity after the diagnosis of cancer. This report summarizes their findings and updates the most recent report published in 2003.<sup>3</sup> Although this report is intended for health care providers caring for cancer survivors, it can also be used directly by survivors and their families. The underlying premise in creating this report is that, even when the scientific evidence is incomplete, reasonable conclusions can be made on several issues that can guide choices about body weight, foods, physical activity, and nutritional supplement use.

This report presents information in four sections. The first section addresses nutrition and physical activity issues across the phases of cancer survivorship, including treatment, recovery, living after recovery from treatment, and living with advanced cancer. The second section discusses selected nutrition and physical activity issues, including body weight, food choices, alcohol, food safety, and physical activity. The third section provides information regarding selected cancer sites (breast, colorectal, hematological, lung, prostate, head and neck, and upper gastrointestinal). The fourth section includes common questions about diet, physical activity, and cancer survivorship.

It is important for both health care providers and cancer survivors to consider the nutritional and physical activity issues discussed in this report

within the context of the individual survivor's overall medical and health situation. This report is not intended to imply that nutrition and physical activity are more important than other clinical or self-care approaches. For example, although we present nutritional suggestions for persons with nausea or fatigue, we recognize that other medical interventions may be more important in controlling these symptoms. In writing these suggestions, we have assumed that survivors are receiving appropriate medical and supportive care and are seeking information on self-care strategies to provide further relief of symptoms and to enhance health and improve the quality of their lives.

---

#### NUTRITION AND PHYSICAL ACTIVITY ACROSS THE CONTINUUM OF CANCER SURVIVORSHIP

The continuum of cancer survivorship includes treatment, recovery, living after recovery, and, for some, living with advanced cancer. Survivors in each of these phases have different needs and challenges with respect to nutrition and physical activity. Both the characteristics of the cancer and therapeutic methods influence these needs.

---

#### CANCER AND CANCER TREATMENT

##### **Nutrition During Cancer Treatment**

Even before treatment begins, cancer can cause profound metabolic and physiological alterations that can affect the nutritional needs for protein, carbohydrate, fat, vitamin, and minerals.<sup>4</sup> Symptoms such as anorexia, early satiety, changes in taste and smell, and disturbances of the gastrointestinal tract are common side effects of cancer treatment and can lead to inadequate nutrient intake and subsequent malnutrition.<sup>5,6</sup> Substantial weight loss and poor nutritional status have been documented in more than 50% of patients at the time of diagnosis, although the prevalence of malnutrition and weight loss varies widely across cancer types.<sup>7,8</sup> Maintaining energy balance or preventing weight loss is therefore vital for survivors at risk for unintentional weight loss, such as those who are already malnourished or those who receive directed treatment to the

**TABLE 1** Suggestions for Helping Survivors Locate Specialized Dietary Counseling

- Survivors should ask their oncologist for a referral to see a registered dietitian.
- If a dietitian does not work in the clinic or medical center where they receive their cancer treatment and care, an appointment with a dietitian associated with their primary care clinic can be arranged.
- Survivors and providers can also consult the American Dietetic Association's website [www.eatright.org], using the "Find a Nutrition Professional" feature and putting "Oncology Nutrition" in the expertise/specialty tab, or call the American Dietetic Association at 1-800-366-1655 to identify a dietitian in their area.

gastrointestinal tract.<sup>9</sup> Other patients begin the cancer treatment process in a state of overweight or obesity, and for some, weight gain can be a complication of treatment.<sup>10</sup> Nutritional screening and assessment for survivors should begin while treatment is being planned and should focus on both the current nutritional status and anticipated symptoms related to treatment that could affect nutritional status.<sup>11</sup>

All of the major modalities of cancer treatment, including surgery, radiation, and chemotherapy, can significantly impact nutritional needs, alter regular eating habits, and adversely affect how the body digests, absorbs, and uses food.<sup>4,11</sup> Commonly experienced symptoms of cancer and side effects of treatment that may impact nutritional status include changes in taste or smell, loss of appetite, nausea, vomiting, changes in bowel habits, weight change, loss of lean mass and sarcopenia, pain, and fatigue.<sup>12-14</sup> If these occur, usual food choices and eating patterns may need to be temporarily adjusted to optimize intake and meet nutritional needs.

During active cancer treatment, the overall goals of nutritional care for survivors should be to prevent or reverse nutrient deficiencies, to preserve lean body mass, to minimize nutrition-related side effects (such as decreased appetite, nausea, taste changes, or bowel changes), and to maximize quality of life. Recent studies confirm the benefit of dietary counseling during cancer treatment for improving outcomes, such as fewer treatment-related symptoms, improved quality of life, and better dietary intake.<sup>15-18</sup> Suggestions for finding an oncology nutrition expert to provide dietary counseling are provided in Table 1.

Providing short-term individualized nutritional support can improve appetite and dietary intake and decrease the toxicities associated with cancer treatments.<sup>4</sup> Examples of individualized nutritional therapies include the following:

- For survivors experiencing a reduced appetite, consuming smaller, more frequent meals without liquids can help to increase food intake.
- For survivors who cannot meet their nutritional needs through foods alone, fortified and commercially-prepared or homemade nutrient-dense beverages or foods may improve the intake of energy and nutrients.
- For survivors who are unable to meet their nutritional needs through these measures, other means of short-term nutritional support may be needed, such as pharmacotherapy, enteral nutrition via tube feeding, or intravenous parenteral nutrition.

The use of dietary supplements such as vitamins, minerals, and herbal preparations during cancer treatment remains controversial. For example, it may be counterproductive for survivors to take folate supplements or to eat fortified food products that contain high levels of folate when receiving methotrexate, a chemotherapy drug that acts by interfering with folate metabolism.<sup>4</sup> Many dietary supplements contain levels of antioxidants (such as vitamins C and E) that exceed the amount recommended in the Dietary Reference Intakes for optimal health.<sup>19-22</sup> At the present time, most cancer experts advise against taking higher doses of supplements with antioxidant activity during treatment because antioxidants could prevent the cellular oxidative damage to cancer cells that is required for treatments such as radiotherapy and chemotherapy to be effective.<sup>23,24</sup> In contrast, others have noted that the possible harm from antioxidants is only hypothetical and that there may be a net benefit to help protect normal cells from the collateral damage associated with these therapies.<sup>25</sup> Whether antioxidants or any other dietary supplements specifically are beneficial or harmful is a critical question without a clear scientific answer at this time.<sup>26-29</sup>

Given this uncertainty, until more evidence is available that suggests more benefit than harm, it is prudent for cancer survivors receiving chemotherapy or radiation therapy to avoid exceeding more than 100% of the daily value for antioxidant-

type vitamins such as vitamins C and E during the treatment phase.<sup>19–22</sup>

#### **Exercise During Cancer Treatment**

An increasing number of studies have examined the therapeutic value of exercise during primary cancer treatment.<sup>30–32</sup> Most of these studies have examined women with early-stage breast cancer receiving adjuvant therapies (eg, chemotherapy, radiotherapy) and persons with various cancers immediately after bone marrow transplantation. Despite methodologic limitations and small sample sizes, existing evidence strongly suggests that exercise is not only safe and feasible during cancer treatment, but that it can also improve physical functioning and some aspects of quality of life.<sup>30–33</sup> It is unknown if exercise has any effects on cancer treatment completion rates or on the efficacy of cancer treatments. However, one animal study reported that exercise did not interfere with the efficacy of chemotherapy.<sup>34</sup> Although there is not a strong biological rationale for concerns about adverse effects of exercise during treatment, research into this question is needed.

The decision regarding how to maintain or when to initiate physical activity should be individualized to the survivor's condition and personal preferences. In some circumstances, a training program to improve cardiopulmonary fitness before cancer treatments might aid recovery, although adequate research has not been done in this area. Cross sectional research among men who received radiation therapy for prostate cancer, however, suggests that men who exercise routinely have significantly decreased risk of erectile dysfunction post-treatment.<sup>35</sup> Likewise, resistance training programs may be helpful in hindering rapidly occurring adverse body composition changes (ie, sarcopenic obesity and osteopenia) that may occur among some cancer patients who receive systemic therapy.<sup>36</sup> Persons receiving chemotherapy and radiation therapy who are already on an exercise program may need temporarily to exercise at a lower intensity and progress at a slower pace, but the principal goal should be to maintain activity as much as possible. For those who were sedentary before diagnosis, low-intensity activities such as stretching and brief, slow walks should be adopted and slowly advanced. For older persons and those

with bone disease or significant impairments such as arthritis or peripheral neuropathy, careful attention should be given to balance and safety to reduce the risk for falls and injuries. The presence of a caregiver or exercise professional during exercise sessions can be helpful. If the disease or treatment necessitates periods of bed rest, then reduced fitness and strength, as well as loss of lean body mass, can be expected. Physical therapy during bed rest is therefore advisable to maintain strength and range of motion and to help to counteract the fatigue and depression that are often experienced under those circumstances. Some clinicians advise some survivors to wait to determine their physical response to chemotherapy before beginning an exercise program.

#### **Recovery**

After cancer therapy has been completed, the next phase of cancer survival is recovery. In this phase, many survivors' symptoms and side effects of treatment that impact nutritional and physical well-being begin to diminish and resolve. Typically, survivors recover from the acute effects of their specific treatment within a few weeks after completing therapy, though in some instances, toxic effects of treatment may persist. In addition, late-occurring effects of treatment may appear long after treatment has been completed.<sup>37,38</sup> Examples of continuing side effects or complications of cancer treatment relevant to nutritional status include persistent anorexia, changed sense of taste, inability to replenish lean body mass after completion of therapy, and persistent diarrhea or constipation.

Survivors require ongoing nutritional assessment and guidance in this phase of survival.<sup>13,14,39</sup> For those who emerge from treatment underweight or who have compromised nutritional status, continued supportive care, including dietary counseling and pharmacotherapy (eg, drugs to relieve symptoms and stimulate appetite), is helpful in the recovery process.<sup>15,40</sup> After treatment, a program of regular physical activity is essential to aid in the process of recovery and improve fitness.

#### **Living After Recovery**

During this phase, setting and achieving life-long goals for an appropriate weight, a physically

**TABLE 2** American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention

<p>Maintain a healthy weight throughout life.</p> <ul style="list-style-type: none"> <li>• Balance caloric intake with physical activity.</li> <li>• Avoid excessive weight gain throughout the lifecycle.</li> <li>• Achieve and maintain a healthy weight if currently overweight or obese.</li> </ul> <p>Adopt a physically active lifestyle.</p> <ul style="list-style-type: none"> <li>• Adults: engage in at least 30 minutes of moderate-to-vigorous physical activity, above usual activities, on 5 or more days of the week. Forty-five to 60 minutes of intentional physical activity are preferable.</li> <li>• Children and adolescents: engage in at least 60 minutes per day of moderate-to-vigorous physical activity at least 5 days per week.</li> </ul> <p>Consume a healthy diet, with an emphasis on plant sources.</p> <ul style="list-style-type: none"> <li>• Choose foods and beverages in amounts that help achieve and maintain a healthy weight.</li> <li>• Eat five or more servings of a variety of vegetables and fruits each day.</li> <li>• Choose whole grains in preference to processed [refined] grains.</li> <li>• Limit consumption of processed and red meats.</li> </ul> <p>If you drink alcoholic beverages, limit consumption.</p> <ul style="list-style-type: none"> <li>• Drink no more than one drink per day for women or two per day for men.</li> </ul>
---

active lifestyle, and a healthy diet are important to promote overall health, quality of life, and longevity.<sup>41</sup> The ACS has established nutrition and physical activity guidelines for the prevention of cancer (Table 2).<sup>42</sup> Although it may seem reasonable to assume that following these guidelines would also favorably affect cancer recurrence or survival rates, few data are available to directly support this assumption. In some instances, there is evidence for such a link, as with obesity and breast cancer recurrence, but in many instances the evidence linking food choices and physical activity to cancer recurrence and survival is limited or unclear. Although the scientific evidence for advice on nutrition and physical activity after cancer is much less certain than for cancer prevention, it is likely that following the ACS Guidelines on diet, nutrition, and cancer prevention may be helpful for reducing the risk of developing second cancers.<sup>42</sup> It is also important to realize that, because persons who have been diagnosed with cancer may be at increased risk for other cancers and for cardiovascular disease, diabetes, and osteoporosis, the guidelines established to prevent those diseases are especially important for cancer survivors.<sup>43-48</sup>

Convincing data exist that obesity is associated with breast cancer recurrence, and evidence on obesity and prognosis is also accumulating for other cancers.<sup>49-51</sup> Therefore, achieving and maintaining a healthy weight, as well as consuming a nutrient-rich diet and maintaining a physically active lifestyle, are important to improve overall health and well-being and survival.

An increasing number of studies have examined exercise during recovery and long-term survival after cancer treatment.<sup>30-32</sup> Most research has been conducted among women with breast cancer or those who have received bone marrow transplants. Exercise has been shown to improve cardiovascular fitness, muscle strength, body composition, fatigue, anxiety, depression, self-esteem, happiness, and several components of quality of life (physical, functional, and emotional) in cancer survivors.<sup>30</sup> A few recent cohort studies have examined the association between physical activity and cancer recurrence, cancer-specific mortality, and all-cause mortality in cancer survivors.<sup>52-55</sup> Data from almost 3,000 breast cancer survivors in the Nurses' Health Study showed that higher levels of post-treatment physical activity were associated with a 26% to 40% reduction in the risk of breast cancer recurrence, breast cancer-specific mortality, and all-cause mortality. The risk reduction was seen with as little as 1 to 3 hours per week of moderate intensity activity with further reductions for those performing 3 to 5 hours per week.<sup>55</sup> Similar associations have been reported between physical activity and clinical outcomes in colorectal cancer survivors.<sup>52-54</sup> Although preliminary, these data suggest that physical activity may be important for reducing the risk of recurrence and extending survival for some cancer survivors.

#### Living With Advanced Cancer

Although some persons are cured or experience cancer as a controllable chronic disease, others live with advanced cancer. For these persons, a healthy diet and physical activity are important factors in establishing and maintaining a sense of well-being and enhancing quality of life. Although advanced cancer may be accompanied by substantial weight loss, it is not inevitable that persons with cancer lose weight or experience

malnutrition.<sup>4</sup> Many persons with advanced cancer may need to adapt food choices and eating patterns to meet nutritional needs and to manage symptoms and adverse effects such as pain, constipation, and loss of appetite. For persons with poor appetite, weight loss, or both, convincing evidence exists that some medications (eg, megestrol acetate) enhance appetite.<sup>56–59</sup> Furthermore, using nonsteroidal anti-inflammatory drugs or omega-3 fatty acid oral supplements may stabilize or improve nutritional status, body weight, and functional status.<sup>60–63</sup>

Additional nutritional support such as nutrient-dense beverages can be provided for those who cannot eat enough solid food to maintain energy intake. The use of tube feedings and total parenteral nutrition should be individualized with clear recognition of the associated risks for complications. Both the American Society for Parenteral and Enteral Nutrition and the American Dietetic Association recommend that total parenteral nutrition should be used selectively and with caution.<sup>64,65</sup>

In principle, some level of physical activity is desirable for persons with advanced cancer, but there is limited research on exercise in such individuals. Thus, the evidence of benefit from exercise for advanced cancer survivors is insufficient to make specific recommendations. Recommendations for nutrition and physical activity for persons who are living with advanced cancer are best made based on individual needs and abilities.

---

SELECTED ISSUES IN NUTRITION AND PHYSICAL ACTIVITY FOR CANCER SURVIVORS

**Body Weight**

Throughout the cancer continuum, individuals should strive to achieve and maintain a healthy weight.<sup>43</sup> Some cancer survivors can be malnourished and underweight at diagnosis or as a result of aggressive cancer treatments. For these persons, further loss of weight can impair their quality of life, interfere with completion of treatment, delay healing, and increase risk of complications. In survivors with these difficulties, dietary intake and factors affecting energy expenditure should be carefully assessed. For those at risk for unintentional weight loss, multifaceted inter-

ventions should focus on increasing food intake to achieve a positive energy balance and therefore increase weight.<sup>59</sup> Physical activity may be useful to the underweight survivor when tailored to provide stress reduction and to increase strength, but high levels of physical activity make weight gain more difficult.<sup>30</sup>

In the United States, obesity is a problem of epidemic proportions<sup>66</sup> and is a well-established risk factor for some of the most common cancers.<sup>49</sup> Increased body weight has been associated with increased risk for cancers at several specific sites, including the breast (postmenopausal), colorectum, esophagus, liver, gallbladder, pancreas, kidney, uterus, and for advanced prostate cancer.<sup>49,67–70</sup> Thus, many cancer survivors are overweight or obese at the time of diagnosis. Increasing evidence indicates that being overweight increases the risk for recurrence and reduces the likelihood of survival for many cancers.<sup>10,50,68,71–74</sup>

For cancer survivors who are overweight or obese, modest weight loss (ie, a maximum of 2 pounds per week)<sup>75,76</sup> can be encouraged during treatment, as long as the treating oncologists approve, weight loss is monitored closely, and weight loss does not interfere with treatment. Safe weight loss should be achieved through a well-balanced diet that is reduced in energy density and increased physical activity tailored to the specific needs of the person being treated. After cancer treatment, weight gain or loss should be managed with a combination of dietary and physical activity strategies. For some who need to gain weight, this means increasing energy intake (food intake) to exceed energy expended, and for others who need to lose weight, this means increasing energy expenditure (via increased physical activity) to exceed energy intake. Emerging evidence suggests that reducing the energy density of the diet by emphasizing low-energy density foods (eg, water- and fiber-rich vegetables, fruits, and soups; cooked whole grains) and limiting intake of fat and sugars promotes healthy weight control.<sup>77</sup> The mechanism by which this strategy may be useful is that food volume is not reduced, which may help to avoid hunger and feelings of deprivation. Limiting portion sizes of energy dense foods is an important accompanying strategy.<sup>78–81</sup> Increased physical activity is also an important element to prevent

weight gain, promote weight loss, and most important, to promote maintenance of weight loss in patients who are overweight or obese.<sup>82</sup> For those who need to lose weight, even if ideal weight reduction is not achieved, it is likely that any weight loss achieved by physical activity and healthful eating is beneficial, with weight losses of 5% to 10% still likely to have significant health benefits.<sup>43</sup> Although the evidence related to these weight management strategies does not come from studies of cancer survivors, it is likely that these common-sense approaches can apply in the special circumstances of the cancer experience.

### Nutrition and Food Choices

During all phases of cancer survival, even for those with no apparent nutritional problems, the principles outlined in the *American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention* should be regarded as the basis for a healthful diet.<sup>42</sup> These guidelines are similar to those recommended by several other organizations, agencies, and expert panels as a reasonable basis for the dietary prevention of other chronic diseases and cancer.<sup>43,46,83</sup>

#### *Balancing Fat, Protein, and Carbohydrate Intake*

Protein, carbohydrate, and fat all contribute energy (calories) to the diet, and each of these dietary constituents is available from a wide variety of foods. Informed choices about foods that provide these macronutrients should be based in goals of achieving variety and nutrient adequacy. Many cancer survivors are at high risk for other chronic diseases, such as heart disease. Therefore, the recommended amounts and type of fat, protein, and carbohydrate to reduce cardiovascular disease risk are also appropriate for cancer survivors.<sup>42-46</sup>

Several studies have been conducted on the relationship between fat intake and survival after the diagnosis of breast cancer, and the results across these studies are inconsistent, with some studies suggesting increased fat intake may decrease survival, whereas others suggest no effect.<sup>84</sup> Two large clinical trials, one recently completed and the other still ongoing, were designed to test whether a reduction in fat intake can reduce

risk for recurrence and increase overall survival in women who have been diagnosed with early stage breast cancer (the Women's Intervention Nutrition Study [WINS] and the Women's Healthy Eating and Living [WHEL] Study).<sup>85,86</sup> Preliminary results from the recently-completed WINS suggest that women assigned to the low-fat diet arm of the study (targeting 20% of energy from fat) exhibited a 24% reduction in risk for recurrence; subset analyses suggest that this effect was even greater among women with estrogen receptor-negative disease.<sup>87</sup> Results from the WHEL Study are anticipated by 2008. A smaller number of observational follow-up studies of diet and survival after the diagnosis of prostate cancer have also been reported. In one of these studies, higher saturated fat intake predicted shorter disease-specific survival, and in another, greater monounsaturated fat intake predicted longer survival.<sup>88,89</sup>

Currently, the recommended level of fat in the diet is 20% to 35% of energy, with saturated fat intake limited to <10% and trans fatty acids limited to <3% of total energy intake.<sup>82</sup> Some studies have suggested that omega-3 fatty acids may have specific benefits for cancer survivors, such as ameliorating cachexia, improving quality of life, and perhaps enhancing the effects of some forms of treatment.<sup>90,91</sup> These findings are not certain, however, and more research is needed.<sup>92</sup> However, including foods that are rich in omega-3 fatty acids (eg, fish, walnuts) in the diet should still be encouraged because this is associated with a lower risk for cardiovascular diseases and a lower overall mortality rate,<sup>43,45,46</sup> and evidence is largely lacking for a detrimental effect.

Adequate protein intake is essential during all stages of cancer treatment, recovery, and long-term survival. The best choices to meet protein needs are foods that are also low in saturated fat (eg, fish, lean meat and poultry, eggs, nonfat and low-fat dairy products, nuts, seeds, and legumes). An intake of 10% to 35% of energy from protein, or at least 0.8 g/kg body weight, is recommended for the general population<sup>82</sup> and will generally meet the protein needs of adult cancer survivors.

Healthful carbohydrate sources are foods that are rich in essential nutrients, phytochemicals, and fiber, such as vegetables, fruit, whole grains,



and legumes. These foods should provide the majority of carbohydrate in the diet. The recommended level of carbohydrate in the diet is 45% to 65% of energy intake for the general population.<sup>82</sup> Vegetables and fruits contain numerous dietary constituents that potentially affect cancer progression, such as essential vitamins and minerals, biologically active phytochemicals, and fiber. Additionally, these are low energy dense foods that promote satiety, and thus may promote healthy weight management.<sup>93</sup> Whole fruit (instead of juice) adds more fiber and fewer calories to the diet. When fruit juice is chosen, 100% fruit juice is the preferred choice.

Whole grains are rich in a variety of compounds (in addition to fiber) that have important biologic activity, including hormonal and antioxidant effects. For example, whole grains contain antioxidants, such as phenolic acids, flavonoids, and tocopherols; compounds with weak hormonal effects such as lignans; and compounds that may influence lipid metabolism, such as phytosterols and unsaturated fatty acids. All of these compounds and their biologic effects have been hypothesized to reduce risk and progression of cancer as well as cardiovascular disease.<sup>94</sup> Choosing whole grains and whole grain food products as a source of fiber, rather than relying on fiber supplements, adds nutritional value to the diet.

Refined grains have been milled, a process that removes the bran and germ. This results in levels of vitamins and minerals that are lower than the unrefined, whole grain counterpart. Examples of refined grain products include white flour, degermed cornmeal, white bread, and white rice. In the United States, most refined grain products have been enriched, which means that micronutrients such as thiamin, riboflavin, niacin, iron, and folate have been added back to the product after processing. Thus, they are not completely without nutritional value, but many of the potentially helpful constituents, such as fiber and other biologically active phytochemicals, have not been added back.

Sugar intake has not been shown to directly increase risk or progression of cancer. However, sugars (including honey, raw sugar, brown sugar, high-fructose corn syrup, and molasses) and beverages that are major sources of these sugars (such

as soft drinks and many fruit-flavored drinks) add substantial amounts of calories to the diet and thus can promote weight gain. In addition, most foods that are high in sugar do not contribute many nutrients to the diet and often replace more nutritious food choices. Therefore, limiting sugar consumption is recommended.

Vegetarian diets can be healthy or unhealthy, depending on one's food choices. Vegetarian diets differ with respect to inclusion of dairy foods, fish, and/or eggs, but avoiding red meat is a universal feature. Fish, dairy foods, or both contain sufficient quantity and quality of protein, and a vegetarian diet that contains these foods typically has a nutrient content similar to an omnivorous diet. A vegan diet, which excludes all animal foods and animal products, can meet protein needs if nuts, seeds, legumes, and cereal-grain products are consumed in sufficient quantities, although supplemental vitamin B12 will be necessary to meet needs for that vitamin. As dietary vitamin D in the United States comes primarily from fortified dairy foods, a vegan diet may also need to include supplemental vitamin D if adequate exposure to the sun or ultraviolet light is not obtained. Vegetarian diets can have many healthful characteristics because they tend to be low in saturated fat and high in fiber, vitamins, and phytochemicals. A vegetarian diet is consistent with the ACS Nutrition Guidelines for the Prevention of Cancer. However, no direct evidence has determined whether consuming a vegetarian diet has any additional benefit for the prevention of cancer recurrence over an omnivorous diet high in vegetables, fruits, and whole grains, and low in red meats.

#### *Vegetables and Fruits*

Higher intakes of vegetables and fruits have been specifically associated with a lower incidence of cancer at several sites, including the colorectum, stomach, lung, oral cavity, and esophagus.<sup>44</sup> Few studies exist, however, on the relationship between a diet including many vegetables and fruits and the risk for reducing cancer recurrence or increasing survival after cancer. In the observational studies that have examined the relationship between intakes of vegetables and fruit (or nutrients indicative of those foods) and risk for recurrence of breast cancer, the findings have been mixed,<sup>84</sup>

although plasma carotenoids (a marker of vegetable and fruit intake) have been associated with greater likelihood of recurrence-free survival in one study.<sup>95</sup> In the single study that examined diet and survival after the diagnosis of ovarian cancer, higher intake of vegetables, especially cruciferous vegetables, was found to be associated with longer survival.<sup>96</sup> A recent observational study of diet after diagnosis and risk of prostate cancer progression found those who consumed more tomato sauce had longer survival.<sup>97</sup>

The benefits of eating a variety of vegetables and fruits probably exceed the health-promoting effects of any individual constituents in these foods because the various vitamins, minerals, and other phytochemicals in these whole foods act in synergy. It is reasonable to recommend that cancer survivors adopt the general recommendations issued by the ACS for cancer prevention to eat at least five servings of a variety of vegetables and fruit each day. This can be achieved by eating a minimum of 2 1/2 cups of vegetables and fruits each day. Colorful choices such as dark green and orange vegetables are typically good sources of nutrients and healthful phytochemicals. Fresh, frozen, canned, raw, cooked, or dried vegetables and fruits all contribute nutrients and other biologically active constituents to the diet. Cooking vegetables and fruits, especially with methods such as microwaving or steaming in preference to boiling in large amounts of water, preserves the bioavailability of water-soluble nutrients and can improve absorption of others. For example, the antioxidant lycopene is better absorbed from cooked tomato and tomato products than from raw tomatoes. At present, no research exists to demonstrate that organically grown vegetables and fruits are superior in their content of potential cancer-preventive constituents.

#### *Alcohol*

Substantial observational evidence indicates that alcohol intake has both positive and negative health effects.<sup>44,98,99</sup> Alcoholic drinks up to one or two drinks per day (for women and men, respectively) can lower risk for heart disease, but higher levels do not offer additional benefit and may increase risk not only for complications of

alcohol overuse, but also for cancer. For this reason, it is important for the health care provider to tailor advice on alcohol consumption to the individual cancer survivor. The cancer type and stage of disease, treatment, risk factors for recurrence or new primary cancers, and comorbid conditions should be considered in making recommendations. For example, alcohol, even in the small amounts found in mouthwashes, can be irritating to survivors with oral mucositis and can exacerbate that condition. Therefore, it is reasonable to recommend that alcohol intake should be avoided or limited among survivors with mucositis and among those beginning head and neck radiotherapy or chemotherapeutic regimens that put them at risk for mucositis.

Many studies have found a link between alcohol intake and risk for some primary cancers, including cancers of the mouth, pharynx, larynx, esophagus, liver, breast, and probably colon cancer.<sup>44,98,100</sup> In persons who have already received a diagnosis of cancer, alcohol intake could also affect the risk for new primary cancers of these sites. Alcohol intake can increase the circulating levels of estrogens, which theoretically could increase the risk for recurrence of breast cancer. In most studies of breast cancer survivors conducted to date, there is little evidence of an effect of alcohol on increased risk of recurrence or decreased survival.<sup>73</sup> However, the level of alcohol intake in these studies of women with breast cancer has generally been so low that the results of these studies should not be interpreted as indicating alcohol intake after cancer diagnosis does not increase risk of recurrence or new primary cancers.<sup>101</sup> Therefore, the degree of risk present should be considered in recommendations regarding individual alcohol consumption.

#### *Food Safety*

Food safety is of special concern for cancer survivors, especially during episodes of iatrogenic immunosuppression that can occur with certain cancer treatment regimens.<sup>102</sup> Survivors can become susceptible to developing infections due to treatment-induced leukopenia and neutropenia. During any immunosuppressive cancer treatment, survivors should take extra precautions to prevent infection, and they should be particu-

larly careful to avoid eating foods that may contain unsafe levels of pathogenic microorganisms. Because chemotherapy can impair the immune response, raw vegetables and fruits may increase the risk for infection in some patients during immune-suppressant treatment (ie, some chemotherapies and radiotherapies) as a result of bacteria on these foods.<sup>102</sup> By following safe food practices, cancer survivors and their caregivers can reduce the risk of food-borne illness. Refer to the general guidelines for food safety as shown in Table 3.

### Dietary Supplements

Dietary supplements include vitamins, minerals, herbs, botanicals, amino acids, and glandular products. Across various studies, the use of dietary supplements is reported by 25% to 80% of cancer survivors,<sup>103–106</sup> and most reports of dietary supplement use among survivors suggest that frequency of dietary supplementation is higher than the general population or controls who have not been diagnosed with cancer.<sup>106</sup> Cancer patients use supplements for a variety of reasons, including following the advice of health care providers or others, treating a symptom, to feel better, and/or as a general insurance of adequate nutrient intake, as is the case among those taking multivitamin-mineral supplements.<sup>107,108</sup> In addition, although it might be assumed that cancer survivors take dietary supplements to treat cancer-

related health issues, evidence suggests that many were taking similar supplements prior to diagnosis<sup>109</sup> or report taking them to treat other health conditions.<sup>107</sup> One additional rationale for dietary supplementation among cancer patients stems from observations of lower cancer risk among those who eat diets rich in vegetables and fruits. There is little evidence, however, that dietary supplements can reproduce the benefit of a nutrient- and phytochemical-rich diet.

The VITAL (Vitamins and Lifestyle) cancer patient cohort study provides estimates of the frequency with which cancer survivors use specific dietary supplements. Data collected from more than 10,800 cancer survivors showed significant differences across cancer sites, including the use of cranberry extract among patients with bladder cancer, folic acid supplementation among patients with colorectal and uterine cancer, and vitamin A supplementation among women diagnosed with ovarian cancer, as well as both men and women who had been diagnosed with melanoma. Interestingly, although there is little direct evidence of a beneficial effect of vitamin E in breast cancer survival, this study reported increased vitamin E use among breast cancer patients (49.2% of women previously diagnosed with breast cancer), a practice that was also reported by 46% of breast cancer survivors in another study.<sup>106</sup> The quantity of vitamin E intake in this study also indicated that supplementation levels were much higher than for healthy adults (averaging 268 mg/d and 34 mg/d, respectively).

During and after cancer treatment, there is a probable benefit of taking a standard multiple vitamin and mineral supplement that contains approximately 100% of the Daily Value because during these times, it may be difficult to eat a diet with adequate amounts of these micronutrients.<sup>110,111</sup> One report among children with cancer showed that diets were inadequate in vitamin C and E and total carotenoids. In this same study, diets with sufficient vitamin E were associated with lower risk for infection, and diets adequate in vitamin C were associated with fewer delays in treatment related to low blood counts,<sup>112</sup> suggesting that working to improve dietary adequacy through food selections may improve health during treatment for cancer. In contrast,

TABLE 3 General Guidelines for Food Safety

<ul style="list-style-type: none"> <li>• Wash hands thoroughly before eating.</li> <li>• Keep all aspects of food preparation clean, including washing hands before food preparation and washing fruits and vegetables thoroughly.</li> <li>• Use special care in handling raw meats, fish, poultry, and eggs.</li> <li>• Thoroughly clean all utensils, countertops, cutting boards, and sponges that have contacted raw meat; keep raw meats and ready-to-eat foods separate.</li> <li>• Cook to proper temperatures; meat, poultry, and seafood should be thoroughly cooked, and beverages (milk and juices) should be pasteurized.</li> <li>• Store foods promptly at low temperatures to minimize bacterial growth (below 40°F).</li> <li>• When eating in restaurants, avoid foods that may have potential bacterial contamination such as salad bars, sushi, raw or undercooked meat, fish, shellfish, poultry, and eggs.</li> <li>• If there is any question or concern about water purity (eg, well water), it can be checked for bacterial content by contacting local public health departments.</li> </ul>
--

the use of very large doses of vitamins, minerals, and other dietary supplements is not recommended.<sup>113,114</sup> There is reason for caution in taking high-dose supplements. The best example of this risk comes from studies of beta-carotene and lung cancer. Although many observational epidemiologic studies suggested that dietary beta-carotene was associated with lower risk for lung cancer,<sup>115</sup> two clinical trials showed that high-dose beta-carotene supplements actually increased (not decreased) the rate of occurrence of lung cancer.<sup>113,114</sup> In addition, one recent trial suggests that beta-carotene supplements may increase colorectal adenoma recurrence in persons who smoke cigarettes, consume alcohol, or both.<sup>116</sup> High doses of beta-carotene taken as a supplement clearly do not result in the same effects as consumption of dietary patterns that include foods rich in beta-carotene. Because other vitamins and micronutrients at high doses have not been studied in large clinical trials, the adverse effects of high-dose beta-carotene should suggest caution in the use of high-dose nutritional supplements. There are, however, some indications for lower-dose nutrient supplementation by cancer patients and survivors. These include the following:

- Biochemically demonstrated nutrient deficiency (eg, low plasma vitamin D levels, B12 deficiency) where dietary approaches have been inadequate.
- Nutrient intakes persistently below recommended intake levels.
- To meet public health recommended levels of intake (ie, calcium or vitamin D supplementation for bone health, folate among women of child-bearing age planning pregnancy) *if* not contraindicated due to cancer therapy.
- Known health sequelae related to cancer therapy (ie, bone loss requiring calcium and/or vitamin D supplementation).

Open dialogue between patients and health care providers should occur regarding dietary supplementation to assure there is no contraindication in relation to the prescribed cancer therapy or for longer-term health effects.<sup>117,118</sup> In turn, health care providers should make an effort not only to provide time to review dietary supplement decisions with patients, but also to stay

abreast of recent research in this area, particularly related to potential drug interactions. It is most prudent to encourage cancer survivors to obtain the potentially beneficial compounds from food. A daily multivitamin supplement in amounts equivalent to 100% of the Daily Value is a good choice for anyone who, for whatever reasons, cannot eat a healthful diet,<sup>110,111</sup> but the need for vitamin and mineral supplements in higher doses should be assessed and discussed on an individual basis.

#### Physical Activity Issues for Cancer Survivors

Physical activity may have benefits throughout the spectrum of the cancer experience, but cancer survivors are often more likely to become sedentary for several reasons. Survivors tend to decrease their physical activity levels after their diagnosis of cancer, and most continue lower levels of activity through treatment and beyond, rarely returning to their prediagnosis levels of activity.<sup>119-121</sup> Because being sedentary is a risk factor for the incidence of several of the most common types of cancer, such as breast cancer and colorectal cancer, many survivors from these cancers will tend to have been sedentary before diagnosis. In addition, some therapies may reduce the capacity to exercise because of adverse effects on cardiopulmonary, neurologic, and muscular systems. Thus, both preexisting reduced levels of fitness, stamina, and strength and the new stresses of cancer diagnosis, treatment, and recovery challenge cancer survivors who want to increase their physical activity levels. For these reasons, exercise that is of low or moderate intensity for a healthy person may seem to be of high intensity for some cancer survivors.

Physical activity capabilities and effects will differ among cancer survivors depending on their diagnosis, treatment modalities, and the spectrum of cancer survival.<sup>122</sup> Many cancer survivors are at increased risk for comorbid conditions that can be reduced through increased physical activity.<sup>123</sup> The effects of physical activity on cardiovascular disease and diabetes have not been studied in cancer survivors, but it is reasonable to expect that the beneficial effects of physical activity on such outcomes would not differ from those observed in the general

population. Similarly, resistance exercise has been reported to improve bone strength in persons without cancer; thus, resistance exercise programs may be expected to favorably decrease risk of osteoporosis in cancer survivors, although such effects have not yet been studied. Women who experience menopause during or after treatment and men with prostate cancer who are treated with long-term androgen-suppressive medications are at high risk for osteoporosis<sup>124,125</sup> and may therefore be especially likely to benefit from resistance training to increase bone strength. Additional positive outcomes of exercise training can include improved lean body mass and balance, with resulting reduced risk for falls and subsequent fractures. Clinical trials are underway that are testing the effects of aerobic and resistance exercise on bone density in postmenopausal breast cancer survivors.

Cancer survivors with lymphedema may also benefit from exercise, specifically range-of-motion exercises, with approval from their treating physicians. The benefits and risks of resistance training in survivors with lymphedema have not been investigated systematically. There have been some concerns that physical activity involving the affected limbs may have adverse effects on lymphedema. However, this is an area that is understudied, and the few results, including from a randomized trial, an early pilot clinical study, and a small cohort study, suggest that resistance training does not adversely affect lymphedema.<sup>126–128</sup>

No clinical trials have reported the effect of physical activity on the risk for cancer recurrence or survival, but several clinical trials have assessed the effect of physical activity interventions on quality of life and other psychosocial outcomes in cancer survivors. The exercise programs in these trials were primarily 3 days per week of moderate to vigorous activity that was progressively increased in duration to approximately 45-minute sessions during a period of 3 or 4 months. These studies have shown that such exercise programs can reduce anxiety and depression, improve mood, boost self-esteem, and reduce symptoms of fatigue.<sup>30</sup> In general, physical activity is likely to be beneficial for most cancer survivors who have completed their primary treatments.

**TABLE 4** Suggested Ways to Increase Physical Activity

- Use stairs rather than an elevator.
- If you can, walk or bike to your destination.
- Exercise with your family, friends, and coworkers.
- Take an exercise break to stretch or take a short walk.
- Walk to visit nearby friends or coworkers instead of sending an e-mail.
- Plan active vacations rather than only driving trips.
- Wear a pedometer every day and increase your daily steps.
- Use a stationary bicycle or treadmill while watching TV.

Although some cancer survivors can adopt an exercise program independently, many will benefit from referral to an exercise specialist. Survivors should seek individuals who have been certified by an exercise-related professional organization, such as the American College of Sports Medicine. A physical therapist is the appropriate resource for survivors with injuries, pain, or specific postsurgical issues such as lymphedema or amputation. Exercise physiologists receive college training and are certified by various professional organizations to develop individualized exercise programs. Personal trainers are also popular choices for persons who want to increase their fitness and activity levels. Recommendations on the type, frequency, duration, and intensity of exercise should be individualized to the survivor's age, previous fitness activities, type of cancer, stage of treatment, type of therapy, and comorbid conditions. Table 4 contains some suggested ways to increase physical activity.

Particular issues for cancer survivors may affect their ability to exercise. Effects of treatment may also promote the risk for exercise-related injuries and adverse effects. Specific precautions should be heeded:

- Survivors with severe anemia should delay exercise, other than activities of daily living, until the anemia is improved.
- Survivors with compromised immune function should avoid public gyms and other public places until their white blood cell counts return to safe levels. Survivors who have completed a bone marrow transplant are usually advised to avoid such exposures for 1 year after transplantation.
- Survivors suffering from severe fatigue from their therapy may not feel up to an exercise

program, so they may be encouraged to do 10 minutes of stretching exercises daily.

- Survivors undergoing radiation should avoid chlorine exposure to irradiated skin (eg, from swimming pools).
- Survivors with indwelling catheters should avoid water or other microbial exposures that may result in infections, as well as resistance training of muscles in the area of the catheter to avoid dislodgment.
- Survivors with significant peripheral neuropathies or ataxia may have a reduced ability to use the affected limbs because of weakness or loss of balance. They may do better with a stationary reclining bicycle, for example, than walking on a treadmill.

For the general population, the ACS recommends at least 30 to 60 minutes of moderate to vigorous physical activity at least 5 days per week to reduce the risk for cancer, cardiovascular disease, and diabetes.<sup>42,46,123</sup> These levels of activity have not been studied systematically in cancer survivors, but aside from specific circumstances related to treatment or other cancer-specific conditions such as outlined above, there is no reason to think that these recommendations would not also be beneficial for cancer survivors. Therefore, although daily and regular activity may be preferred and may be a goal, any steps that are taken to move from a sedentary to an active lifestyle should be encouraged. If an individual has been completely sedentary, encouragement to take short walks may be appropriate. If someone already exercises three times a week, encouragement to increase this to five times a week may be appropriate. For survivors wanting maximum benefit, the message should be that the health benefits of exercise are generally linear, with increasing health benefit with a higher volume of physical activity. Caution should be noted that extremely high levels of exercise might increase the risk for infections,<sup>129</sup> and the risk of exercise-related injuries should also be minimized.

---

NUTRITION AND PHYSICAL ACTIVITY ISSUES  
BY SELECTED CANCER SITES

**Breast Cancer**

For a woman diagnosed with breast cancer, achieving or maintaining a desirable weight may

be one of the most important lifestyle pursuits. The majority of studies conducted over several decades indicate that overweight or obesity at the time of diagnosis is a poor prognostic factor and may be associated with less favorable nodal status, as well as a variety of undesirable outcomes (eg, contralateral disease, recurrence, comorbid disease, and/or disease-specific or overall mortality).<sup>10,69,130-134</sup> Given that overweight and obesity are well-established risk factors for worse prognosis, and many women are overweight when diagnosed with breast cancer, weight management is a concern for a substantial proportion of breast cancer survivors. A compounding problem is the fact that additional weight gain is frequently reported after diagnosis.<sup>135-137</sup> Studies have provided conflicting evidence as to the effect of post-diagnosis weight gain on prognosis, although the largest of these found that those who gained more than 13 pounds were 50% more likely to relapse and 60% more likely to die than were women who gained less weight.<sup>138</sup> Analyses conducted on a cohort of nonsmoking breast cancer survivors within the Nurses' Health Study cohort corroborated these findings. Women who increased their body mass index (BMI) by 0.5 to 2 units were found to have a 40% greater chance of recurrence, and those who gained more than 2 BMI units had 53% greater chance of recurrence compared with those who did not gain more than 0.5 BMI units.<sup>139</sup> In that study, survivors in whom weight decreased did not experience significantly poorer outcomes. However, other recent studies have not found an effect of weight gain on prognosis.<sup>140</sup> Although it must be borne in mind that unexplained weight loss may be a symptom of recurrent disease and should be monitored closely,<sup>141</sup> there is a vast difference between weight loss that is intentional or purposeful versus that which is unexplained or a consequence of disease. Indeed, given accumulating data to suggest that overweight and obesity adversely influence not only cancer-specific outcomes, but also overall health and quality of life, weight management is now considered a standard of care for overweight women diagnosed with early stage breast cancer.<sup>10,142,143</sup> A decade of previous research,<sup>144-147</sup> as well as more recent studies, also suggests that the weight gain experienced by women who

have been treated with adjuvant chemotherapy or hormonal treatment seems to be the result of increases in adipose tissue mass, with no change or a decrease in lean body mass.<sup>137,148,149</sup> This unfavorable shift in body composition suggests that interventions should be aimed at not only curbing weight gain during treatment, but also at preserving muscle mass. Moderate physical activity (especially resistance training) during and after treatment may help survivors maintain lean muscle mass while avoiding excess body fat.<sup>136,150</sup> Even if an ideal weight is not achieved, it has been established in the general population that a weight loss of 5% to 10% over 6 to 12 months is sufficient to reduce the levels of factors associated with chronic disease risk, such as elevated plasma lipids and fasting insulin levels. Although overweight women should definitely be encouraged to lose weight after active treatment, modest weight loss (1–2 pounds per week) could also be pursued safely during therapy as long as it is approved by the treating oncologists, is monitored closely, and does not interfere with treatments.<sup>151,152</sup>

Several studies have examined exercise during and after treatment in breast cancer survivors.<sup>150,153</sup> Few studies are large randomized clinical trials, but the evidence consistently suggests a benefit from exercise during and after breast cancer treatment on various measures of quality of life, as well as physical fitness (eg, cardiovascular endurance, flexibility, and body composition) and factors such as self-esteem, anxiety, depression, and fatigue.<sup>150</sup> There are good reasons to suspect that the benefits of physical activity for the primary prevention of breast cancer, heart disease, diabetes, and overall mortality rate would also extend to breast cancer survivors.<sup>55</sup> Furthermore, recent studies suggest that breast cancer survivors who are physically active have significantly lower rates of recurrence, as well as disease-specific and overall mortality, than those who are sedentary.<sup>55,133</sup>

Research is currently under way to evaluate various components of the prudent dietary pattern on cancer-specific outcomes, as well as overall health. To date, evidence that dietary fat intake could be associated with risk for recurrence or survival is not strongly or consistently supportive, especially when total energy intake and the degree of obesity are considered.<sup>154,155</sup> Two

large clinical trials, one recently completed and the other an ongoing study, were designed to test whether change in diet composition can reduce risk for recurrence and increase overall survival in women who have been diagnosed with breast cancer. The recently-completed WINS was a randomized multicenter clinical trial testing whether a reduction in fat intake as an adjuvant to standard breast cancer therapy can reduce disease recurrence and increase survival for women with localized breast cancer. This trial was conducted among 2,437 postmenopausal women with early stage breast cancer, with 975 women randomly assigned to the low-fat dietary intervention group. Unpublished results suggest that study participants in the low-fat diet arm of the study (targeting 20% of energy from fat) exhibited a 24% reduction in risk for recurrence, with a greater reduction in risk observed in the subgroup of women with estrogen receptor-negative cancer.<sup>87</sup>

Eating more vegetables is inconsistently related to reducing breast cancer risk, and the evidence that fruit intake is related to recurrence or survival is weak.<sup>156,157</sup> In the ongoing WHEL Study, the major intervention is on increased vegetable and fruit intake, although the intervention group women are also encouraged to reduce fat and increase fiber intakes.<sup>158</sup> Results from the WHEL Study are anticipated by 2008. In a recent cross-sectional study of women assigned to the control arm of the WHEL Study, higher levels of baseline serum carotenoid concentrations (a biologic marker of vegetable and fruit intake) were found to be associated with longer recurrence-free survival.<sup>95</sup> Vegetables can reduce the total energy density in the diet, and both vegetables and fiber are associated with improved satiety. Recent data on breast cancer survivors participating in the Nurses' Health Study, who were followed for a mean period of nearly 10 years postdiagnosis, suggest that those who consume a prudent diet, with higher intakes of fruits, vegetables, and whole grains and lower intakes of sugars, refined grains, and animal products, may not have significantly lower rates of recurrence or cancer-specific mortality, although women who report this eating pattern have significantly lower rates of mortality from other diseases, when compared to those who eat typical western diets.<sup>159</sup>

Low folate intake (determined in large part by low dietary intakes of fruit, vegetables, legumes, and grains) has been hypothesized to be related to increased breast cancer risk.<sup>160-162</sup> Folate might ameliorate the adverse effects of alcohol on breast cancer risk because some studies have shown that the increased risk associated with alcohol is more pronounced among women reporting lower intakes of folate.<sup>162-164</sup> A specific relationship between folate intake and risk for recurrence or survival in women who have been diagnosed with breast cancer has not been observed in studies that have addressed that question.<sup>165</sup>

Although alcohol intake has been linked with an increase in the risk for primary breast cancer,<sup>100</sup> there is limited evidence from studies of breast cancer survivors of a relationship with the risk for recurrence and survival.<sup>73,166</sup> This is in part due to the fact that alcohol intake among women in these studies of breast cancer prognosis is generally at very low levels.<sup>101</sup> Theoretically, however, alcohol intake could affect the risk for a second primary breast cancer, for which all breast cancer survivors are at increased risk. Alcohol is an unusual factor, however, because it presents both risks and benefits. In the general population, clear and consistent evidence links moderate alcohol intake (1-2 drinks per day) with a lower risk for cardiovascular disease.<sup>99</sup> For breast cancer survivors, the decision to drink alcoholic beverages at moderate levels is complex because they must consider their levels of risk for both cardiovascular disease and recurrent breast cancer.

There is considerable public and scientific interest in the role of soy foods in the prevention of breast cancer, although evidence from human studies in support for such a role is limited.<sup>167-170</sup> The interest in soy foods stems from the observation that they are consumed commonly in most Asian countries, where the rates of breast cancer are lower than in the United States and other western countries, and several epidemiologic studies in Asia or in Asian-American populations suggest that soy food intake may decrease the risk of breast cancer. Soy contains high levels of plant isoflavones that exert a variety of anticancer activities in laboratory studies.<sup>167</sup> Perhaps because soy has the potential to produce both estrogenic and antiestrogenic

effects, studies on soy and breast carcinogenesis have produced conflicting results.<sup>167-170</sup> For the breast cancer survivor, current epidemiologic and laboratory evidence suggests there are unlikely to be harmful effects when soy is provided in the diet consistent with amounts in a typical Asian diet; whether such levels of soy intake may result in beneficial effects is also unclear.<sup>167</sup> This amount would be provided by as many as three servings per day of soy foods, such as tofu and soy milk. However, because higher doses of soy may have estrogenic effects<sup>170</sup> and because higher levels of estrogens clearly increase the risk for breast cancer progression,<sup>166</sup> it is prudent for breast cancer survivors to avoid the high doses of soy and soy isoflavones that are provided by more concentrated sources such as soy powders and isoflavone supplements.

As we consider results from the WINS trial<sup>87</sup> and await results of the WHEL Study,<sup>86</sup> it is important to remember that nutrition and physical activity recommendations to reduce the risks for primary breast cancer and heart disease are especially important for breast cancer survivors.<sup>42,46,171,172</sup> Diets should emphasize vegetables and fruits, low amounts of saturated fats, and sufficient dietary fiber. If soy foods are consumed, intakes should be kept in moderation, and concentrated sources of isoflavones should be avoided. Most importantly, breast cancer survivors should strive to achieve and maintain a healthy weight through appropriate diet and regular physical activity.<sup>84</sup> In addition, regular physical activity should be maintained regardless of any weight concerns.

#### Colorectal Cancer

Many epidemiologic studies indicate that colorectal cancer risk is increased by diets high in red and processed meats and low in vegetables and fruits and by sedentary lifestyles and obesity. Excess alcohol consumption may also increase the risk for this cancer.<sup>173</sup> Whether these or other dietary factors also influence prognosis of colorectal cancer is largely unknown. Only a few studies have tried to determine whether dietary factors influence prognosis after colorectal cancer diagnosis, and their findings have varied. Findings from two studies suggest that increased body weight is associated with shorter survival.<sup>72,174</sup>



Three additional studies suggest that higher levels of physical activity may be associated with better clinical outcomes in colorectal cancer survivors.<sup>52-54</sup>

Because colorectal cancers arise from adenomatous polyps, the prevention of polyp recurrence has been a focus of considerable clinical research. To date, trials have failed to show benefits in preventing new polyp growth during a 3- or 4-year period from antioxidant vitamins, fiber supplements, or modest dietary changes to increase fruit and vegetable intake.<sup>175</sup> Calcium supplements, however, provided a modest benefit in preventing polyp recurrence.<sup>176</sup> Clinical trials testing the effects of folate, vitamin D, and selenium are underway. After a diagnosis of colorectal cancer, the most important determinants of survival seem to be adherence to the full treatment regimen (especially if chemotherapy is recommended) and colonoscopic surveillance to identify new lesions.

Three studies have shown positive associations among exercise, physical fitness, and quality of life among colorectal cancer survivors.<sup>120,177,178</sup> Two recent studies have shown a positive association between physical activity and survival in colorectal cancer survivors.<sup>53,54</sup> Moreover, the evidence for a relation between physical activity and the primary prevention of colon cancer is convincing.<sup>49</sup> Consequently, there is emerging evidence that physical activity may improve quality of life, reduce risk of recurrence, and extend survival after colorectal cancer.

Colorectal cancer survivors should be advised to maintain a healthy weight, eat a well-balanced diet consistent with guidelines for cancer and heart disease prevention, and participate in regular physical activity. Colorectal cancer survivors with chronic bowel problems or surgery that affects normal nutrient absorption should be referred to a registered dietitian to modify their diets to accommodate these changes and maintain optimal health.

**Hematologic Cancers and Cancers Treated With Bone Marrow Transplantation or Hematopoietic Stem Cell Transplantation**

A possible relationship between dietary factors and outcomes of hematologic cancers has been examined in only a few studies to date.

Overweight or obesity seems to adversely affect prognosis for patients who receive hematopoietic stem cell transplantation, although the evidence is limited. In a study that focused on clinical data from patients who underwent autologous stem cell transplantation, obesity had significant adverse effects on treatment-related toxicity and mortality, overall survival, and disease-free survival.<sup>179</sup>

Preliminary research has examined the effects of exercise in survivors of hematologic cancers. Most of these studies have been conducted in the context of acute recovery from bone marrow or stem cell transplantation.<sup>180-184</sup> Overall, these studies have reported some beneficial effects of exercise on functional capacity and aerobic fitness, muscular strength, fatigue, and psychosocial functioning and quality of life. More recently, several studies have examined hematologic cancer survivors outside the context of stem cell transplantation.

Observational studies have reported associations between exercise and quality of life in non-Hodgkin lymphoma<sup>185</sup> and multiple myeloma<sup>186</sup> survivors. One uncontrolled intervention trial found that chronically fatigued Hodgkin disease survivors reported reduced fatigue after 20 weeks of aerobic exercise.<sup>187</sup> Another study of patients with various cancers (mostly non-Hodgkin lymphoma and breast cancer) treated with high-dose chemotherapy and stem cell transplantation showed that a 6-week program of daily walking improved both physical performance and fatigue.<sup>182</sup>

The conditioning regimen of intensive chemotherapy, often in conjunction with total body irradiation, is associated with several specific side effects that have significant adverse nutritional consequences, such as nausea, vomiting, diarrhea, oropharyngeal mucositis, and esophagitis. Total body irradiation damages the gastrointestinal mucosa, resulting in malabsorption and diarrhea because these epithelial cells are highly susceptible to the effects of radiation. Nutritional problems also result from adverse effects of various drug therapies, such as oral immunosuppressive agents and antibiotics that may be necessary for post-transplant management. Finally, the common complication of graft-versus-host disease (in patients who receive an allogeneic transplant) results in abdominal pain,

nausea, severe diarrhea, malabsorption, and substantial nitrogen losses. Patients who do not receive nutrition support or specialized nutritional support typically eat poorly for a prolonged period and are at high risk of poor nutritional status.<sup>188-190</sup>

As an infection prevention strategy, low-microbial diets are often prescribed for transplant recipients. A low-microbial or low-bacteria diet is primarily a cooked-food diet because the major limitation imposed is on fresh or uncooked food items.<sup>191</sup> Because many food restrictions are imposed with this strategy, the nutrient adequacy of actual food intake of patients who are prescribed the low-microbial diet should be monitored. Prevention of malnutrition and correction of energy and nutrient inadequacies has been incorporated into the standardized post-transplant treatment at most transplant centers. In a recent review of the evidence relating to the relative effectiveness of enteral nutrition versus parenteral nutrition support, the issue could not be evaluated due to lack of evaluable data.<sup>192</sup> Recent trends include prescribing less parenteral nutrition support and more enteral nutrition support,<sup>191</sup> which could reduce risk of medical complications and control costs.

### Lung Cancer

Lung cancer is largely due to cigarette smoking, but diets low in vegetables and fruits have also been associated with increased lung cancer risk, even after accounting for tobacco use.<sup>115</sup> This observation led to the idea that perhaps beta-carotene, found in vegetables and fruits, might reduce lung cancer risk, but two large randomized clinical trials showed that high-dose beta-carotene supplementation actually increased the risk for lung cancer.<sup>113,114</sup> The possible effect (either beneficial or harmful) of nutritional supplements other than beta-carotene after the diagnosis of lung cancer has not been studied. One clinical trial of selenium and skin cancer noted a reduced incidence of lung cancer in association with selenium supplementation.<sup>193</sup> A new clinical trial is now under way to attempt to replicate and extend this work among lung cancer survivors.<sup>194</sup>

Few studies have examined the relation between dietary factors and lung cancer progn-

osis. Two small studies sought to determine whether dietary intervention with selected vegetables improved survival among those with advanced lung cancer.<sup>195,196</sup> Weight loss was less and survival was longer in the intervention groups in those studies, but these preliminary findings need to be confirmed by larger studies. Three randomized clinical trials that included lung cancer survivors, among others, encouraged participants to increase energy intake.<sup>197-199</sup> Although successful in increasing energy intake, none of the strategies used within these studies prevented weight loss.

Lung cancer treatment is often aggressive and causes adverse effects. Furthermore, many lung cancer survivors have low blood nutrient levels even before diagnosis as a result of inadequate diets, the adverse effects of smoking, or both, on micronutrient status. During treatment and the immediate recovery period, lung cancer survivors may benefit from eating foods that are energy-dense and are easy to swallow. Small, frequent meals may be easier to manage than three large meals per day. Medications, omega-3 fatty acid supplements, and nutritional support via energy-dense dietary supplements or enteral nutrition may be helpful for those experiencing weight loss.<sup>59</sup> If nutrient deficiencies are present or survivors cannot eat enough to adequately meet micronutrient needs, a multivitamin-mineral supplement is advisable, either in pill or liquid form. The potential role of physical activity in improving outcomes in lung cancer survivors has not been characterized.

Recommendations for nutrition and physical activity for persons who are living with lung cancer are best made based on individual needs. Striving toward a healthy weight by adjusting food intake and physical activity is a reasonable goal, as is ensuring that nutritional needs are met with a well-balanced diet and a multivitamin-mineral supplement, if needed to achieve adequate levels of intake.

### Prostate Cancer

Most research on diet and prostate cancer has focused on prostate cancer incidence.<sup>200,201</sup> Because asymptomatic prostate cancer is very common in older men, the same dietary factors that

are associated with reduced prostate cancer incidence might also reduce the rate of prostate cancer growth after diagnosis, thus preventing or slowing progression of early stage prostate cancer. In recent years, a few studies have tried to determine directly whether such dietary factors may prolong survival from prostate cancer or may influence biomarkers (eg, prostate-specific antigen levels) that are associated with outcomes for men with prostate cancer.

A high intake of foods from animal sources, especially foods high in saturated fat, has been associated with increased risk for prostate cancers.<sup>155,200</sup> Whether this increased risk is due to saturated fat per se or to the consumption of red meat and high-fat dairy products is unclear. The observation that fatty fish intake may decrease prostate cancer mortality rates suggests that, if fat is important, the type of fat may play a key role. There are now two follow-up studies of dietary factors and survival in prostate cancer survivors. One found that saturated fat intake (but not total fat) is associated with worse survival,<sup>202</sup> and the other found that monounsaturated fat intake is associated with better survival.<sup>88</sup> Based on what we currently know and on the role of saturated fat in cardiovascular disease and potential role in prostate and colon cancer incidence, decreasing saturated fat intake is likely very beneficial in this population.<sup>45,46</sup>

Most studies of prostate cancer prevention have not shown an association between vegetable and fruit intake and prostate cancer risk.<sup>42,44,201</sup> A possible beneficial effect of lycopene, found in tomatoes and tomato products, watermelon, and pink grapefruit, has captured attention,<sup>203</sup> but it is unclear whether this association is causal or spurious.<sup>204</sup> In one study in which the relationship between dietary intakes and prostate cancer recurrence was examined, intakes of fish and tomato sauce were observed to be associated with reduced risk.<sup>97</sup> Although benefits to prostate health from vegetables and fruits are far from certain, a diet high in vegetables and fruits has been found to reduce the risk for cardiovascular diseases.<sup>46</sup> Therefore, it is probably beneficial for prostate cancer survivors to eat plenty of micronutrient- and phytochemical-rich vegetables and fruits.

Increased consumption of soy foods (eg, tofu and soy milk) is a common self-care strategy

among prostate cancer survivors, under the assumption that the phytoestrogens may be beneficial. Although some studies suggest that soy foods may decrease the risk for prostate cancer, no rigorous studies have examined the effects of soy or other phytoestrogens on the progression of prostate cancer after diagnosis, although studies are underway. One small study of flaxseed, a concentrated source of lignan phytoestrogens, suggested some potentially beneficial effects on prostate-specific antigen levels<sup>205</sup>; it is not known whether these findings result in better prognoses.

Several epidemiologic studies have shown that men who have high levels of calcium in their diets, from both supplements and dairy products, might be at increased risk for aggressive forms of prostate cancer.<sup>206</sup> The possible effects of calcium after prostate cancer treatment, however, are not known. Prostate cancer survivors undergoing androgen-suppressive therapy are at high risk for osteoporosis. It is not known if calcium or vitamin D supplements would be useful or detrimental in these cases. It would seem prudent for men to adopt a diet that contains at least 600 IU per day and to consume adequate, but not excessive amounts of calcium (ie, exceeding 1,200 mg/d), as well as to pursue active lifestyles that include routine weight-bearing exercises. The role of vitamin D and related compounds in the prevention of prostate cancer recurrence is being studied; two preliminary studies suggest that vitamin D may reduce prostate-specific antigen levels, administered either separately or in conjunction with chemotherapy, although further research is needed to determine the longer-term effects of vitamin D supplementation.<sup>207,208</sup>

Vitamin E supplementation in a large prevention trial intended to affect lung cancer was shown to be associated with a reduced risk for prostate cancer, but vitamin E had no effect on survival in the men in whom prostate cancer developed in that study.<sup>113,209</sup> Selenium supplements reduced prostate cancer incidence in a small trial intended to prevent skin cancers.<sup>193,210</sup> Trials are now under way to assess the effects of both vitamin E and selenium on both prostate cancer prevention and suppression of tumor growth after diagnosis.<sup>211,212</sup>

Studies that have examined the association between obesity or physical activity and the risk for primary prostate cancer have not shown a consistent relationship,<sup>49</sup> although one large cohort study did find that prostate cancer survivors who were obese had higher mortality rates.<sup>68</sup> Two follow-up studies of men in whom prostate cancer was diagnosed have not found a relationship between obesity and the risk for recurrence and survival.<sup>88,202,213</sup> However, one study found that obesity was associated with a higher risk of biochemical failure rates in men treated with radical prostatectomy.<sup>214</sup> Two trials have examined the effects of exercise in prostate cancer survivors. One trial investigated the effects of resistance exercise training 3 times weekly for 12 weeks in patients receiving androgen deprivation therapy and reported improvements in quality of life, fatigue, and muscular fitness.<sup>215</sup> The other trial showed increased physical functioning from a home-based walking program 3 times weekly for 4 weeks during radiation therapy.<sup>216</sup>

Men in whom prostate cancer has been diagnosed should consume diets that are rich in vegetables and fruit and low in saturated fat and pursue a physically active lifestyle. Based on studies of prostate cancer incidence, it may also be prudent to consume diets that are moderate in calcium and low in dairy intake, although such dietary suggestions need to be considered in the context of increased risk of fractures from anti-androgen therapy and physical activity patterns. Although the evidence relating these recommendations to prostate cancer recurrence is limited, there are likely substantial other benefits, most prominently decreasing cardiovascular disease risk, which is the major cause of death in prostate cancer survivors.

#### Upper Gastrointestinal and Head and Neck Cancers

Research on the primary prevention of head and neck, esophageal, gastric, and pancreatic cancers suggests the importance of diets that emphasize vegetable and fruit intake and, in the case of pancreatic cancer, prevent obesity.<sup>67,217-219</sup> After the diagnosis of these cancers, however, little is known regarding whether such dietary patterns or other dietary or physical activity factors may affect prognosis.

Studies on the causes of head and neck cancers suggest that vegetable and fruit intake may be associated with decreased risk for developing these cancers, but few studies have considered whether these dietary factors or physical activity influence prognosis in survivors with these cancers. A clinical trial of the effects of a beta-carotene supplement (versus placebo) among survivors with head and neck cancers found that those receiving beta-carotene had no changes in cancer recurrence or survival rates.<sup>220</sup>

Persons with esophageal or gastric cancer may have symptoms that compromise food and nutrient intake and absorption, and the effects of treatment may result in long-term nutritional complications. A common problem in survivors with esophageal cancer is reflux.<sup>4</sup> Eating a high-protein, low-fat, high-carbohydrate diet helps increase lower esophageal sphincter pressure. Chocolate, fat, alcohol, coffee, spearmint, peppermint, garlic, and onion may decrease lower esophageal sphincter pressure and should be avoided. Acidic foods, such as tomato-based products and orange juice, may cause irritation. Nutritional management for persons who have gastric cancer is based on determining the portion of the stomach involved or that which has been surgically resected. For example, if the pyloric sphincter has been affected, rapid transit of food through the stomach may occur and call for smaller, more frequent feedings.

In the case of pancreatic cancer, there is increasing evidence that supplementation with omega-3 fatty acids has a favorable effect on short-term weight status, performance status, or related factors.<sup>61,221-223</sup> A preliminary study examined the Gonzalez dietary and supplementation regimen, with results suggesting an improvement in survival rates. Because these results were in a self-selected group of patients, findings are not definitive. However, a study funded by the National Cancer Institute is under way to determine whether this regimen has a beneficial effect.<sup>224</sup> A small study found that thalidomide (200 mg daily) was associated with slower loss of weight among persons with advanced pancreatic cancer.<sup>225</sup>

Head and neck cancers can directly compromise food intake, and high proportions of patients are malnourished at the time of diagnosis. Comprehensive care of these survivors includes appro-

appropriate nutritional assessment and support, and physical activity and physical therapy to improve overall health before, during, and after treatment. Poor nutrient intake can stem from difficulties in biting, chewing, and swallowing that follow surgery and from dry mouth, mucositis, and taste alterations resulting from radiation therapy. Many long-term survivors of head and neck cancer will experience at least some degree of aspiration associated with substantial weight loss, diminished swallowing efficiency, and lower quality of life scores.<sup>226</sup> During and after treatment, the texture, temperature, consistency, nutrient content, and frequency of oral feedings may need to be changed. Acidic, salty, spicy, and very hot or cold foods may not be well tolerated. Sugar-free gums and mints and the use of oral rinses and gels may provide limited relief of symptoms and enhance appetite. Liquid, pureed, or juiced foods may be better tolerated during treatment and recovery. Chemoradiation may have a significant effect on patients' eating ability, which should improve by 12 months after treatment.<sup>227</sup> Health care providers may offer alternate forms of feeding if eating and drinking by mouth cannot support nutritional needs. When tube feeding is started immediately after surgery for esophageal or gastric cancer, it may reduce both the duration of intensive care unit treatment and total hospital stay.<sup>228</sup> Several small studies have shown that physical activity may improve functioning, reduce pain and disability, and be related to quality of life in head and neck cancer survivors.<sup>229–231</sup>

In the absence of more definitive information, survivors of head and neck and upper gastrointestinal cancers should strive to follow the ACS Nutrition and Physical Activity Guidelines for the Prevention of Cancer. High intakes of vegetables and fiber have been shown to be beneficial.<sup>232</sup> Because food intake can be compromised due to the effects of disease or therapy, consultation with a registered dietitian for individualized recommendations is recommended.<sup>233</sup>

---

COMMON QUESTIONS ABOUT DIET, PHYSICAL ACTIVITY, AND CANCER SURVIVORSHIP

Cancer survivors often request information and advice from their healthcare providers about

food choices, physical activity, and dietary supplement use to improve their quality of life and survival. Health professionals who counsel patients should emphasize that no one study provides the last word on any subject, and that individual news reports may overemphasize what seem to be contradictory or conflicting results because they seem to be new, different, or challenge conventional wisdom. In brief news stories, reporters cannot always put new research findings in their proper context. The best advice about diet and physical activity is that it is rarely advisable to change diet or activity levels based on a single study or news report. The following questions and answers address common concerns of cancer survivors regarding diet and physical activity.

#### Alcohol

*Does alcohol increase the risk of cancer recurrence?*

Many studies have found a link between alcohol intake and risk for some primary cancers, including cancers of the mouth, pharynx, larynx, esophagus, liver, breast, and probably colon cancer.<sup>44,99,100</sup> In persons who have already received a diagnosis of cancer, alcohol intake could also affect the risk for new primary cancers of these sites. Alcohol intake can increase the circulating levels of estrogens, which theoretically could increase the risk for recurrence of estrogen receptor–positive breast cancer, but studies conducted to date have not been well suited to address this question.<sup>101</sup>

*Should alcohol be avoided during cancer treatment?*

The cancer type and stage of disease, as well as treatment, should be considered in making recommendations on alcohol use during treatment. Alcohol, even in the small amounts found in mouthwashes, can be irritating to survivors with oral mucositis and can exacerbate that condition.<sup>234</sup> Therefore, it is reasonable to recommend that alcohol intake should be avoided or limited among survivors with mucositis and among those beginning head and neck radiotherapy or chemotherapeutic regimens that put them at risk for mucositis. It is unknown whether

similar effects may occur in adjuvant therapy for other gastrointestinal cancers.

### Antioxidants

*What do antioxidants have to do with cancer?*

Antioxidants exist naturally in many forms and help prevent oxidative damage to tissues. Because oxidative damage may be important in the development of cancer, it has long been thought that antioxidants may help prevent cancer. Studies suggest that people who eat more vegetables and fruits, which are rich sources of antioxidants (including vitamin C, vitamin E, carotenoids, and many other antioxidant phytochemicals), may have a lower risk for some types of cancer.<sup>235</sup> Because cancer survivors may be at increased risk for second cancers, they should be encouraged to consume a variety of antioxidant-rich foods each day. So far, clinical studies of antioxidant vitamin or mineral supplements have not yet demonstrated a reduction in cancer incidence.<sup>236,237</sup> The best advice presently is to consume antioxidants through food sources rather than supplements.

*Is it safe to take antioxidant supplements during cancer treatment?*

Many dietary supplements contain levels of antioxidants (such as vitamins C and E) that substantially exceed the amount recommended in the Dietary Reference Intakes for optimal health.<sup>19-22</sup> At the present time, most oncologists advise against taking higher doses of supplements with antioxidant activity during chemotherapy or radiotherapy because antioxidants could repair cellular oxidative damage to cancer cells that contributes to the effectiveness of these treatments.<sup>23,24</sup> Others, however, have noted that the possible harm from antioxidants is only hypothetical and that there may be a net benefit to help protect normal cells from the collateral damage associated with these therapies.<sup>25</sup> Whether antioxidants or any other dietary supplements specifically are beneficial or harmful during chemotherapy or radiotherapy is a critical question without a clear scientific answer at this time.<sup>26-28</sup> Given this uncertainty, until more evidence is available that suggests more benefit than harm, it is prudent for cancer survivors currently receiv-

ing chemotherapy or radiation therapy to avoid dietary supplements exceeding 100% of the Daily Value for antioxidant-type vitamins.<sup>19-22</sup>

### Fat

*Will eating less total fat lower risk of cancer recurrence or improve survival?*

Several studies have been conducted on the relationship between fat intake and survival after the diagnosis of breast cancer, with inconsistent results.<sup>84</sup> Preliminary results from a large clinical trial of early-stage breast cancer survivors suggest that low-fat diets may reduce the risk of recurrence, particularly in women with estrogen receptor-negative disease.<sup>87</sup> It is important to note that although there is not conclusive evidence that total fat consumption influences cancer outcomes, diets high in fat tend to be high in calories and may contribute to obesity, which in turn is associated with increased cancer incidence at several sites, increased risk of recurrence, and reduced likelihood of survival for many cancer sites (see *Obesity*).

*Do different types of fat influence cancer incidence and survival?*

There is evidence that certain types of fat, such as saturated fats, may have an effect on increasing cancer risk.<sup>44,45,238</sup> There is little evidence that other types of fat (omega-3 fatty acids, found primarily in fish), monounsaturated fatty acids (found in olive and canola oils), or other polyunsaturated fats reduce cancer risk. In one study, saturated fat intake was inversely associated with prostate cancer-specific survival, and in another, monounsaturated fat intake and risk of death from prostate cancer were inversely associated.<sup>88,89</sup> In addition, excess saturated fat intake is a known risk factor for cardiovascular diseases, a major cause of morbidity and mortality in all populations, including cancer survivors. Although trans fats have adverse cardiovascular effects, such as raising blood cholesterol levels,<sup>46,75</sup> their relationship to cancer incidence or survival has not been determined. Regardless, survivors (especially those at increased cardiovascular disease risk) should consume as few trans fats as possible. Major sources of trans fats are margarines and snack foods that contain partially hydrogenated oils.

### Fiber

*Can dietary fiber prevent cancer or improve cancer survival?*

Dietary fiber includes a wide variety of plant carbohydrates that are not digestible by humans. Specific categories of fiber are “soluble” (like oat bran) or “insoluble” (like wheat bran and cellulose). Soluble fiber helps lower the risk of coronary heart disease by reducing blood cholesterol levels. Fiber is also associated with improved bowel function. Good sources of fiber are beans, vegetables, whole grains, and fruits. Associations between fiber and cancer incidence are weak, but consumption of these foods is still recommended because they contain other nutrients that may help reduce cancer risk and provide other health benefits, such as reduced risk of coronary heart disease.<sup>43</sup>

### Food Safety

*Are there special food safety precautions for individuals undergoing cancer treatment?*

Infection is of special concern for cancer survivors, especially during episodes of immunosuppression and leukopenia that can occur with certain cancer treatment regimens.<sup>102</sup> During immunosuppressive cancer treatment, survivors should be particularly careful to avoid eating foods that may contain unsafe levels of pathogenic microorganisms. General food safety practices, such as washing hands before eating, thoroughly washing vegetables and fruits, and keeping foods at proper temperatures, should be encouraged, and survivors should receive specific instructions regarding food safety as outlined in Table 3.

### Meat: Cooking and Preserving

*Should I avoid meats?*

Several epidemiologic studies have linked high consumption of red meat and processed meats with increased risk of colorectal, prostate, and stomach cancers.<sup>218,238–240</sup> Some research suggests that frying, broiling, or grilling meats at very high temperatures creates chemicals that might increase incidence of some types of cancer. For these reasons, ACS Guidelines for cancer prevention recommend limiting consumption

of processed and red meats. There is no evidence available regarding the effect of processed meat, meat cooked at high temperature, or meat in general on cancer recurrence or progression.

### Obesity

*Does being overweight increase risk of cancer recurrence and second primary cancers?*

Increasing evidence indicates that being overweight increases the risk for recurrence and reduces the likelihood of survival for many cancers.<sup>10,50,71,74</sup> Increased body weight has been associated with increased death rates for all cancers combined and for increased incidence for cancers at several specific sites, including cancer of the esophagus, colon and rectum, liver, gallbladder, pancreas, kidney, non-Hodgkin lymphoma, and multiple myeloma, in addition to cancers of the stomach and prostate in men and cancers of the breast, uterus, cervix, and ovary in women.<sup>49,68</sup> Because of other proven health benefits to losing weight, people who are overweight are encouraged to stop gaining weight, then to lose weight and prevent re-gain. The avoidance of excessive weight gain during adulthood is important not only to reduce cancer incidence and risk of recurrence, but the risk of other chronic diseases as well.<sup>42,46,75</sup>

### Organic Foods

*Are foods labeled organic recommended for cancer survivors?*

The term *organic* is popularly used to designate plant foods grown without pesticides and genetic modifications, or meat, poultry, eggs, and dairy products that come from animals that are given no antibiotics or growth hormones. Use of *organic* on food labels and packaging is regulated by the US Department of Agriculture to meet these and other criteria. It is commonly thought that organic foods may be more healthful because they reduce exposure to agricultural chemicals. It has also been suggested that their nutrient composition may be better than their conventionally grown counterparts. Whether this translates into health benefits from consumption of organic foods is unknown. At present, no epidemiologic studies in humans exist to demonstrate whether such foods are more effective in reducing can-

cer incidence, recurrence, or progression than similar foods produced by other farming and production methods.

### Physical Activity

*Should I exercise during cancer treatment and recovery?*

Evidence strongly suggests that exercise is not only safe and feasible during cancer treatment, but that it can also improve physical functioning and various aspects of quality of life.<sup>30-33,150</sup> Moderate exercise has been shown to improve fatigue, anxiety, and self-esteem, as well as cardiovascular fitness, muscle strength, and body composition. Persons receiving chemotherapy and radiation therapy who are already on an exercise program may need to temporarily exercise at a lower intensity and progress at a slower pace compared with persons who are not receiving cancer treatment. The principal goal should be to maintain activity as much as possible.

*Are there special precautions survivors should consider?*

Particular issues for cancer survivors may affect or contraindicate their ability to exercise. Some effects of treatment may also increase the risk for exercise-related injuries and adverse effects. For example, survivors with severe anemia should delay activity until the anemia is improved; survivors with compromised immune function should avoid public gyms and other public places until their white blood cell counts return to safe levels; survivors undergoing radiation should avoid swimming pools because chlorine exposure may irritate irradiated skin. For those who were sedentary before diagnosis, low-intensity activities should be adopted and slowly advanced. For older persons and those with bone disease (due to skeletal metastases or to severe osteoporosis) or significant impairments such as arthritis or peripheral neuropathy, careful attention should be given to balance to reduce the risk for falls and injuries.

*Can regular exercise reduce the risk of cancer recurrence?*

It is not known whether exercise will reduce the chances of cancer recurrence or will slow

cancer growth. Nonetheless, overweight and obesity have been associated with increased incidence of many types of cancer<sup>49</sup> and with risk of recurrence of some cancers, and physical activity is a key component of maintaining and achieving a healthy body weight. In addition, physical activity has a beneficial effect on preventing cardiovascular disease, diabetes, and osteoporosis.<sup>49,123</sup> Therefore, cancer survivors should be encouraged to adopt a physically active lifestyle.

### Phytochemicals

*What are phytochemicals, and do they reduce cancer risk?*

The term *phytochemicals* refers to a wide variety of compounds produced by plants. Some have either antioxidant or hormone-like actions both in plants and in people who eat them.<sup>44</sup> Studies examining the effects of phytochemicals or specific plant foods such as vegetables or fruits on cancer recurrence or progression are very limited, and the little evidence that exists is inconsistent or comes from only a few studies. Because consumption of vegetables and fruits reduces incidence of some types of cancer, researchers are searching for specific components that might account for the beneficial effects. There is no evidence that phytochemicals taken as supplements are as beneficial as the vegetables, fruits, beans, and grains from which they are extracted.

### Soy Products

*Is including soy-based foods in the diet recommended for cancer survivors?*

Soy-derived foods are an excellent source of protein and in this respect, a good alternative to meat. Soy contains several phytochemicals, some of which have weak estrogenic activity and seem to protect against hormone-dependent cancers in animal studies. Other compounds have antioxidant properties, are protease inhibitors, and may have anti-angiogenic activity. There is considerable public and scientific interest in the role of soy foods in the prevention of cancer in general and breast cancer in particular, although scientific support for such a role is inconsistent.<sup>167-170</sup>

For the breast cancer survivor, current evidence suggests neither specific benefits nor harm-



ful effects when soy is provided in the moderate amounts observed in most traditional Asian diets (no more than three servings per day) as part of a healthy diet.<sup>167</sup> However, because higher doses of soy may have estrogenic effects<sup>170</sup> and because higher levels of estrogens clearly increase the risk for progression of estrogen receptor–positive breast cancer,<sup>167</sup> it is prudent for breast cancer survivors to avoid the high doses of soy and soy isoflavones that are provided by more concentrated sources such as soy powders and isoflavone supplements.

### **Sugar**

*Does sugar “feed” cancer?*

No. Sugar intake has not been shown to directly increase risk or progression of cancer. However, sugars (including honey, raw sugar, brown sugar, high-fructose corn syrup, and molasses) and beverages that are major sources of these sugars (such as soft drinks and fruit-flavored beverages) add substantial amounts of calories to the diet and thus can promote weight gain, which adversely affects cancer outcomes. In addition, most foods and beverages that are high in sugar do not contribute many nutrients to the diet and often replace more nutritious food choices. Therefore, limiting sugar consumption is recommended.

### **Supplements**

*Would survivors benefit from using vitamin and mineral supplements?*

During and after cancer treatment, there is a probable benefit of taking a standard multiple vitamin and mineral supplement that contains approximately 100% of the Daily Value because, during these times, it may be difficult to eat a diet with adequate amounts of these micronutrients. The use of very large doses of vitamins, minerals, and other dietary supplements is not recommended<sup>237</sup> because some evidence exists that indicates that high-dose supplements can increase cancer risk.<sup>113,114</sup>

*Can nutritional supplements lower cancer incidence or risk of recurrence?*

There is strong evidence that a diet rich in vegetables, fruits, and other plant-based foods

may reduce the risk of some types of cancer, and some recent studies suggest there may be a beneficial effect on recurrence or survival for breast, prostate, and ovarian cancers. However, there is no evidence at this time that supplements can provide these benefits. Many healthful compounds are found in vegetables and fruits, and it is likely that these compounds work synergistically to exert their beneficial effect. There are likely to be important, but as yet poorly understood or unidentified, components of whole food that are not included in supplements. The small amount of dried powder in the pills that are represented as being equivalent to vegetables and fruits frequently contains only a small fraction of the levels contained in the whole foods. Food is the best source of vitamins and minerals.

### **Vegetables and Fruits**

*Will eating vegetables and fruits lower risk of cancer recurrence?*

Greater consumption of vegetables and fruits has been associated in the majority of epidemiologic studies with a lower risk of lung, oral, esophageal, stomach, and colon cancer.<sup>241</sup> Few studies exist, however, on whether a diet including many vegetables and fruits can reduce the risk of cancer recurrence or improve survival. Some recent studies suggest increasing intake of vegetables may exert a beneficial effect on recurrence or survival for breast, prostate, and ovarian cancers.<sup>95–97</sup> Nonetheless, cancer survivors should be encouraged to consume at least five servings of a variety of vegetables and fruits each day because of their other health benefits. Because it is not known which of the many compounds in vegetables and fruits are most protective, the best advice is to consume five or more servings of a variety of colorful vegetables and fruits each day.

*Is there a difference in the nutritional value of fresh, frozen, and canned vegetables and fruits?*

Yes, but they can all be good choices. Fresh foods are usually considered to have the most nutritional value. Often, though, frozen foods can be more nutritious than fresh foods because they are often picked ripe and quickly frozen;

nutrients can be lost in the time between harvest and consumption for fresh foods. Canning is more likely to reduce the heat-sensitive and water-soluble nutrients because of the high heat temperatures necessary in the canning process.<sup>242</sup> Be aware that some fruits are packed in heavy syrup, and some canned vegetables are high in sodium. Choose vegetables and fruits in a variety of forms.

*Does cooking affect the nutritional value of vegetables?*

Boiling vegetables, especially for long periods, can leach out their content of water-soluble vitamins. Microwaving and steaming are the best ways to preserve the nutritional content in vegetables.

*Should I be juicing my vegetables and fruits?*

Juicing can add variety to the diet and can be a good way to consume vegetables and fruits, especially for those who have difficulty chewing or swallowing. Juicing also improves the body's absorption of some of the nutrients in vegetables and fruits. However, juices may be less filling than whole vegetables and fruits and contain less fiber. Fruit juice, in particular, can contribute excess calories to one's diet if large amounts are consumed. Commercially juiced products should be 100% vegetable or fruit juices and should be pasteurized to eliminate harmful microorganisms. This is true for the general population, but is of particular concern for people who may be immunocompromised, such as cancer patients undergoing chemotherapy.

#### **Vegetarian Diets**

*Do vegetarian diets reduce risk of cancer recurrence?*

No direct evidence has determined whether consuming a vegetarian diet has any additional benefit for the prevention of cancer recurrence over an omnivorous diet high in vegetables, fruits, and whole grains and low in red meats. However, vegetarian diets can have many healthful characteristics because they tend to be low in saturated fat and high in fiber, vitamins, and phytochemicals,<sup>243</sup> and are consistent with the ACS Nutrition Guidelines for the Prevention of Cancer.

#### **Water and Other Fluids**

*How much water and other fluids should I drink?*

Many symptoms of fatigue, light-headedness, and nausea can be due to dehydration; survivors should therefore be encouraged to try to remain adequately hydrated. Consumption of water and other liquids may reduce the incidence of bladder and colon cancer.<sup>244</sup> Drinking at least eight cups of liquid a day is usually recommended for the general public and is a reasonable recommendation for survivors, with the exception of those who have a specific medical reason for restricting fluid intake.

ACS 2006 NUTRITION, PHYSICAL ACTIVITY AND  
CANCER SURVIVORSHIP ADVISORY COMMITTEE

**Volunteer Members:** **Noreen M. Aziz, MD, PhD, MPH;** Senior Program Director, Office of Cancer Survivorship, Division of Cancer Control & Population Sciences, National Cancer Institute, NIH/DHHS, Bethesda, MD; **Abby F. Bloch, PhD, RD, FADA;** Nutrition Consultant, New York, NY; **Jean K. Brown, PhD, RN, FAAN;** Acting Dean and Professor in Nursing, Nutrition, and Rehabilitation Science, University at Buffalo School of Nursing, Buffalo, NY; **Tim Byers, MD, MPH;** Professor, Department of Preventive Medicine and Biometrics; and Deputy Director, University of Colorado Cancer Center, Aurora, CO; **Bette Caan, DrPH;** Senior Research Scientist, Division of Research, Kaiser Permanente, Oakland, CA; **June M. Chan, ScD;** Assistant Professor and Program Director, Genitourinary Cancer Epidemiology and Population Science, University of California, San Francisco, CA; **Kerry S. Courneya, PhD;** Professor and Canada Research Chair in Physical Activity and Cancer, Faculty of Physical Education, University of Alberta, Edmonton, Alberta; **Wendy Demark-Wahnefried, PhD, RD, LDN;** Professor, School of Nursing and Department of Surgery, Duke University Medical Center, Durham, NC; **Brandy M. Gazo, MA, MSSW;** Research Program Coordinator, Lance Armstrong Foundation, Austin, TX; **Barbara Grant, MS, RD;** Oncology Nutritionist, Saint

Alphonsus Regional Medical Center, Cancer Care Center, Boise, ID; **Kathryn K. Hamilton, MA, RD, CDN**; Outpatient Oncology Dietitian, Carol G. Simon Cancer Center, Morristown Memorial Hospital, Morristown, NJ; **Carolyn Katzin, MSPH, CNS**; Certified Nutrition Specialist, Los Angeles, CA; **Lawrence H. Kushi, ScD**; Associate Director for Etiology & Prevention Research, Division of Research, Kaiser Permanente, Oakland, CA; **Anne McTiernan, MD, PhD**; Full Member, Fred Hutchinson Cancer Research Center, Cancer Prevention Research Program, Seattle, WA; **Marion Morra, MA, ScD**; President, Morra Communications, Milford, CT; **Margaret S. Pierce, MSN, MPH, AOCN, APRN, BC**; Assistant Professor, University of Tennessee, College of Nursing, Knoxville, TN; **Cheryl L. Rock, PhD, RD**; Professor, Department of Family and Preventive Medicine, School of Medicine, University of

California, San Diego, La Jolla, CA; **Julia H. Rowland, PhD**; Director, Office of Cancer Survivorship, Division of Cancer Control and Population Sciences, National Cancer Institute, NIH/DHHS, Bethesda, MD; **Cyndi Thompson, PhD**; Assistant Professor, University of Arizona Department of Nutritional Sciences, Tucson, AZ

**American Cancer Society Staff Members:** **Terri Ades, RN, MS, AOCN**; Director of Cancer Information; **Kimberly S. Andrews**; Research Associate, Cancer Control Science; **Colleen Doyle, MS, RD**; Director, Nutrition and Physical Activity; **Ted Gansler, MD, MBA**; Director of Medical Content; **Greta Greer**; Manager, Cancer Survivors Network; **Sheri Knecht, RD, CNSD, LDN**; Dietitian on Call, South-Atlantic Division; **Kristina Ratley, RD, LDN**; Dietitian on Call, South-Atlantic Division

#### REFERENCES

- Ries LA, Harkins D, Krapcho M, et al. SEER Cancer Statistics Review, 1975–2003. Bethesda, MD: National Cancer Institute; 2006.
- Chelf JH, Agre P, Axelrod A, et al. Cancer-related patient education: an overview of the last decade of evaluation and research. *Oncol Nurs Forum* 2001;28:1139–1147.
- Brown JK, Byers T, Doyle C, et al. Nutrition and physical activity during and after cancer treatment: an American Cancer Society guide for informed choices. *CA Cancer J Clin* 2003;53:268–291.
- Schattner M, Shike M. Nutrition Support of the Patient with Cancer, in Shils ME, Shike M, Ross AC (eds). *Modern Nutrition in Health and Disease*. 10th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2006:1290–1313.
- Nitenberg G, Raynard B. Nutritional support of the cancer patient: issues and dilemmas. *Crit Rev Oncol Hematol* 2000;34:137–168.
- Ollenschlaeger G, Konkol K, Wickramanayake PD, et al. Nutrient intake and nitrogen metabolism in cancer patients during oncological chemotherapy. *Am J Clin Nutr* 1989;50:454–459.
- Langstein HN, Norton JA. Mechanisms of cancer cachexia. *Hematol Oncol Clin N Am* 1991;5:103–123.
- McMahon K, Decker G, Ottery FD. Integrating proactive nutritional assessment in clinical practices to prevent complications and cost. *Semin Oncol* 1998;25(Suppl 6):20–27.
- Dewys WD, Begg C, Lavin PT, et al. Prognostic effect of weight loss prior to chemotherapy in cancer patients. Eastern Cooperative Oncology Group. *Am J Med* 1980;69:491–497.
- Chlebowski RT, Aiello E, McTiernan A. Weight loss in breast cancer patient management. *J Clin Oncol* 2002;20:1128–1143.
- McMahon K, Brown JK. Nutritional screening and assessment. *Semin Oncol Nurs* 2000;16:106–112.
- Wojtaszek CA, Kochis LM, Cunningham RS. Nutrition impact symptoms in the oncology patient. *Oncology Issues* 2002;17:15–17.
- Grosvenor M, Bulcavage L, Chlebowski RT. Symptoms potentially influencing weight loss in a cancer population. Correlations with primary site, nutritional status, and chemotherapy administration. *Cancer* 1989;63:330–334.
- Deitel M, To TB. Major intestinal complications of radiotherapy. Management and nutrition. *Arch Surg* 1987;122:1421–1424.
- Ravasco P, Monteiro-Grillo I, Vidal PM, Camilo ME. Dietary counseling improves patient outcomes: a prospective, randomized, controlled trial in colorectal cancer patients undergoing radiotherapy. *J Clin Oncol* 2005;23:1431–1438.
- Rock CL. Dietary counseling is beneficial for the patient with cancer. *J Clin Oncol* 2005;23:1348–1349.
- McGough C, Baldwin C, Frost G, Andreyev HJ. Role of nutritional intervention in patients treated with radiotherapy for pelvic malignancy. *Br J Cancer* 2004;90:2278–2287.
- Ornish D, Weidner G, Fair WR, et al. Intensive lifestyle changes may affect the progression of prostate cancer. *J Urol* 2005;174:1065–1069; discussion 1069–1070.
- Monsen ER. Dietary reference intakes for the antioxidant nutrients: vitamin C, vitamin E, selenium, and carotenoids. *J Am Diet Assoc* 2000;100:637–640.
- Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, DC: National Academy Press; 2000.
- Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington, DC: National Academy Press; 1997.
- Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline*. Washington, DC: National Academy Press; 1998.
- Labriola D, Livingston R. Possible interactions between dietary antioxidants and chemotherapy. *Oncology (Williston Park)* 1999;13:1003–1008; discussion 1008, 1011–1012.
- Lamson DW, Brignall MS. Antioxidants in cancer therapy; their actions and interactions with oncologic therapies. *Altern Med Rev* 1999;4:304–329.
- Prasad KN, Kumar A, Kochupillai V, Cole WC. High doses of multiple antioxidant vitamins: essential ingredients in improving the efficacy of standard cancer therapy. *J Am Coll Nutr* 1999;18:13–25.
- D'Andrea GM. Use of antioxidants during chemotherapy and radiotherapy should be avoided. *CA Cancer J Clin* 2005;55:319–321.
- Kucuk O, Ottery FD. Dietary supplements during cancer treatment. *Oncology Issues* 2002;17:22–30.
- Weiger WA, Smith M, Boon H, et al. Advising patients who seek complementary and alternative medical therapies for cancer. *Ann Intern Med* 2002;137:889–903.

29. Davies AA, Davey Smith G, Harbord R, et al. Nutritional interventions and outcome in patients with cancer or preinvasive lesions: systematic review. *J Natl Cancer Inst* 2006;98:961-973.
30. Courneya KS. Exercise in cancer survivors: an overview of research. *Med Sci Sports Exerc* 2003;35:1846-1852.
31. Schmitz KH, Holtzman J, Courneya KS, et al. Controlled physical activity trials in cancer survivors: a systematic review and meta-analysis. *Cancer Epidemiol Biomarkers Prev* 2005;14:1588-1595.
32. Knols R, Aaronson NK, Uebelhart D, et al. Physical exercise in cancer patients during and after medical treatment: a systematic review of randomized and controlled clinical trials. *J Clin Oncol* 2005;23:3830-3842.
33. Holtzman J, Schmitz K, Babes G, et al. Effectiveness of Behavioral Interventions to Modify Physical Activity Behaviors in General Populations and Cancer Patients and Survivors. Evidence Report/Technology Assessment No. 102 (Prepared by the Minnesota Evidence-based Practice Center, under Contract No. 290-02-0009.) AHRQ Publication No. 04-E027-2. Rockville, MD. Agency for Healthcare Research and Quality. June 2004.
34. Jones LW, Eves ND, Courneya KS, et al. Effects of exercise training on antitumor efficacy of doxorubicin in MDA-MB-231 breast cancer xenografts. *Clin Cancer Res* 2005;11:6695-6698.
35. Dahn JR, Penedo FJ, Molton I, et al. Physical activity and sexual functioning after radiotherapy for prostate cancer: beneficial effects for patients undergoing external beam radiotherapy. *Urology* 2005;65:953-958.
36. Demark-Wahnefried W, Kenyon AJ, Eberle P, et al. Preventing sarcopenic obesity among breast cancer patients who receive adjuvant chemotherapy: results of a feasibility study. *Clinical Exercise Physiology* 2002;4:44-49.
37. Sunga AY, Eberl MM, Oeffinger KC, et al. Care of cancer survivors. *Am Fam Physician* 2005;71:699-706.
38. Oeffinger KC, Hudson MM. Long-term complications following childhood and adolescent cancer: foundations for providing risk-based health care for survivors. *CA Cancer J Clin* 2004;54:208-236.
39. Ottery FD. Definition of standardized nutritional assessment and interventional pathways in oncology. *Nutrition* 1996;12(Suppl):S15-S19.
40. Von Roenn JH. Pharmacologic interventions for cancer-related weight loss. *Oncology Issues* 2002;17:18-21.
41. Coward DD. Supporting health promotion in adults with cancer. *Fam Community Health* 2006;29(Suppl):52S-60S.
42. Kushi LH, Byers T, Doyle C, et al. American Cancer Society guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin* 2006;56:254-281.
43. Department of Health and Human Services (HHS), Department of Agriculture (USDA). *Dietary Guidelines for Americans*, 2005. Washington, DC: US Government Printing Office; 2005.
44. World Cancer Research Fund/American Institute for Cancer Research. *Food, nutrition, and the prevention of cancer: a global perspective*. Washington, DC: American Institute for Cancer Research; 1997.
45. Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases. *Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation*. Geneva, Switzerland: World Health Organization; 2003.
46. Lichtenstein AH, Appel LJ, Brands M, et al. Diet and lifestyle recommendations revision 2006: a scientific statement from the American Heart Association Nutrition Committee. *Circulation* 2006;114:82-96.
47. August D. Nutrition and cancer: where are we going? *Top Clin Nutr* 2003;18:268-279.
48. Eyre H, Kahn R, Robertson RM. Preventing cancer, cardiovascular disease, and diabetes: a common agenda for the American Cancer Society, the American Diabetes Association, and the American Heart Association. *CA Cancer J Clin* 2004;54:190-207.
49. Vanio H, Bianchini F. *IARC Handbooks of Cancer Prevention. Volume 6: Weight Control and Physical Activity*. Lyon, France: International Agency for Research on Cancer; 2002.
50. Freedland SJ, Grubb KA, Yiu SK, et al. Obesity and risk of biochemical progression following radical prostatectomy at a tertiary care referral center. *J Urol* 2005;174:919-922.
51. Amling CL. Relationship between obesity and prostate cancer. *Curr Opin Urol* 2005;15:167-171.
52. Haydon AM, Macinnis RJ, English DR, Giles GG. Effect of physical activity and body size on survival after diagnosis with colorectal cancer. *Gut* 2006;55:62-67.
53. Meyerhardt JA, Giovannucci EL, Holmes MD, et al. Physical activity and survival after colorectal cancer diagnosis. *J Clin Oncol* 2006;24:3527-3534.
54. Meyerhardt JA, Heseltine D, Niedzwiecki D, et al. Impact of physical activity on cancer recurrence and survival in patients with stage III colon cancer: findings from CALGB 89803. *J Clin Oncol* 2006;24:3535-3541.
55. Holmes MD, Chen WY, Feskovich D, et al. Physical activity and survival after breast cancer diagnosis. *JAMA* 2005;293:2479-2486.
56. Gagnon B, Bruera E. A review of the drug treatment of cachexia associated with cancer. *Drugs* 1998;55:675-688.
57. Goldberg RM, Loprinzi CL. *Cancer Anorexia/Cachexia*, in von Gunten CF (ed). *Palliative Care and Rehabilitation of Cancer Patients*. Boston, MA: Kluwer Academic, 1999:31-41.
58. Maltoni M, Nanni O, Scarpi E, et al. High-dose progestins for the treatment of cancer anorexia-cachexia syndrome: a systematic review of randomized clinical trials. *Ann Oncol* 2001;12:289-300.
59. Brown JK. A systematic review of the evidence on symptom management of cancer-related anorexia and cachexia. *Oncol Nurs Forum* 2002;29:517-532.
60. McCarthy DO. Rethinking nutritional support for persons with cancer cachexia. *Biol Res Nurs* 2003;5:3-17.
61. Bruera E, Strasser F, Palmer JL, et al. Effect of fish oil on appetite and other symptoms in patients with advanced cancer and anorexia/cachexia: a double-blind, placebo-controlled study. *J Clin Oncol* 2003;21:129-134.
62. Winkler M. Body compositional changes in cancer cachexia: are they reversible? *Top Clin Nutr* 2004;19:85-94.
63. Deans C, Wigmore SJ. Systemic inflammation, cachexia and prognosis in patients with cancer. *Curr Opin Clin Nutr Metab Care* 2005;8:265-269.
64. Mirtallo J, Canada T, Johnson D, et al. Safe practices for parenteral nutrition. *JPEN J Parenter Enteral Nutr* 2004;28:S39-S70.
65. Maillat JO, Potter RL, Heller L. Position of the American Dietetic Association: ethical and legal issues in nutrition, hydration, and feeding. *J Am Diet Assoc* 2002;102:716-726.
66. Mokdad AH, Ford ES, Bowman BA, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA* 2003;289:76-79.
67. Cheng KK, Day NE. Nutrition and esophageal cancer. *Cancer Causes Control* 1996;7:33-40.
68. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. *N Engl J Med* 2003;348:1625-1638.
69. Carmichael AR, Bates T. Obesity and breast cancer: a review of the literature. *Breast* 2004;13:85-92.
70. van den Brandt PA, Spiegelman D, Yaun SS, et al. Pooled analysis of prospective cohort studies on height, weight, and breast cancer risk. *Am J Epidemiol* 2000;152:514-527.
71. Rock CL. Energy Balance and Cancer Prognosis: Colon, Prostate and Other Cancers, in McTiernan A (ed). *Physical Activity, Energy Balance, and Cancer: Etiology and Prognosis*. New York, NY: Marcel Dekker, Inc.; 2006:437-443.
72. Tartter PI, Slater G, Papatostas AE, Aufses AH Jr. Cholesterol, weight, height, Quetelet's index, and colon cancer recurrence. *J Surg Oncol* 1984;27:232-235.
73. Rock CL, Demark-Wahnefried W. Nutrition and survival after the diagnosis of breast cancer: a review of the evidence. *J Clin Oncol* 2002;20:3302-3316.
74. Amling CL. The association between obesity and the progression of prostate and renal cell carcinoma. *Urol Oncol* 2004;22:478-484.
75. Expert Panel on the Identification, Evaluation, and Treatment of Overweight in Adults. *Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: executive summary*. *Am J Clin Nutr* 1998;68:899-917.
76. Cummings S, Parham ES, Strain GW. Position of the American Dietetic Association: weight management. *J Am Diet Assoc* 2002;102:1145-1155.
77. Rolls BJ, Drewnowski A, Ledikwe JH. Changing the energy density of the diet as a strategy for weight management. *J Am Diet Assoc* 2005;105(Suppl 1):S98-S103.

78. Nestle M. Increasing portion sizes in American diets: more calories, more obesity. *J Am Diet Assoc* 2003;103:39–40.
79. Nielsen SJ, Popkin BM. Patterns and trends in food portion sizes, 1977–1998. *JAMA* 2003;289:450–453.
80. Rolls BJ, Morris EL, Roe LS. Portion size of food affects energy intake in normal-weight and overweight men and women. *Am J Clin Nutr* 2002;76:1207–1213.
81. Young LR, Nestle M. The contribution of expanding portion sizes to the US obesity epidemic. *Am J Public Health* 2002;92:246–249.
82. Institute of Medicine. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. Washington, DC: National Academy Press; 2002.
83. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA* 2001;285:2486–2497.
84. Rock CL. Diet and breast cancer: can dietary factors influence survival? *J Mammary Gland Biol Neoplasia* 2003;8:119–132.
85. Chlebowski RT, Blackburn GL, Buzzard IM, et al. Adherence to a dietary fat intake reduction program in postmenopausal women receiving therapy for early breast cancer. The Women's Intervention Nutrition Study. *J Clin Oncol* 1993;11:2072–2080.
86. Pierce JP, Faerber S, Wright FA, et al. A randomized trial of the effect of a plant-based dietary pattern on additional breast cancer events and survival: the Women's Healthy Eating and Living (WHEL) Study. *Control Clin Trials* 2002;23:728–756.
87. Chlebowski RT, Blackburn GL, Elshoff RE, et al. Dietary fat reduction in postmenopausal women with breast cancer: Phase III Women's Intervention Nutrition Study (WINS) (Abstract). 2005 ASCO Annual Meeting Proceedings. *J Clin Oncol* 2005;23:10. Abstract 10.
88. Kim DJ, Gallagher RP, Hislop TG, et al. Premorbid diet in relation to survival from prostate cancer (Canada). *Cancer Causes Control* 2000;11:65–77.
89. Fradet Y, Meyer F, Bairati I, et al. Dietary fat and prostate cancer progression and survival. *Eur Urol* 1999;35:388–391.
90. Gogos CA, Ginopoulos P, Salsa B, et al. Dietary omega-3 polyunsaturated fatty acids plus vitamin E restore immunodeficiency and prolong survival for severely ill patients with generalized malignancy: a randomized control trial. *Cancer* 1998;82:395–402.
91. Hardman WE. (n-3) fatty acids and cancer therapy. *J Nutr* 2004;134(Suppl):3427S–3430S.
92. MacLean CH, Newberry SJ, Mojica WA, et al. Effects of Omega-3 Fatty Acids on Cancer. Evidence Report/Technology Assessment No. 113. AHRQ Publication No. 05-E010-1. Rockville, MD: Agency for Healthcare Research and Quality. February 2005.
93. Tohill BC, Seymour J, Serdula M, et al. What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight. *Nutr Rev* 2004;62:365–374.
94. Slavin J. Why whole grains are protective: biological mechanisms. *Proc Nutr Soc* 2003;62:129–134.
95. Rock CL, Flatt SW, Natarajan L, et al. Plasma carotenoids and recurrence-free survival in women with a history of breast cancer. *J Clin Oncol* 2005;23:6631–6638.
96. Nagle CM, Purdie DM, Webb PM, et al. Dietary influences on survival after ovarian cancer. *Int J Cancer* 2003;106:264–269.
97. Chan JM, Holick CN, Leitzmann MF, et al. Diet after diagnosis and the risk of prostate cancer progression, recurrence, and death (United States). *Cancer Causes Control* 2006;17:199–208.
98. Colditz GA, DeJong W, Hunter DJ, et al. Harvard Report on Cancer Prevention, Vol. 1. Causes of human cancer. *Cancer Causes Control* 1996;7(Suppl 1):S3–S59.
99. Rimm E. Alcohol and cardiovascular disease. *Curr Atheroscler Rep* 2000;2:529–535.
100. Smith-Warner SA, Spiegelman D, Yaun SS, et al. Alcohol and breast cancer in women: a pooled analysis of cohort studies. *JAMA* 1998;279:535–540.
101. Bandera EV, Kushi LH. Alcohol and cancer, in Heber D, Blackburn GL, Go VL, Milner J (eds). *Nutritional Oncology*. 2nd ed. San Diego, CA: Academic Press; 2006:219–272.
102. Moe G. Low-microbial diets for patients with granulocytopenia, in Bloch AS (ed). *Nutrition Management of the Cancer Patient*. Rockville, MD: Aspen Publishers; 1990:125.
103. Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States, 1990–1997: results of a follow-up national survey. *JAMA* 1998;280:1569–1575.
104. Newman V, Rock CL, Faerber S, et al. Dietary supplement use by women at risk for breast cancer recurrence. The Women's Healthy Eating and Living Study Group. *J Am Diet Assoc* 1998;98:285–292.
105. McDavid K, Breslow RA, Radimer K. Vitamin/mineral supplementation among cancer survivors: 1987 and 1992 National Health Interview Surveys. *Nutr Cancer* 2001;41:29–32.
106. Rock CL, Newman VA, Neuhouser ML, et al. Antioxidant supplement use in cancer survivors and the general population. *J Nutr* 2004;134:3194S–3195S.
107. Reedy J, Haines PS, Steckler A, Campbell MK. Qualitative comparison of dietary choices and dietary supplement use among older adults with and without a history of colorectal cancer. *J Nutr Educ Behav* 2005;37:252–258.
108. Yates JS, Mustian KM, Morrow GR, et al. Prevalence of complementary and alternative medicine use in cancer patients during treatment. *Support Care Cancer* 2005;13:806–811.
109. Patterson RE, Neuhouser ML, Hedderson MM, et al. Changes in diet, physical activity, and supplement use among adults diagnosed with cancer. *J Am Diet Assoc* 2003;103:323–328.
110. Willett WC, Stampfer MJ. Clinical practice. What vitamins should I be taking, doctor? *N Engl J Med* 2001;345:1819–1824.
111. Fletcher RH, Fairfield KM. Vitamins for chronic disease prevention in adults: clinical applications. *JAMA* 2002;287:3127–3129.
112. Kennedy DD, Tucker KL, Ladas ED, et al. Low antioxidant vitamin intakes are associated with increases in adverse effects of chemotherapy in children with acute lymphoblastic leukemia. *Am J Clin Nutr* 2004;79:1029–1036.
113. The Alpha-Tocopherol, Beta Carotene Cancer Prevention Study Group. The effect of vitamin E and beta carotene on the incidence of lung cancer and other cancers in male smokers. *N Engl J Med* 1994;330:1029–1035.
114. Omenn GS, Goodman GE, Thornquist MD, et al. Effects of a combination of beta carotene and vitamin A on lung cancer and cardiovascular disease. *N Engl J Med* 1996;334:1150–1155.
115. Ziegler RG, Mayne ST, Swanson CA. Nutrition and lung cancer. *Cancer Causes Control* 1996;7:157–177.
116. Baron JA, Cole BF, Mott L, et al. Neoplastic and antineoplastic effects of beta-carotene on colorectal adenoma recurrence: results of a randomized trial. *J Natl Cancer Inst* 2003;95:717–722.
117. Hewitt M, Greenfield S, Stovall E. From Cancer Patient to Cancer Survivor: Lost in Transition. Committee on Cancer Survivorship: Improving Care and Quality of Life, Institute of Medicine and National Research Council. Washington, DC: The National Academies Press; 2006.
118. Monti DA, Yang J. Complementary medicine in chronic cancer care. *Semin Oncol* 2005;32:225–231.
119. Irwin ML, Crumley D, McTiernan A, et al. Physical activity levels before and after a diagnosis of breast carcinoma: the Health, Eating, Activity, and Lifestyle (HEAL) study. *Cancer* 2003;97:1746–1757.
120. Courneya KS, Friedenreich CM. Relationship between exercise pattern across the cancer experience and current quality of life in colorectal cancer survivors. *J Altern Complement Med* 1997;3:215–226.
121. Courneya KS, Friedenreich CM. Relationship between exercise during treatment and current quality of life among survivors of breast cancer. *J Psychosoc Oncol* 1997;15:35–57.
122. Courneya KS, Friedenreich CM. Framework PEACE: an organizational model for examining physical exercise across the cancer experience. *Ann Behav Med* 2001;23:263–272.
123. US Surgeon General. *Physical Activity and Health. A Report of the Surgeon General*. Atlanta, GA: US Dept of Health and Human Services; 1996.
124. Saarto T, Blomqvist C, Valimaki M, et al. Chemical castration induced by adjuvant cyclophosphamide, methotrexate, and fluorouracil chemotherapy causes rapid bone loss that is reduced by clodronate: a randomized study in premenopausal

- breast cancer patients. *J Clin Oncol* 1997;15:1341-1347.
125. Smith MR. Diagnosis and management of treatment-related osteoporosis in men with prostate carcinoma. *Cancer* 2003;97(Suppl):789-795.
126. McKenzie DC, Kalda AL. Effect of upper extremity exercise on secondary lymphedema in breast cancer patients: a pilot study. *J Clin Oncol* 2003;21:463-466.
127. Harris SR, Niesen-Vertommen SL. Challenging the myth of exercise-induced lymphedema following breast cancer: a series of case reports. *J Surg Oncol* 2000;74:95-98; discussion 98-99.
128. Ahmed RL, Thomas W, Yee D, Schmitz KH. Randomized controlled trial of weight training and lymphedema in breast cancer survivors. *J Clin Oncol* 2006;24:2765-2772.
129. Nieman DC. Is infection risk linked to exercise workload? *Med Sci Sports Exerc* 2000;32(Suppl):S406-S411.
130. Loi S, Milne RL, Friedlander ML, et al. Obesity and outcomes in premenopausal and postmenopausal breast cancer. *Cancer Epidemiol Biomarkers Prev* 2005;14:1686-1691.
131. Rose DP, Komninou D, Stephenson GD. Obesity, adipocytokines, and insulin resistance in breast cancer. *Obes Rev* 2004;5:153-165.
132. Enger SM, Greif JM, Polikoff J, Press M. Body weight correlates with mortality in early-stage breast cancer. *Arch Surg* 2004;139:954-958; discussion 58-60.
133. Enger SM, Bernstein L. Exercise activity, body size and premenopausal breast cancer survival. *Br J Cancer* 2004;90:2138-2141.
134. Stephenson GD, Rose DP. Breast cancer and obesity: an update. *Nutr Cancer* 2003;45:1-16.
135. Caan B, Sternfeld B, Gunderson E, et al. Life After Cancer Epidemiology (LACE) Study: a cohort of early stage breast cancer survivors (United States). *Cancer Causes Control* 2005;16:545-556.
136. Herman DR, Ganz PA, Petersen L, Greendale GA. Obesity and cardiovascular risk factors in younger breast cancer survivors: The Cancer and Menopause Study (CAMS). *Breast Cancer Res Treat* 2005;93:13-23.
137. Harvie MN, Campbell IT, Baidam A, Howell A. Energy balance in early breast cancer patients receiving adjuvant chemotherapy. *Breast Cancer Res Treat* 2004;83:201-210.
138. Camoriano JK, Loprinzi CL, Ingle JN, et al. Weight change in women treated with adjuvant therapy or observed following mastectomy for node-positive breast cancer. *J Clin Oncol* 1990;8:1327-1334.
139. Kroenke CH, Chen WY, Rosner B, Holmes MD. Weight, weight gain, and survival after breast cancer diagnosis. *J Clin Oncol* 2005;23:1370-1378.
140. Caan BJ, Emond JA, Natarajan L, et al. Post-diagnosis weight gain and breast cancer recurrence in women with early stage breast cancer. *Breast Cancer Res Treat* 2006;99:47-57.
141. Marinho LA, Rettori O, Vieira-Matos AN. Body weight loss as an indicator of breast cancer recurrence. *Acta Oncol* 2001;40:832-837.
142. Grunfeld E, Dhesis-Thind S, Levine M. Clinical practice guidelines for the care and treatment of breast cancer: follow-up after treatment for breast cancer (summary of the 2005 update). *CMAJ* 2005;172:1319-1320.
143. McTiernan A. Obesity and cancer: the risks, science, and potential management strategies. *Oncology (Williston Park)* 2005;19:871-881; discussion 881-882, 885-886.
144. Aslani A, Smith RC, Allen BJ, et al. Changes in body composition during breast cancer chemotherapy with the CMF-regimen. *Breast Cancer Res Treat* 1999;57:285-290.
145. Cheney CL, Mahloch J, Freeny P. Computerized tomography assessment of women with weight changes associated with adjuvant treatment for breast cancer. *Am J Clin Nutr* 1997;66:141-146.
146. Demark-Wahnefried W, Hars V, Conaway MR, et al. Reduced rates of metabolism and decreased physical activity in breast cancer patients receiving adjuvant chemotherapy. *Am J Clin Nutr* 1997;65:1495-1501.
147. Demark-Wahnefried W, Peterson BL, Winer EP, et al. Changes in weight, body composition, and factors influencing energy balance among premenopausal breast cancer patients receiving adjuvant chemotherapy. *J Clin Oncol* 2001;19:2381-2389.
148. Harvie MN, Howell A, Thatcher N, et al. Energy balance in patients with advanced NSCLC, metastatic melanoma and metastatic breast cancer receiving chemotherapy—a longitudinal study. *Br J Cancer* 2005;92:673-680.
149. Freedman RJ, Aziz N, Albanes D, et al. Weight and body composition changes during and after adjuvant chemotherapy in women with breast cancer. *J Clin Endocrinol Metab* 2004;89:2248-2253.
150. Schmitz KH, Ahmed RL, Hannan PJ, Yee D. Safety and efficacy of weight training in recent breast cancer survivors to alter body composition, insulin, and insulin-like growth factor axis proteins. *Cancer Epidemiol Biomarkers Prev* 2005;14:1672-1680.
151. McTiernan A, Ulrich C, Slate S, Potter J. Physical activity and cancer etiology: associations and mechanisms. *Cancer Causes Control* 1998;9:487-509.
152. Irwin ML, Yasui Y, Ulrich CM, et al. Effect of exercise on total and intra-abdominal body fat in postmenopausal women: a randomized controlled trial. *JAMA* 2003;289:323-330.
153. Pinto BM, Frierson GM, Rabin C, et al. Home-based physical activity intervention for breast cancer patients. *J Clin Oncol* 2005;23:3577-3587.
154. Smith-Warner SA, Spiegelman D, Adami HO, et al. Types of dietary fat and breast cancer: a pooled analysis of cohort studies. *Int J Cancer* 2001;92:767-774.
155. Kushi L, Giovannucci E. Dietary fat and cancer. *Am J Med* 2002;113(Suppl 9B):63S-70S.
156. Gandini S, Merzenich H, Robertson C, Boyle P. Meta-analysis of studies on breast cancer risk and diet: the role of fruit and vegetable consumption and the intake of associated micronutrients. *Eur J Cancer* 2000;36:636-646.
157. Smith-Warner SA, Spiegelman D, Yaun SS, et al. Intake of fruits and vegetables and risk of breast cancer: a pooled analysis of cohort studies. *JAMA* 2001;285:769-776.
158. Pierce JP, Newman VA, Flatt SW, et al. Telephone counseling intervention increases intakes of micronutrient- and phytochemical-rich vegetables, fruit and fiber in breast cancer survivors. *J Nutr* 2004;134:452-458.
159. Kroenke CH, Fung TT, Hu FB, Holmes MD. Dietary patterns and survival after breast cancer diagnosis. *J Clin Oncol* 2005;23:9295-9303.
160. Zhang S, Hunter DJ, Hankinson SE, et al. A prospective study of folate intake and the risk of breast cancer. *JAMA* 1999;281:1632-1637.
161. Rohan TE, Jain MG, Howe GR, Miller AB. Dietary folate consumption and breast cancer risk. *J Natl Cancer Inst* 2000;92:266-269.
162. Sellers TA, Kushi LH, Cerhan JR, et al. Dietary folate intake, alcohol, and risk of breast cancer in a prospective study of postmenopausal women. *Epidemiology* 2001;12:420-428.
163. Feigelson HS, Jonas CR, Robertson AS, et al. Alcohol, folate, methionine, and risk of incident breast cancer in the American Cancer Society Cancer Prevention Study II Nutrition Cohort. *Cancer Epidemiol Biomarkers Prev* 2003;12:161-164.
164. Zhang SM, Willett WC, Selhub J, et al. Plasma folate, vitamin B6, vitamin B12, homocysteine, and risk of breast cancer. *J Natl Cancer Inst* 2003;95:373-380.
165. Sellers TA, Alberts SR, Vierkant RA, et al. High-folate diets and breast cancer survival in a prospective cohort study. *Nutr Cancer* 2002;44:139-144.
166. McDonald PA, Williams R, Dawkins F, Adams-Campbell LL. Breast cancer survival in African American women: is alcohol consumption a prognostic indicator? *Cancer Causes Control* 2002;13:543-549.
167. Messina MJ, Loprinzi CL. Soy for breast cancer survivors: a critical review of the literature. *J Nutr* 2001;131(Suppl):3095S-3108S.
168. Kris-Etherton PM, Hecker KD, Bonanome A, et al. Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. *Am J Med* 2002;113(Suppl 9B):71S-88S.
169. Peeters PH, Keinan-Boker L, van der Schouw YT, Grobbee DE. Phytoestrogens and breast cancer risk. Review of the epidemiological evidence. *Breast Cancer Res Treat* 2003;77:171-183.
170. Petrakis NL, Barnes S, King EB, et al. Stimulatory influence of soy protein isolate on breast secretion in pre- and postmenopausal women. *Cancer Epidemiol Biomarkers Prev* 1996;5:785-794.
171. Brown BW, Brauner C, Minnotte MC. Noncancer deaths in white adult cancer patients. *J Natl Cancer Inst* 1993;85:979-987.
172. Howard BV, Van Horn L, Hsia J, et al. Low-fat dietary pattern and risk of cardiovascular disease: the Women's Health Initiative Randomized Controlled Dietary Modification Trial. *JAMA* 2006;295:655-666.

173. Potter JD. Nutrition and colorectal cancer. *Cancer Causes Control* 1996;7:127-146.
174. Slattery ML, Anderson K, Samowitz W, et al. Hormone replacement therapy and improved survival among postmenopausal women diagnosed with colon cancer (USA). *Cancer Causes Control* 1999;10:467-473.
175. Byers T. What can randomized controlled trials tell us about nutrition and cancer prevention? *CA Cancer J Clin* 1999;49:353-361.
176. Baron JA, Beach M, Mandel JS, et al. Calcium supplements for the prevention of colorectal adenomas. Calcium Polyp Prevention Study Group. *N Engl J Med* 1999;340:101-107.
177. Courneya KS, Friedenreich CM, Arthur K, Bobick TM. Physical exercise and quality of life in postsurgical colorectal cancer patients. *Psychology, Health and Medicine* 1999;4:181-187.
178. Courneya KS, Friedenreich CM, Quinney HA, et al. A randomized trial of exercise and quality of life in colorectal cancer survivors. *Eur J Cancer Care (Engl)* 2003;12:347-357.
179. Meloni G, Proia A, Capria S, et al. Obesity and autologous stem cell transplantation in acute myeloid leukemia. *Bone Marrow Transplant* 2001;28:365-367.
180. Coleman EA, Coon S, Hall-Barrow J, et al. Feasibility of exercise during treatment for multiple myeloma. *Cancer Nurs* 2003;26:410-419.
181. Dimeo F, Bertz H, Finke J, et al. An aerobic exercise program for patients with hematological malignancies after bone marrow transplantation. *Bone Marrow Transplant* 1996;18:1157-1160.
182. Dimeo FC, Tilmann MH, Bertz H, et al. Aerobic exercise in the rehabilitation of cancer patients after high dose chemotherapy and autologous peripheral stem cell transplantation. *Cancer* 1997;79:1717-1722.
183. Hayes SC, Rowbottom D, Davies PS, et al. Immunological changes after cancer treatment and participation in an exercise program. *Med Sci Sports Exerc* 2003;35:2-9.
184. Hayes S, Davies PS, Parker T, et al. Quality of life changes following peripheral blood stem cell transplantation and participation in a mixed-type, moderate-intensity, exercise program. *Bone Marrow Transplant* 2004;33:553-558.
185. Vallance JK, Courneya KS, Jones LW, Reiman T. Differences in quality of life between non-Hodgkin's lymphoma survivors meeting and not meeting public health exercise guidelines. *Psychooncology* 2005;14:979-991.
186. Jones LW, Courneya KS, Vallance JK, et al. Association between exercise and quality of life in multiple myeloma cancer survivors. *Support Care Cancer* 2004;12:780-788.
187. Oldervoll LM, Kaasa S, Knobel H, Loge JH. Exercise reduces fatigue in chronic fatigued Hodgkins disease survivors-results from a pilot study. *Eur J Cancer* 2003;39:57-63.
188. Weisdorf SA, Lysne J, Wind D, et al. Positive effect of prophylactic total parenteral nutrition on long-term outcome of bone marrow transplantation. *Transplantation* 1987;43:833-838.
189. Lenssen P, Sherry ME, Cheney CL, et al. Prevalence of nutrition-related problems among long-term survivors of allogeneic marrow transplantation. *J Am Diet Assoc* 1990;90:835-842.
190. Rowe JM, Ciobanu N, Ascensao J, et al. Recommended guidelines for the management of autologous and allogeneic bone marrow transplantation. A report from the Eastern Cooperative Oncology Group (ECOG). *Ann Intern Med* 1994;120:143-158.
191. Lipkin AC, Lenssen P, Dickson BJ. Nutrition issues in hematopoietic stem cell transplantation: state of the art. *Nutr Clin Pract* 2005;20:423-439.
192. Murray SM, Pindoria S. Nutrition support for bone marrow transplant patients. *Cochrane Database Syst Rev* 2002;CD002920. Available at: [http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=12076459](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=12076459). Accessed September 27, 2006.
193. Clark LC, Combs GF Jr, Turnbull BW, et al. Effects of selenium supplementation for cancer prevention in patients with carcinoma of the skin. A randomized controlled trial. Nutritional Prevention of Cancer Study Group. *JAMA* 1996;276:1957-1963.
194. Karp DD, Eastern Cooperative Oncology Group. Phase III Randomized Chemoprevention Study of Selenium in Participants With Previously Resected Stage I Non-Small Cell Lung Cancer (ECOG-5597). Clinical trial, Active. Bethesda, MD: National Cancer Institute; 2005.
195. Sun AS, Yeh HC, Wang LH, et al. Pilot study of a specific dietary supplement in tumor-bearing mice and in stage IIIB and IV non-small cell lung cancer patients. *Nutr Cancer* 2001;39:85-95.
196. Sun AS, Ostadal O, Ryznar V, et al. Phase I/II study of stage III and IV non-small cell lung cancer patients taking a specific dietary supplement. *Nutr Cancer* 1999;34:62-69.
197. Evans WK, Nixon DW, Daly JM, et al. A randomized study of oral nutritional support versus ad lib nutritional intake during chemotherapy for advanced colorectal and non-small-cell lung cancer. *J Clin Oncol* 1987;5:113-124.
198. Ovesen L, Allingstrup L. Different quantities of two commercial liquid diets consumed by weight-losing cancer patients. *JPEN J Parenter Enteral Nutr* 1992;16:275-278.
199. Ovesen L, Allingstrup L, Hannibal J, et al. Effect of dietary counseling on food intake, body weight, response rate, survival, and quality of life in cancer patients undergoing chemotherapy: a prospective, randomized study. *J Clin Oncol* 1993;11:2043-2049.
200. Kolonel LN, Nomura AM, Cooney RV. Dietary fat and prostate cancer: current status. *J Natl Cancer Inst* 1999;91:414-428.
201. Cohen JH, Kristal AR, Stanford JL. Fruit and vegetable intakes and prostate cancer risk. *J Natl Cancer Inst* 2000;92:61-68.
202. Meyer F, Bairati I, Shadmani R, et al. Dietary fat and prostate cancer survival. *Cancer Causes Control* 1999;10:245-251.
203. Giovannucci E. Tomatoes, tomato-based products, lycopene, and cancer: review of the epidemiologic literature. *J Natl Cancer Inst* 1999;91:317-331.
204. Miller EC, Hadley CW, Schwartz SJ, et al. Lycopene, tomato products and prostate cancer prevention. Have we established causality? *Pure Applied Chemistry* 2002;74:1435-1441.
205. Demark-Wahnefried W, Price DT, Polascik TJ, et al. Pilot study of dietary fat restriction and flaxseed supplementation in men with prostate cancer before surgery: exploring the effects on hormonal levels, prostate-specific antigen, and histopathologic features. *Urology* 2001;58:47-52.
206. Giovannucci E, Rimm EB, Wolk A, et al. Calcium and fructose intake in relation to risk of prostate cancer. *Cancer Res* 1998;58:442-447.
207. Beer TM, Eilers KM, Garzotto M, et al. Weekly high-dose calcitriol and docetaxel in metastatic androgen-independent prostate cancer. *J Clin Oncol* 2003;21:123-128.
208. Beer TM, Lemmon D, Lowe BA, Henner WD. High-dose weekly oral calcitriol in patients with a rising PSA after prostatectomy or radiation for prostate carcinoma. *Cancer* 2003;97:1217-1224.
209. Heinonen OP, Albanes D, Virtamo J, et al. Prostate cancer and supplementation with alpha-tocopherol and beta-carotene: incidence and mortality in a controlled trial. *J Natl Cancer Inst* 1998;90:440-446.
210. Clark LC, Dalkin B, Krongrad A, et al. Decreased incidence of prostate cancer with selenium supplementation: results of a double-blind cancer prevention trial. *Br J Urol* 1998;81:730-734.
211. Southwest Oncology Group, National Cancer Institute (NCI), National Center for Complementary and Alternative Medicine (NCCAM), Eastern Cooperative Oncology Group, Cancer and Leukemia Group B, National Cancer Institute of Canada. Phase III Randomized Study of Selenium and Vitamin E for the Prevention of Prostate Cancer (SELECT Trial) (Protocol ID SWOG-50000). Bethesda, MD: National Cancer Institute (NCI); 2005.
212. Roswell Park Cancer Institute. Phase II Randomized Study of Selenium in Patients Undergoing Brachytherapy for Stage I or II Prostate Cancer (RPCI-I-14603). Bethesda, MD: National Cancer Institute (NCI); 2006.
213. Chen H, Miller BA, Giovannucci E, Hayes RB. Height and the survival of prostate cancer patients. *Cancer Epidemiol Biomarkers Prev* 2003;12:215-218.
214. Freedland SJ, Aronson WJ, Kane CJ, et al. Impact of obesity on biochemical control after radical prostatectomy for clinically localized prostate cancer: a report by the Shared Equal Access Regional Cancer Hospital database study group. *J Clin Oncol* 2004;22:446-453.
215. Segal RJ, Reid RD, Courneya KS, et al. Resistance exercise in men receiving androgen deprivation therapy for prostate cancer. *J Clin Oncol* 2003;21:1653-1659.
216. Windsor PM, Nicol KF, Potter J. A randomized, controlled trial of aerobic exercise for treatment-related fatigue in men receiving radical external beam radiotherapy for localized prostate carcinoma. *Cancer* 2004;101:550-557.
217. Marshall JR, Boyle P. Nutrition and oral cancer. *Cancer Causes Control* 1996;7:101-111.

218. Kono S, Hirohata T. Nutrition and stomach cancer. *Cancer Causes Control* 1996;7:41-55.
219. Michaud DS, Giovannucci E, Willett WC, et al. Physical activity, obesity, height, and the risk of pancreatic cancer. *JAMA* 2001;286:921-929.
220. Mayne ST, Cartmel B, Baum M, et al. Randomized trial of supplemental beta-carotene to prevent second head and neck cancer. *Cancer Res* 2001;61:1457-1463.
221. Bauer J, Capra S, Battistutta D, et al. Compliance with nutrition prescription improves outcomes in patients with unresectable pancreatic cancer. *Clin Nutr* 2005;24:998-1004.
222. Moses AW, Slater C, Preston T, et al. Reduced total energy expenditure and physical activity in cachectic patients with pancreatic cancer can be modulated by an energy and protein dense oral supplement enriched with n-3 fatty acids. *Br J Cancer* 2004;90:996-1002.
223. Barber MD. Cancer cachexia and its treatment with fish-oil-enriched nutritional supplementation. *Nutrition* 2001;17:751-755.
224. Chabot J, Herbert Irving Comprehensive Cancer Center at Columbia University. Prospective Cohort Study of Gemcitabine Versus Intensive Pancreatic Proteolytic Enzyme Therapy With Ancillary Nutritional Support (Gonzalez Regimen) in Patients With Stage II, III, or IV Adenocarcinoma of the Pancreas, CPMC-IRB-8544, Clinical trial, Closed. 2006.
225. Gordon JN, Trebble TM, Ellis RD, et al. Thalidomide in the treatment of cancer cachexia: a randomised placebo controlled trial. *Gut* 2005;54:540-545.
226. Campbell BH, Spinelli K, Marbella AM, et al. Aspiration, weight loss, and quality of life in head and neck cancer survivors. *Arch Otolaryngol Head Neck Surg* 2004;130:1100-1103.
227. Rademaker AW, Vonesh EF, Logemann JA, et al. Eating ability in head and neck cancer patients after treatment with chemoradiation: a 12-month follow-up study accounting for dropout. *Head Neck* 2003;25:1034-1041.
228. Gabor S, Renner H, Matzi V, et al. Early enteral feeding compared with parenteral nutrition after oesophageal or oesophagogastric resection and reconstruction. *Br J Nutr* 2005;93:509-513.
229. McNeely ML, Parliament MB, Courneya KS, Haykowsky M. Resistance exercise for post neck dissection shoulder pain: three case reports. *Physiother Theory Pract* 2004;20:41-56.
230. McNeely ML, Parliament M, Courneya KS, et al. A pilot study of a randomized controlled trial to evaluate the effects of progressive resistance exercise training on shoulder dysfunction caused by spinal accessory neurapraxia/neurectomy in head and neck cancer survivors. *Head Neck* 2004;26:518-530.
231. Rogers LQ, Courneya KS, Robbins KT, et al. Physical activity and quality of life in head and neck cancer survivors. *Support Care Cancer* 2006;14:1012-1019.
232. Dikshit RP, Boffetta P, Bouchardy C, et al. Lifestyle habits as prognostic factors in survival of laryngeal and hypopharyngeal cancer: a multicentric European study. *Int J Cancer* 2005;117:992-995.
233. Wood K. Audit of nutritional guidelines for head and neck cancer patients undergoing radiotherapy. *J Hum Nutr Diet* 2005;18:343-351.
234. Cawley MM, Benson LM. Current trends in managing oral mucositis. *Clin J Oncol Nurs* 2005;9:584-592.
235. Willett WC. Micronutrients and cancer risk. *Am J Clin Nutr* 1994;59(Suppl):1162S-1165S.
236. Meyskens FL Jr, Szabo E. Diet and cancer: the disconnect between epidemiology and randomized clinical trials. *Cancer Epidemiol Biomarkers Prev* 2005;14:1366-1369.
237. NIH Consensus Development Program: State-of-the-Science Conference Statement: Multivitamin/mineral supplements and chronic disease prevention (draft statement). National Institutes of Health; 2006. Available at: <http://consensus.nih.gov/2006/MVMDRAFT051706.pdf>. Accessed September 30, 2006.
238. Kolonel LN. Fat, meat, and prostate cancer. *Epidemiol Rev* 2001;23:72-81.
239. Sandhu MS, White IR, McPherson K. Systematic review of the prospective cohort studies on meat consumption and colorectal cancer risk: a meta-analytical approach. *Cancer Epidemiol Biomarkers Prev* 2001;10:439-446.
240. Norat T, Lukanova A, Ferrari P, Riboli E. Meat consumption and colorectal cancer risk: dose-response meta-analysis of epidemiological studies. *Int J Cancer* 2002;98:241-256.
241. Fruits and Vegetables. Vol. 8. Lyon, France: International Agency for Research on Cancer, World Health Organization; 2003.
242. Duyff RL. The American Dietetic Association's Complete Food and Nutrition Guide. Hoboken, NJ: John Wiley & Sons; 2006.
243. American Dietetic Association, Dietitians of Canada. Position of the American Dietetic Association and Dietitians of Canada: Vegetarian diets. *J Am Diet Assoc* 2003;103:748-765.
244. Shannon J, White E, Shattuck AL, Potter JD. Relationship of food groups and water intake to colon cancer risk. *Cancer Epidemiol Biomarkers Prev* 1996;5:495-502.